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ISYDE2023

Italian Symposium on
DIGITAL EDUCATION

Reggio Emilia, 13 - 15 September 2023

Innovating Teaching & Learning.
Inclusion and Wellbeing for the Data Society

Tommaso MINERVA & Annamaria DE SANTIS (Eds.)

Conference PROCEEDINGS

Pearson

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Preface

ISYDE, *Italian SYmposium on Digital Education*, is the yearly conference organized by the *Italian e-Learning Society* (SIe-L, https://www.sie-l.it/) in line with previous conferences (EMEMITALIA and SIEL), whose organization was interrupted by the COVID-19 pandemic.

As it resumes its conference activities, SIe-L aims to broaden the focus from *e-Learning* and media education to *Digital Education* in a wider meaning as a concern emerging from recent years' experiences.

ISYDE addresses and debates the major transformations induced by technologies in the processes of training, learning, continuing education and knowledge construction as well as citizenship and interpersonal relations.

The 2023 edition focused on "Innovating Teaching & Learning. Inclusion and Wellbeing for the Data Society".

As always alongside the pinning down of the main thread, the conference served as a meeting point and sounding board for the research, experiences, developments and technological applications that are fostering development in the following significant, though not exhaustive, subject areas: AI in Education; Digital Citizenship; Blended Learning; Career Development and Training; Collaboration Projects and Networks; Computer Supported Collaboration; Digital Inclusion; Data Literacy & Education; Digital Literacy; Digital mediated diseases and behavioral risks; Digital Wellness; Distance Learning in Times of Crisis; e-Content Management and Development; Educational Software & Serious Games; e-Learning; Emerging Technologies in Education; Experiences in Education and Research; Faculty Development and Higher Education; Gaming and Gamification in Education; Learning Spaces; Pedagogical Innovations in Education; Post-Digital Education; Third Spaces Literacies; Trends and Issues in Education.

Topics refer to application areas, including: University; School; Continuing Education; Public Administration; Health Care; Society; Culture; Technology Use, Integration, and Development; Business.

The conference was held at the University of Modena and Reggio Emilia (Italy) from September 13 to 15, 2023.

Participants presented more than 50 contributions in ten Sessions that we merged into four Sections in the proceedings:

- Artificial Intelligence and Analytics (7);
- Design (5);
- Games, Social Networks, and Virtual/Augmented Reality (8);
- Scenarios, Experiences, and Research Reports (12).

The conference, as also shown in the Plenary Sessions, prepared the ground for the process of innovation of higher and lifelong education toward the design and establishment of nationwide *Digital Education Hubs*, which represent the new challenge faced by Italian universities.

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Artificial Intelligence and Analytics

Assessing AI Literacy: a framework-based approach

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Abstract

Artificial Intelligence (AI) has the potential to transform various aspects of our lives, but its rapid development is posing several concerns related to its application in increasingly more aspects of daily life. To make informed decisions and fully comprehend AI and its implications, a solid understanding of its underlying mechanisms and awareness of its benefits and drawbacks are crucial. This article presents the development process of a questionnaire designed to assess AI literacy in high-education context. The questionnaire adopts a framework-based approach based upon most recent literature findings. The questionnaire was developed to be administered to doctoral students in the Doctorate Program on Learning Sciences and Digital Technologies. Guided by a comprehensive framework encompassing cognitive, operational, critical, and ethical dimensions, the questionnaire aims at assessing participants' awareness and understanding of AI. The questionnaire includes over 60 items, covering a wide range of AI topics. Each item aligns with specific dimensions of the framework, assessing participants' knowledge, application, critical thinking, and ethical considerations about AI. The questionnaire, grounded upon an extensive literature review, and complemented with specific questions related to AI in education, is now undergoing several key steps, to be validated, tested and released as an effective tool to comprehensively assess AI literacy.

Keywords: Artificial Intelligence, AI Literacy, AI Awareness Assessment, Education, Ethics.

1. Introduction

Artificial Intelligence (AI) is a rapidly evolving field that is showing its potential to transform many aspects of our lives, from healthcare and transportation to education and entertainment (JRC, OECD, & UNESCO, 2021; OECD, 2019; WIPO, 2019). However, the development of AI is not without controversy, and concerns have been raised about the possible ethical implications (Floridi et al., 2018; UNESCO, 2019; UNICEF, 2021; Zhang et al., 2022). In order to fully comprehend its evolution and application, it is essential to have a thorough understanding of the underlying principles and algorithms of AI (Cuomo et al., 2022). It is also crucial to cultivate a broad awareness and comprehension of the technological aspects, as well as both AI potential benefits and drawbacks (Gašević et al., 2023; Selwyn, 2022) to develop and implement AI taking into consideration ethical issues and human well-being.

In this context, this article aims to present the developmental process of a questionnaire designed to assess AI literacy in higher-education contexts. Although a common definition of AI literacy is not currently available (Cuomo et al., 2022; Kong & Zhang, 2023), it is widely recognized its importance to ensure individuals are equipped with skills to understand, navigate, and contribute to society where AI and its applications play an increasingly pervasive role. AI literacy aims at fostering responsible AI uses, addresses ethical concerns, reduces inequalities, nurtures adaptability, and enables informed decision-making. AI literacy can contribute – together with wider intended policies – to harnessing the transformative potential of AI, while safeguarding human values and promoting a more inclusive and equitable future (Selwyn, 2023; Wilton et al., 2022). Indeed, for an open and democratic discussion around the role of AI in our society, we need more literate citizens that are able to confront such challenging issues (Floridi, 2021).

2. Background

As mentioned in the introduction, the applications of AI are becoming increasingly numerous and pervasive. It can be difficult for both the typical user and the expert to detect the line between their cognitive talents and those provided by an AI program, due to the inherent "mimetic" character of human behavior. The aforementioned factors can readily lead to ethical dilemmas even without considering futuristic possibilities (Mockander, 2022). These problems highlight how critical the issue of AI literacy and required competencies is. However, there are several factors making it far from easy to define the concept of AI literacy. The challenge is primarily linked to the lack of a generally accepted definition of the idea of AI, or the subject matter for which literacy should be practiced. There are various research traditions within the subject of AI as well as various interpretations of AI that vary in strength, as we have previously seen. Secondly, as a result of the "digital turn" (Mills, 2010), the idea of literacy has also experienced a substantial development (Cappello, 2017; Ranieri, 2019). Particularly, the dispute over the definition of literacy has focused on two significant schools of thought since the second half of the 20th century, each of which defines literacy as either a "set of cognitive skills" or a "situated social practice" (Street, 2003).

Long and Magerko (2020) introduced the subject and offered a preliminary description of AI literacy, emphasizing the capability to assess and make use of AI as well as to interact and work with it. They put out a list of skills that served as the basis for further investigation. Based on this list, Heyder and Posegga (2021) determined that, in addition to a technical component, AI literacy also has important societal components. Using categories like TPACK (Technological, Pedagogical, and Content Knowledge) (Ng et al., 2021) as a foundation, others discriminate between technical aspects and non-technical, content-focused components. This classification into a technical and a social portion, which was determined by a literature review, is further supported by the implicit division of AI literacy (Cetindamar et al., 2022). In conclusion, the segmentation topic in the literature distinguishes between the technical component – the AI and the social one – the social environment, which includes cultural, content-focused, and additional non-technical components of AI. The manner in which users interact with the particular AI further subdivides AI literacy (Wang et al., 2022; Ng et al., 2021). For instance, humans can utilize or create AI, which represents two distinct sorts of interaction and calls for separate sets of skills.

Even if there is no agreement on the definition of AI literacy, various attempts have been undertaken to construct measurement tools for capturing its dimensions. These tools mostly deal with some components of AI (e.g., affective or collaboration), overlooking the concept of AI literacy in its inherent complexity (Laupichler et al., 2023). Illustrative instances for this phenomenon encompass the "Attitudes Towards Artificial Intelligence Scale" (Sindermann et al., 2021), the "General Attitudes Towards Artificial Intelligence Scale" (Schepman & Rodway, 2022), and the "Artificial Intelligence Anxiety Scale" (Wang & Wang, 2022). To overcome this limitation, we first developed an AI literacy multidimensional framework, grounded on a wide review of the literature (Cuomo et al., 2022). Subsequently, we created a questionnaire involving either items from preexisting assessment tools and new or adapted items, that were framed within the original AI literacy framework we elaborated. In the next two paragraphs, we provide additional details starting with the construction of the framework.

The availability of a general method capable of measuring AI literacy may provide helpful insights into the effectiveness of educational interventions. By encompassing the multidimensional nature of literacies (Cappello, 2017; Ranieri, 2019), and AI literacy in specific, this universally applicable scale could be a valuable tool for researchers and educators in assessing and enhancing AI literacy across diverse contexts. To this end additional, specific questions have been included to explore participants' perceptions of AI in the field of education.

3. Methodology

The creation and assessment of a scale to gauge AI literacy is the primary aim of the study here presented. Questionnaire-based survey methods are extensively employed in social science, business management, and clinical research to gather quantitative data from consumers, customers, and patients

(Aithal & Aithal, 2020). This article outlines the process of designing and developing an empirical questionnaire developing such a scale in accordance with well-established systematic and rigorous methodologies (DeVellis, 2016). Following these recommendations, we established a four- step study plan to create a measurement tool: clearly define the construct to measure, generate the item pool, determine the scale for measurement, administer items to a development sample for the evaluation of the items (Figure 1).

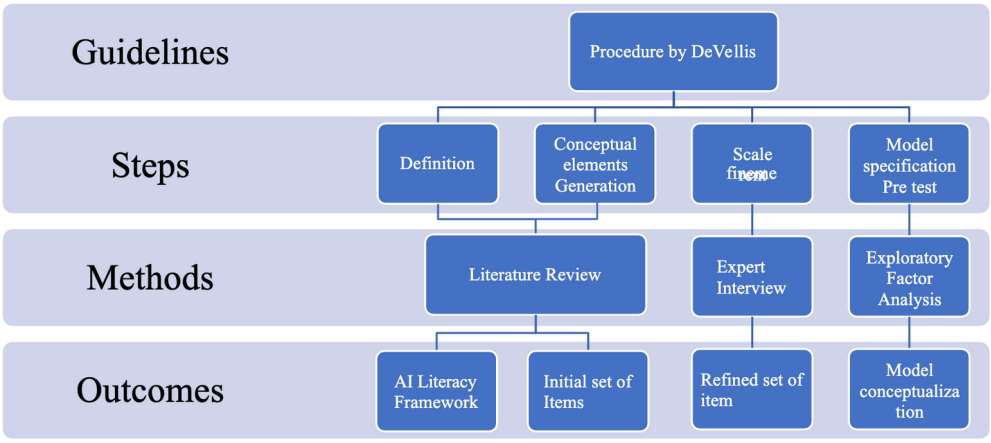

Figure 1 - Research Design of the AI literacy questionnaire.

Having established a foundational framework for the AI literacy (Cuomo et al., 2022), our journey progressed towards a more empirical and structured measurement model. Recognizing the need for a nuanced and comprehensive construct, we initially dove deep into our pre-existing knowledge base, refining the broad themes of AI competences through an extensive literature review (step 1). This set the stage for the next step (step 2), where we formulated specific conceptual elements aligned with each identified dimension of our AI literacy model. To ensure the robustness and relevance of these items, we engaged with experts, leveraging their insights and feedback, further strengthening the content validity (step 3). As we transitioned into the final phase (step 4), we detailed a rigorous measurement model, punctuated by a pre-test study to gauge its preliminary efficacy. In the following, we elaborate on each step of the scale development process.

3.1 Definition of the focal measurement constructs (step 1)

The relevant dimensions to conceptually describe the idea of AI literacy have been determined after a thorough assessment of the literature. To ensure a diligent literature review, we followed established guidelines practiced by the PRISMA model (Moher, 2009). Aside from reliable sources like the European Commission (2018, 2019, 2020, 2021), the Joint Research Center (JRC, 2018), and the Organization for Economic Co-operation and Development (OECD, 2018a, 2018b, 2018c), this review also drew on seminal works by authors like Floridi, Ng, and Selwyn. Based on this assessment of the literature and as discussed in the backdrop of the study, we referred to an existing framework for AI literacy (Cuomo et al., 2022) that is articulated along four dimensions: cognitive, operational, critical, and ethical.

Figure 2 summarizes the procedure.

As anticipated, for identifying the meaningful dimensions to conceptually represent the notion of AI literacy, a thorough review of literature has been carried out, incorporating insights from seminal works such as the contributions by Floridi, Ng and Selwyn, among others, and authoritative sources such as the European Commission (2018, 2019, 2020, 2021), the Joint Research Centre (JRC, 2018), the Organisation for Economic Co-operation and Development (OECD, 2018a, 2018b, 2021), the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2019a, 2019b, 2021), the United Nations Children's Fund (UNICEF, 2020, 2021a, 2021b).

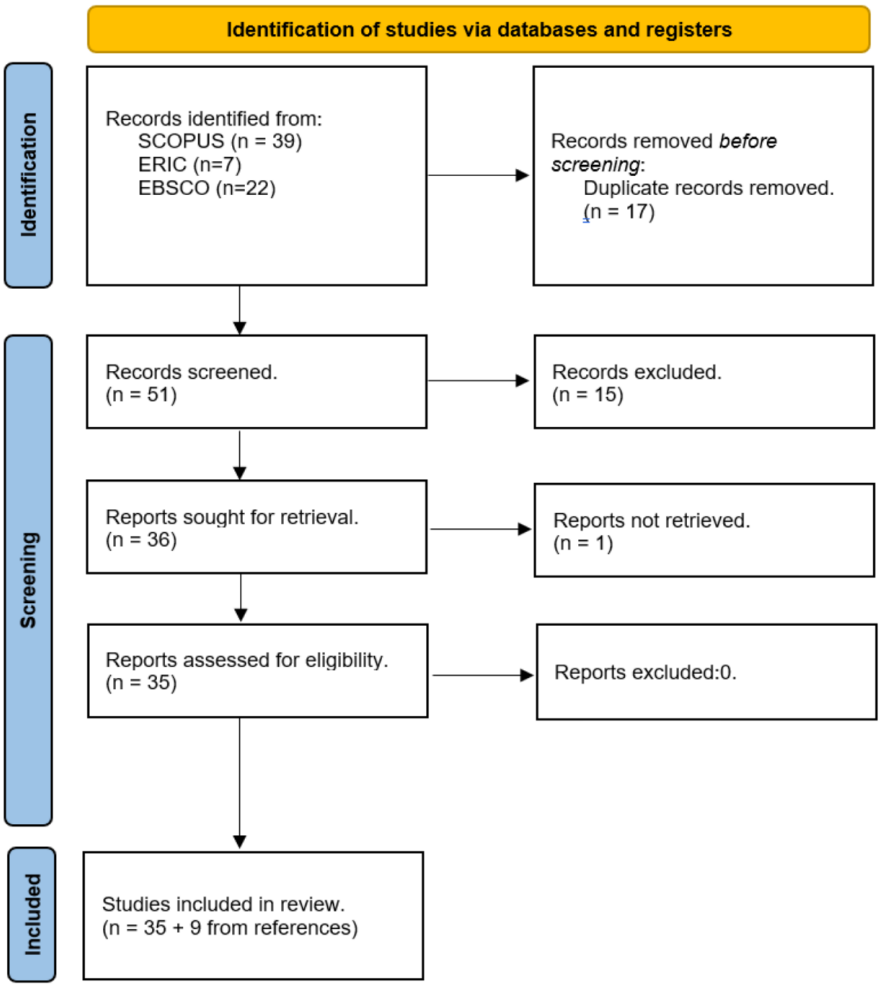

Figure 2 - PRISMA model for the review.

Through the review, we were also able to revise the different tools already adopted to evaluate the different elements of AI literacy (see point 3.2 "Item Generation"). On this ground, we elaborated a questionnaire to appraise participants' AI literacy by measuring their awareness across various aspects related to the cognitive, operational, critical and ethical aspects. The questionnaire comprises more than 60 items, which cover the four dimensions of the framework. The framework indeed provided a structured outline for the questionnaire leading to an operationalization of the different dimensions and sub-dimensions, meaning that the abstract concepts were translated into specific, measurable variables or items for the questionnaire. In addition, each item was carefully crafted to be accessible to a specific public, that is higher education students.

3.1.1 AI Literacy Framework

As previously mentioned, the focal point of our measurement of constructs is a comprehensive framework, tackling the various components and interrelations at the center of AI understanding which is due to the complexity and multifaceted nature of AI literacy. Our earlier research put out a framework created by Cuomo and colleagues in 2022, consisting of four essential variables that combined cover the entire range of AI literacy. These factors work together to create a comprehensive prism through which AI literacy can be investigated, evaluated, and developed. They stress the importance of going beyond only consuming AI passively to a more active and responsible knowledge, providing a comprehensive, integrative method to addressing AI literacy.

To be more specific, the framework (Figure 3) is made up of four dimensions as described below:

- *Knowledge-related Dimension*: This dimension includes the comprehension of fundamental AI concepts, concentrating on fundamental behaviors and dispositions that don't necessitate prior technical expertise (Ng et al., 2021). It covers kinds of AI, machine learning fundamentals, and a range of AI applications like voice and vision recognition.
- *Operational Dimension*: This dimension emphasizes the capacity to design and implement algorithms, solve problems using AI tools, and develop simple AI applications to improve analytical and critical thinking (Kim et al., 2021). It is focused on applying AI concepts in a variety of contexts (Druga et al., 2019; Lee et al., 2021).
- *Critical Dimension:* This dimension emphasizes the significance of effective communication and collaboration with AI technologies as well as critical evaluation of their impact on society. It does this by highlighting AI's potential to engage students in cognitive, creative, and critical discernment activities (Su & Zhong, 2022).
- *Ethical Dimension*: Concerning the responsible and conscious use of AI technologies, this dimension stresses the balanced view of delicate ethical issues raised by AI, such as the delegation of personal decisions to a machine (e.g., job placement or therapeutic pathways), and emphasizes the growing attention towards "AI Ethics", encompassing transparency, fairness, responsibility, privacy, and security.

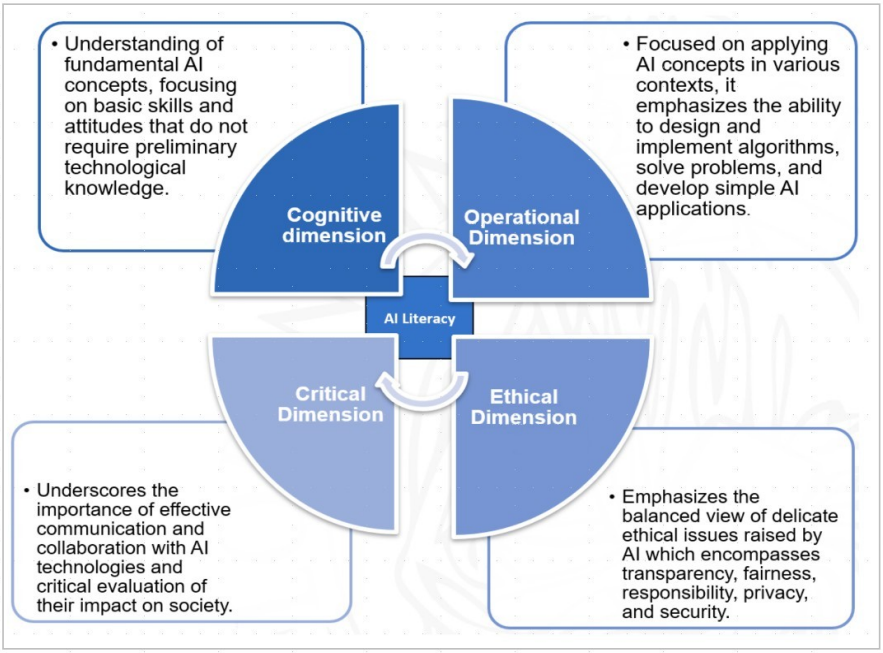

Figure 3 - AIL Framework (Cuomo et al., 2022).

Our research advances the field of empirical research on AI literacy by building on this multidimensional approach. As was already indicated, the available literature frequently concentrates on particular facets of AI or approaches AI literacy in a more segmented way. Our approach, on the other hand, provides a solid platform for a recently created questionnaire that is intended to delve into the nuanced layers of the cognitive, operational, critical, and ethical elements of AI. This theoretical framework's congruence with a useful assessment instrument represents a significant advancement in the discipline.

The questionnaire aims to assess AI literacy in a more comprehensive way by integrating these elements into a single instrument. It also aims to spark additional research and applications that acknowledge the depth and complexity of interacting with AI. We will go into detail about the design and methods of this innovative questionnaire in the part that follows, explaining how it captures the complete range of the AI literacy environment.

3.2 Conceptual elements generation (step 2)

We developed the conceptual elements for the AI literacy questionnaire using a multi-step procedure that combined literature analysis, consultation from experts, and brainstorming.

We started by thoroughly reviewing the body of prior studies on AI literacy. This made it simpler for us to choose which skills, ideas, and aspects of AI literacy be included in the survey. To confirm that our questionnaire matched generally accepted criteria and elements of AI literacy, we also looked at established frameworks and models used in the sector. In order to choose elements that may be modified to assess AI literacy as a result, we also looked at validated surveys on comparable themes, including technical competence or digital literacy (Table 1).

Table 1 - Existing surveys reviewed.

Name	*Author*	*Questionnaire purpose*	*Questionnaire Target*	*Validation process*	*N. of items*
Assessment of non-experts' AI literacy	(Laupichler et al., 2023)	Support the development of a scale for the assessment of AI literacy	Non-experts	Content validation but no factor loadings	38 items
Artificial Intelligence literacy scale (AILS scale)	(B. Wang et al., 2022)	Assess the self-report competence of users in using AI	AI Users (Expert and non-expert)	Complete validation (EFA, CFA, Reliability)	12 items
AI anxiety scale (AIAS scale)	(Y.-Y. Wang & Wang, 2022)	Develop a standardized tool to measure Ai anxiety	Citizens (Expert and non-expert)	Complete validation (EFA, CFA, Reliability)	21 items
Attitude Towards Artificial Intelligence (ATAI scale)	(Sindermann et al., 2021)	Trust in and Usage of Several Specific AI Products	Citizens (Expert and non-expert)	Complete validation (EFA, CFA, Reliability)	5 items
General Attitudes towards Artificial Intelligence Scale (GAAIS scale)	(Schepman & Rodway, 2020)	Inform legislators and organizations developing AI about their acceptance by the end users	Citizens (Expert and non-expert)	Complete validation (EFA, CFA, Reliability)	20 items

Prior to moving forward with the development of a preliminary draft of the questionnaire, we conducted a literature review that would allow us to analyze the existing research on the four dimensions that our questionnaire undertakes to investigate: knowledge-related, operational, critical, and ethical. We also analyzed the existing questionnaires on AI literacy issues. In order to analyze the institutional resources (such as the European Commission, JRC, OECD, UNESCO, UNICEF etc.) available to us, we first began by analyzing the literature on existing frameworks. From there, we moved on to a study of these papers in order to concentrate on an analysis of texts regarded as pivotal on AI subjects. It was only after that that we were able to create a final survey draft that could address a variety of AI-related knowledge, skills, attitudes, and behaviors that are pertinent in the quickly changing technological landscape of today.

A preliminary collection of 118 AI literacy conceptual elements was constructed, and relevant descriptors were gathered from multiple sources and compared.

We took great care to make sure the survey was both clear and pertinent while covering a wide range of AI literacy dimensions. Following this procedure, the initial scale was created, consisting of 34 conceptual elements on AI Ethical Dimension, 30 on AI Critical Dimension, 32 on AI Operational Dimension, and 22 on Knowledge-related Dimension (Table 2).

3.3 Scale refinement (step 3)

The literature suggests combining systematic literature reviews with expert interviews to find a set of prospective items with good validity (Moore & Benbasat, 1991). In order to find additional dimensions and elements of general AI literacy as well as to get input on the initial set of issues, we conducted open-ended expert interviews. We aimed for AI specialists with a variety of backgrounds and specialties since we took a general approach to AI literacy. We sought the aid of a group of

specialists (N = 5) in the fields of AI and educational assessment to ensure the face validity of the questionnaire. It is important to note that this study focused on a cognitive task that did not require an in-depth understanding of the phenomenon being studied, so the use of a small group of experts for content validity assessment was deemed appropriate (Anderson & Gerbing, 1991; Hinkin, 1998; Schriesheim et al., 1993). These professionals had a strong knowledge of the intended construct of the questionnaire and were well-versed in AI literacy. We gave them a draft of the questionnaire and asked for their input on the items' clarity, applicability, and relevance.

Table 2 - Initial scale results.

Framework Dimension	*Description*	*Sample question*	*Matrix option*	*Nr. of items*	*References*
Knowledge-related Dimension	Know how to use AI applications and its fundamental workings	When it comes to AI, I feel my knowledge on the subject would be:	Know and understand AI definitions and theoretical foundations	22	Cuomo et al, 2022; Ng et al, 2021; UNESCO, 2019a, 2019b, 2021.
			Know and understand AI basic mathematical functions behind the algorithm		
Operational Dimension	Using AI concepts, expertise, and applications in various contexts	In your opinion the following tasks could be supported by AI?	Supporting Emergency services	32	Cuomo et al 2022, Ng et al, 2021, Wang & Wang; JRC, 2018; OECD, 2018a, 2018b; UNESCO, 2019.
			News reporting		
			Emotional support		
Critical Dimension	AI applications for critical thinking abilities (such evaluating, appraising, predicting, and designing)	How much do you agree with the following statements?	Artificially intelligent systems make many errors.	30	Schepman & Rodway, 2022; Selwyn, 2022; Wang et al 2022; OECD, 2019; UNICEF, 2020.
			An artificially intelligent agent would be better than an employee in many routine jobs.		
Ethical Dimension	Human-centered factors (such as justice, responsibility, openness, ethics, and safety)	How much do you believe the following considerations affect the trustworthiness of AI?	Social Impact: the risk that AI will further concentrate power and wealth in the hands of the few.	34	European Commission 2018, 2019, 2020, 2021; Floridi 2018; Floridi et al, 2021; JRC & OECD, 2021; Sindermann et al, 2021; UNICEF, 2021a, 2021b; UNESCO, 2021.
			Democratic impact: the impact of AI technologies on democracies.		
			Work impact: Impact of AI on the labour market and how different demographic groups might be affected.		

The definitions were provided to each expert in order to guarantee that they all understood the four AI literacy constructs. The following steps made up the content approval procedure. Each item was carefully examined by the expert panel, who also offered insightful comments and recommendations for improvement. Any items that were ambiguous, repeated, or unrelated to the construct being measured were called out. Their input was crucial in helping to improve the questionnaire and make sure it accurately reflected AI literacy. Following the methodology promoted by Schriesheim et al. (1993), the experts were initially asked to classify each item into one of the four Cuomo et al. constructs (i.e., AI Knowledge, AI Applications, AI Critical Assessment, and AI Ethics). An item was deemed to clearly address a topic if at least four out of the five experts classified it in the same way. There were 118 total items; of those, 15 had incorrect or unclassified classifications from two expert, while 23 had classification errors from multiple experts. These components were therefore excluded from the study. 14 items were rephrased, 20 items related to the impact of AI in education were moved outside the main body of the questionnaire, and they became an appendix that can be used in educational contexts as a wider information section. This procedure left us with 60 items that were then improved, including their phrasing and format, by the experts' suggestions.

3.4 Model specification & pre-test (step 4)

Step 4 involved formalizing the measurement model and conducting a pre-test study in accordance with predetermined standards (DeVellis, 2016). By examining internal consistency and item loadings, we then evaluated the generic AI literacy measurement paradigm (Fornell & Larcker, 1981).

We conducted a pre-test study with 57 participants, doctoral students, a convenience sample, therefore neither probabilistic nor representative of the reference population, who were participating to an AI literacy course. To rate their level of agreement with the general construct items and dimension items on a 5-point Likert scale ranging from "None at all" to "A great deal". Participants were chosen from the doctorate students of the XXXVIII cycle of the Italian National Doctorate on Learning Sciences and Digital Technologies (University of Foggia) and of the Doctorate on Quality of Education (University of Florence), attending an AI Literacy course offered by the Department of Education, Languages and Psychology of the University of Florence. The questionnaire was administered on the online platform Qualtrics, and the data were gathered in April 2023.

The participants' (N = 57) ages ranged from 18 to 65, with the following distribution: 18-24 years (3 respondents, accounting for approximately 5.3%), 25-34 years (22 respondents, representing approximately 38.6%), 35-44 years (14 respondents, constituting approximately 24.6%), 45-54 years (15 respondents, making up approximately 26.3%), and 55-65 years (3 respondents, representing approximately 5.3%); the gender distribution was 37 (64.9%) female respondents, 18 (31.6%) male respondents, and 2 (3.5%) respondents who preferred not to disclose their gender; among the respondents, the distribution of the highest degree of education completed is as follows: University degree: 24 respondents, accounting for approximately 42.1%. Master's degree: 25 respondents, representing approximately 43.9%. Doctorate: 4 respondents, constituting approximately 7.0%. We deemed the sample adequate because our construct is intended to assess broad AI literacy. Although the sample size is at the lower end of the suggested range, we thought it was adequate for a pre-test of internal measurements.

Our initial model with four dimensions showed an overall good fit ($R^2 = 0.72$) and the reliability and validity of our survey were evaluated using Cronbach's alpha, McDonald's omega (McDonald, 1999), the composite reliability (CR), and the average variance extracted (AVE). Table 3 displays the results. The Cronbach's alpha for the survey was 0.937, and the scores for the four constructs were 0.902, 0.922, 0.910, and 0.911, respectively. The overall score of 0.937 indicates that the instrument as a whole is more reliable than the individual constructions, even though the reliabilities of all four constructs were higher than the 0.70 threshold. Fornell and Larcker's (1981) CR and AVE criteria were used to assess the scale's convergent validity. While CR levels of 0.70 and higher are considered to be good (Hair et al., 1998), the AVE, that compares a construct's variation to the variance brought on by measurement error, is considered appropriate demonstrating appropriate convergence at values higher than 0.5 (Hair et al., 1998). According to our scale, adequate convergence was indicated by CR values greater than 0.8 and AVE values greater than 0.5. Finally, item loadings were all above the recommended threshold of 0.70 (Figure 4) at a significance level of $p < 0.001$. Overall, the results indicate strong empirical support for the measurement model.

Table 3 - Results of Cronbach's Alpha, McDonald's Omega, AVE and CR.

Framework dimensions	*Cronbach's α*	*McDonald's ω*	*Average variance extracted*	*Composite Reliability*	*N. of elements*
AI Knowledge	0.903	0.911	0.536	0.902	8
AI Applications	0.906	0.914	0.501	0.922	12
AI Critical assessment	0.911	0.918	0.506	0.910	10
AI Ethics	0.916	0.921	0.511	0.911	10
Total	0.947	0.952	0.512	0.937	40

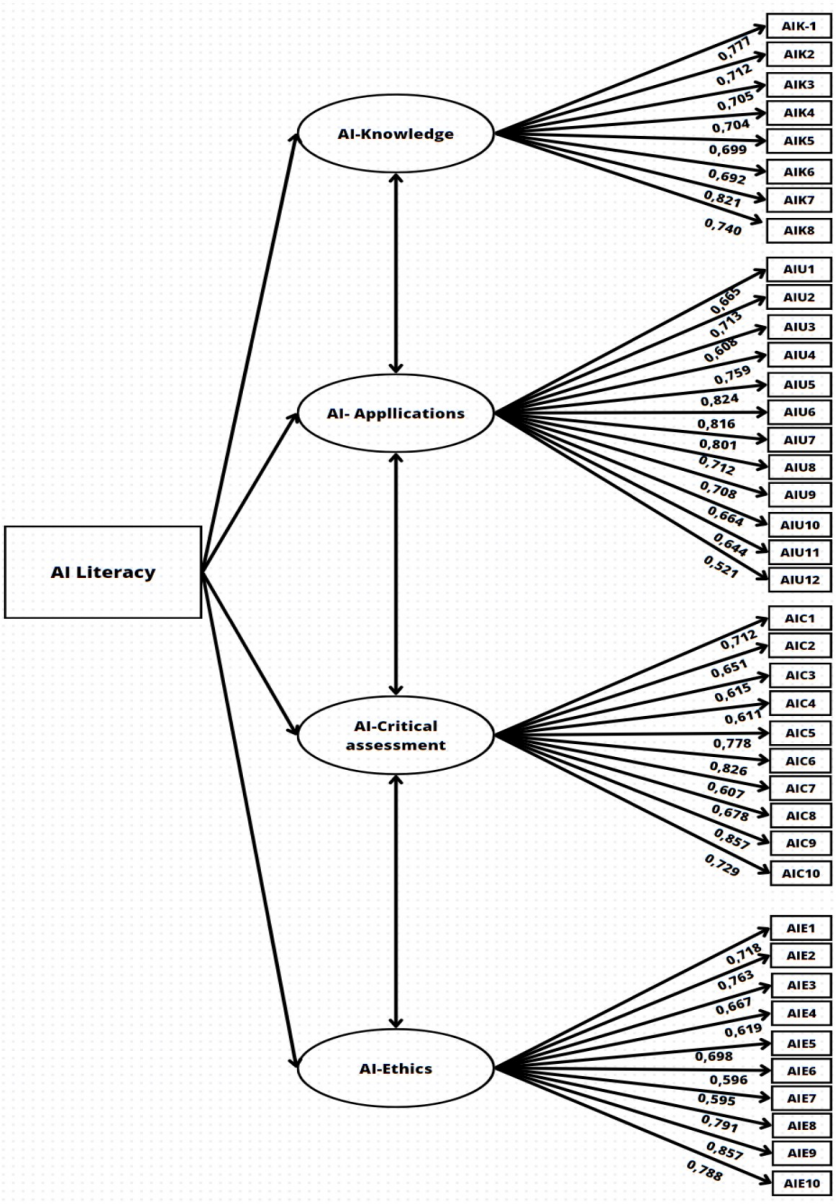

Figure 4 - Model for measuring AIL with factor loadings.

4. Discussion

The introduction of our conceptualization and measurement tool for general AI literacy marks an important juncture in both research and practical applications, especially in a landscape that's becoming increasingly shaped by AI. At the heart of our work is the aim to build upon and enrich existing AI competency frameworks. We have gone beyond merely replicating known models. By weaving in the intricacies and subtleties unique to AI, we've created an instrument that harmoniously integrates insights from well-established AI competency literature. It's not just rooted in theory; it has been put to the test and validated empirically, making sure we're capturing AI literacy in its depth and breadth. Moreover, our instrument opens doors to explore new relational dynamics with AI. One can't help but wonder how understanding AI might sway someone's inclination to trust it, delegate tasks to it, or even follow its guidance. It's these subtle interactions, the underlying perceptions, and behaviors towards AI, that our tool aims to illuminate. Additionally, our endeavor is not just about understanding AI in isolation but situating it within the broader tapestry of technology acceptance. Every

technological tool has its unique adoption curve, influenced by a myriad of factors. With AI, the adoption is even more nuanced, and through our instrument, we aim to unravel the AI-specific layers that drive acceptance or resistance. In essence, our work is not an endpoint but a starting point. It's an invitation for researchers and practitioners alike to delve deeper into the world of AI, equipped with a sharper lens, and with a keen understanding of the intersections between AI literacy, adoption, and application.

5. Limitations and future developments

While the questionnaire serves as a promising tool for gauging AI literacy, it's essential to acknowledge its current stage and limitations. It is important to note that these results cannot be applied consistently due to the sample's characteristics (i.e., convenience sample, hence neither probabilistic nor representative of the reference population). Furthermore, the sample was drawn predominantly from higher education institutions. Other subpopulations, such as those with a secondary education, may have slightly different viewpoints on various aspects of AI literacy. As of now, the questionnaire is undergoing a rigorous validation process. To ensure its accuracy and relevance, a panel of seasoned AI experts will meticulously assess it with a more ample sample and a Confirmatory Factor Analysis. Their collective expertise and diverse perspectives will be invaluable in assessing the content validity of the questionnaire. This step is crucial, ensuring that the tool's items are not just relevant and appropriate but are comprehensive in their coverage of AI literacy. Following this expert evaluation, another pilot study is slated to commence. This study won't just be a preliminary run to gauge the questionnaire's overall feasibility but will be an avenue to gather firsthand feedback from participants. Their insights, experiences, and suggestions will be instrumental in identifying any ambiguities, redundancies, or potential improvements. By engaging with the end-users of the questionnaire in its nascent stage, we aim to make iterative refinements that are both user-centric and aligned with the research objectives. Finally, our approach to validation will incorporate sophisticated item analysis techniques. Both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) will be employed in tandem. While EFA it's already been used to help identify the underlying structure and potential factor loadings of the items, CFA, that is still to be done, will be pivotal in confirming these identified structures and ensuring that the model fits well with the collected data. The combined use of these techniques will not just ascertain the reliability of the questionnaire but will serve as a robust testament to its validity in assessing AI literacy.

6. Conclusion

This study's findings emphasize the necessity and significance of an AI literacy measurement instrument. The requirement for AI literacy is now an immediate necessity because AI is now pervasive and essential to many facets of our lives. After realizing the diversity of definitions and challenges in the development of AI literacy, we created an assessment instrument based on a multidimensional framework with strong construct validity, based on the idea of digital literacy, and embracing different facets of AI literacy, including knowledge, abilities, attitudes, and behaviors. By suggesting an instrument for evaluating AI literacy that is both theoretically and practically valid, our research adds to the ongoing academic conversation. We agree that the tool we've created is by no means conclusive given the variety of definitions and implementations of AI literacy, but instead provides a solid starting point for academics, educators, and policymakers. Future studies must further develop the conceptualization and assessment of AI literacy and investigate how this literacy affects students' capacity to interact with AI and the broader consequences this interaction has on society. If we want to provide the next generation the skills they need to navigate a world that is more mediated by AI, we must embark on the difficult but necessary journey toward general AI literacy.

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Artificial intelligence: a case study in the educational context of young university students

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Abstract

This article, following a historical approach to artificial intelligence in the educational domain, details the exercise conducted with 55 international students from the Master's program in Communication Design at the Politecnico di Milano. Divided into 10 groups, the students tackled various themes, from promoting local craftsmanship through Instagram campaigns to raising awareness about the water crisis through illustrated albums for children. The aim was to discern where the traditional production model deviates from a digital culture-assisted profile and to assess the role of the designer in this context. The students employed various Artificial Intelligence tools, including ChatGPT, Stable Diffusion, Crayion, Dall-e 2, and Tex to image ai, to develop their projects. This paper provides a comprehensive overview of the themes addressed, the tools used, and the objectives of the assignment.

Keywords: Education, Artificial intelligence, Communication Design, MA Students.

"penso che sia sostanzialmente
una simulatrice del comportamento umano medio,
e se è così, imiterà l'uomo
anche nel mostrarsi sensibile alle minacce"
Primo Levi, Vizio di Forma, Einaudi Torino 1971

1. Genetic History of AI in Education

Researchers' interest in the field of education and training predates the hype of generative Artificial Intelligence. Of course, it is not possible here to trace the history of the development of the field of Artificial Intelligence in Education in detail. We refer to the article by Ye, Sun, Li (2021) for this. When we retrace the pivotal moments in the development of Artificial Intelligence in Education (AIED), Rivoltella and Panciroli (2023) provide a comprehensive summary, which we've slightly adapted from its original form in their 2023 publication (p. 49). We'll analyze these phases (Table 1) separately below.

Table 1 - Four phases.

Phase 1 *1945-1950*	Mechanical Phase	Skinner Teaching Machine
Phase 2 *1955-1990*	Programming Phase	Computer Aided Instruction e Computer Based Training (CAI e CBT) Intelligent CAI
Phase 3 *1970-1990*	Personalization Phase Self Adaptive Educational System (SAES)	Automatic tutoring systems, based on constructivism epistemology.
Phase 4 *2000 - oggi*	Intelligent Personalization Intelligent Adaptive Learning System	Cloud Computing, Data Mining, Big Data, Generative AI

2. AIED: Mechanical Phase and Programming Phase

This era was characterized by the rudimentary teaching machines conceptualized by figures like Skinner. His creation, the "Teaching Machine", marked the beginning of technology's role in education: Skinner developed also rudimentary teaching devices, such Glider. This was a simple machine that provided students with multiple-choice answers (Skinner, 1968).

Technology's involvement in education became more pronounced during the Programming phase. Innovations like Computer Aided Instruction and Computer Based Training (CAI & CBT) emerged. Moreover, the concept of Intelligent CAI started to gain traction, further enhancing the intersection of AI and education. Probably the first application of computers in education with "Plato" as the pioneering Computer Based Training system. By the 1980s, with the advent of PCs from Apple and IBM, Computer Aided Instruction and Computer Based Training programs evolved into "Intelligent Computer Aided Instruction". These systems, installable on a PC, comprised a knowledge database, a student model capturing their learning state, a pedagogical model, and a user interface (Yoshida, 2013). Their intelligence stemmed from inferential algorithms adjusting content difficulty based on diagnostic tests, tailoring content to match a student's level of knowledge, usually aligned with Skinner's "programmed instruction" or the ADDIE model (Shih et al., 2003).

3. Artificial Intelligence in Education the Personalization Phase

The third phase is that of the Self-Adaptive Educational System. Here, the emphasis shifted toward creating tailored educational experiences for learners. Systems like the Self-Adaptive Educational System were introduced. Alongside these, auto-tutoring systems, grounded in constructivism and driven by algorithms, began to shape personalized learning paths.

This represents a clear departure from the past, echoing Searle's refutation of the "strong artificial intelligence" paradigm (Searle, 1980, 1990). This shift had significant implications for the educational field, moving distinctly away from the "instructionist" model. The epistemological reference for AI systems supporting education transitioned to constructivism. This transition included theories by David Merril (1992), constructivist coding by Seymour Papert (1993), and hypertext teaching by Spiro and Jacobson (Spiro et al., 1991). The web revolution integrated these AI systems into the earliest Learning Management Systems, where essential knowledge bases for training were loaded. In this phase, inferential algorithms are trained to adapt content and materials to the student's learning style, operating through complex decision-making models and focusing on learning personalization. After logging in, the student undergoes a test; the algorithm identifies their profile and personalizes the system to their needs and learning style. There isn't a "standard student model"; the system becomes a tool (not a tutor) serving the learners' needs and learning styles. User datasets related to training needs and progress are built through the progressive administration of tests validated over a wide range of exercises and a specific knowledge domain (ontology), made available on the platform (Panciroli & Rivoltella, 2023, pp. 56-57). Consumption modes and timings of content by users start to be tracked and contribute to the system's.

4. Intelligent Adaptive Learning System: First AI Tutoring System

The fourth phase is the Intelligent Adaptive Learning System. This represents a significant evolution from the previous phase, influenced by the rise of Web 2.0, User Generated Content, and cloud platforms for education. As LMS/VLE environments migrated to the cloud, a vast amount of data became accessible. With SCORM (Bhol et al., 2000) standardizing learning tracking within LMSs, the resulting wealth of data, termed Learning Analytics (Ferri, 2019), necessitated AI-driven analysis. Current AI applications, harnessing machine learning and deep learning algorithms, allow for semi-automated or automated big data analysis, including data related to learning. The Intelligent Adaptive Learning Systems, using this data, can infer and recommend content or strategies within LMSs.

AutoTutor (Graesser et al., 1999) might be the pioneering educational ChatBot. Key AI applications in education before the generative AI surge are:

1. *Learning analytics and Big Data*: VLE/LCMS environments produce considerable data, termed Learning Analytics (Fergusson, 2019; Bellini et al., 2019). AI tools, using algorithms, transform this data into actionable insights (Franzoni et al., 2020).
2. *Predictive Analysis*: Through Big Data, one can discern learning outcomes and student behaviors, predicting patterns such as dropout risks and thereby prompting targeted educational interventions (Baker & Siemens, 2014; Fitton, Finnegan & Proulx, 2020).
3. *Intelligent Tutoring Systems (ITS)*: Such systems offer promising AI applications in education, allowing for a personalized learning experience without the consistent presence of a human tutor (Woolf, 2009; Gwo et al., 2021).

5. How AI helps Education: Case History

Over the past decade, artificial intelligence has garnered international attention. Over the past decade, artificial intelligence has garnered international attention. States and global organizations began commissioning studies on AI's socio-economic impacts, particularly in education. The US initiated the discourse in 2016 with the "National Artificial Intelligence Research and Development Strategic Plan" (National Science and Technology Council, 2016). This was followed by China in 2017 with the "Next Generation Artificial Intelligence Plan" (Government of the Republic of China, 2017), and three European Union's documents (Tuomi, 2018; Eu, 2020, 2021a, 2021b). We take particularly in the consideration this study "The Impact of Artificial Intelligence on Learning, Teaching, and Education". This study, conducted by IIkka Tuomi (2018), specifically explored AI's potential impact on tasks typically performed by a middle school teacher. It's one of the few that directly assess AI's impact on teaching/learning practice on tasks typically performed by a middle school teacher. It's one of the few that directly assess AI's impact on teaching/learning practices. Notably, conversational agents show a profound influence across most teaching areas. Some high-impact areas identified by Tuomi include:

1. adapt teaching methods and instructional materials to meet students' varying needs and interests;
2. establish and enforce rules for behavior and procedures for maintaining order among students;
3. confer with parents or guardians, other teachers, counsellors, and administrators to resolve students' behavioral and academic problems;
4. maintain, accurate, complete, and correct students records as required by laws, district policies, and administrative regulations;
5. prepare, administer, and grade tests and assignments to evaluate student's progress;
6. prepare material and classrooms for class activities;
7. instruct though lectures, discussions, and demonstrations in one or more subjects, such as english;
8. establish clear objectives for all lessons, units, and projects, and communicate these objectives to students;
9. assist students who need extra help, such as by tutoring, and preparing and implementing remedial programs;
10. assign lessons and correct homework;
11. enforce all administration policies and rules governing students.

Once generative AI models became widely accessible, we embarked on an experiment to test some of these features, particularly focusing on items 1, 5, 6, 9, 10 by Tuomi, with a group of students from Politecnico di Milano.

6. Reshaping Traditional Pedagogical Methods: the use of AI for Designers

This section sets the tone for the transformative potential of AI in higher education. It hints at the paradigm shift that AI can bring about, reshaping traditional pedagogical methods and offering innovative avenues for research and learning.

The case study we present in this article concerns a study on the application of Artificial Intelligence to university teaching. The study was conducted during the second semester of 2023, a period marked by a burgeoning interest in Generative Artificial Intelligences. During the Digital Culture course (taught in English) of the Master's in Communication Design at the Politecnico di Milano, students were tasked with utilizing artificial intelligence as a co-designer for a specific assignment.

The course had 55 enrolled students, approximately half of whom were Italian, with the remainder being international. This international cohort included foreign students enrolled at the Politecnico and exchange students from around the world – China, Brazil, Europe, North America, and the Middle East. Consequently, they brought diverse linguistic competencies, backgrounds, and technical skills, with accessibility to various technological tools being a primary differentiator. The students were divided into 10 groups, each comprising 5 or 6 members. Except for a couple of groups consisting solely of Italian students, the groups were mixed with both Italian and international students. The group formations were determined by the students themselves.

Students were tasked with designing a Digital Culture Product. Each group was expected to design and develop a digital product in line with the productivity parameters of Digital Culture. Specifically, they were to explore how a designer could integrate AI into aspects like Instagramism (Manovich, 2016), live streaming on social media, digital publishing, e-commerce, and more. This assignment was the second task the students had to undertake and held significant weight in the final grade distribution: the first assignment accounted for 20%, the second assignment (the focus of this case study) 40%, and the oral exam 40%.

The assignment was designed to foster a critical approach to the use of Artificial Intelligence in the realm of Design. Specifically, it aimed to discern a) where the traditional production model diverges from a digital culture-assisted model, b) the areas where the designer remains indispensable in shaping the structure and texture of content, and c) instances where this paradigm collapses, leading to products of diminished value and depth.

Each group was assigned one specific topic out of 10 chosen by the instructor. Common to all topics, besides the objective to "Design a Digital Culture Product", was the integration of generative artificial intelligence in the creation of the Digital Culture Product. The students had the liberty to choose from various AI tools, such as the ubiquitous ChatGPT, Dall-e 2 etc., based on their perceived needs.

Topics were allocated to the groups through a random draw, pairing group numbers with topic numbers. Consequently, students did not have the luxury to select a topic based on preference or expertise. The topics the students were required to work on are as follows:

1. design an Instagram campaign to promote local crafts;
2. design an illustrated album (informative text) for kids to explain the war in Ukraine;
3. design an illustrated album for kids to raise awareness of the water crisis;
4. design a Twitter stream on "silenced women";
5. design a(n) guide/illustrated album on ethnic food for elder people;
6. design an Instagram campaign to promote a sustainable smartphone;
7. design a Twitter stream to raise awareness of marine pollution;
8. design a fanzine to talk about the marvel heroes from a different perspective (steampunk culture, feminism);
9. design a(n) guide/app for second hand street markets in Milan;
10. design a fb campaign for the protection of minority languages/dialects.

Table 2 illustrates the pairing between the groups and the topics.

Table 2 - Groups and task description.

Group	*Assignment*
Group 1	Design an Instagram campaign to promote local crafts
Group 2	Design an illustrated album (informative text) for kids to explain the war in Ukraine
Group 3	Design an illustrated album for kids to raise awareness of the water crisis
Group 4	Design a Twitter stream on "silenced women"
Group 5	Design a(n) guide/illustrated album on ethnic food for elder people
Group 6	Design an Instagram campaign to promote a sustainable smartphone
Group 7	Design a Twitter stream to raise awareness of marine pollution
Group 8	Design a fanzine to talk about the marvel heroes from a different perspective (steampunk culture, feminism)
Group 9	Design a(n) guide/app for second hand street markets in Milan
Group 10	Design a fb campaign for the protection of minority languages/dialects

7. From Theory into Practice

In order to assist students who were less familiar with artificial intelligence, specific lectures on the topic were provided. Additionally, two professors were invited to teach students how to craft the necessary prompts for creating their tasks: Professor Mark Marino from the University of Southern California and Professor Michael Hurtado from the Universidad Peruana de Ciencias Aplicadas.

The need for prompt writing became evident after an initial discussion with the students. As Mark Marino himself asserts, it is one of the main challenges in the proper use of specific artificial intelligences like ChatGPT: "Most of the failures that people describe in ChatGPT interactions can be solved by better prompting" (Marino, 2023). The instructors emphasized the importance of crafting a well-written prompt, even if, as Marino (2023) notes, "prompting may not always be a thing we need to do".

Particularly when using ChatGPT, Marino highlights several elements that must always be taken into consideration. This last element, as analyzed by Marino, appears to be particularly valuable for designers (see Table 3).

Table 3 - Resuming Marino's instructions for AI.

Elements	*Instructions*
Personality (or Role)	For more than just generic writing, assign ChatGPT a personality to use as a model for expression.
Rubric	Define what a successful result looks like. Just as a writing instructor would, specify what constitutes good and bad writing.
Objective	Every communication act, every utterance, has a goal.
Models	Indicate the specific model you require.
Particulars	It is essential to provide the content you want the AI to use. Supply it with facts, quotes, data etc.
Task	While most people begin with the task, there are other elements to consider as well.
Setting (or Context)	Always consider the audience and the situation in which you are crafting the prompt.

During the semester, two official reviews were scheduled where students showcased their progress in the development of the assigned task, discussed their ideas, and potential challenges. In addition to the

two scheduled official reviews, further reviews were conducted post-lessons upon students' requests. Finally, in the concluding lecture, all groups presented their products to the class. Students were asked, in their recorded presentation, to showcase the design work in all its phases and to particularly elaborate on how and to what extent artificial intelligence was utilized. Specifically, they were to detail which tools were employed, for what purpose, with what expectations, and the actual outcomes achieved. Lastly, students were instructed to produce all the material created, including the writing and rewriting of various prompts, which was analyzed for the purposes of this study.

In this paper, due to limited space, we will only analyze the work undertaken by three groups, specifically Group 3, Group 4, and Group 10.

The selection of these groups is intentional, as their work allows us to examine various facets of artificial intelligence usage and its role in designing different cultural products across diverse media. What follows in this article is an analysis of three particular projects, taking into account the descriptions provided by the students themselves and the professor's analysis. After an initial description of the work carried out by each of the three mentioned groups, an analysis of the produced results will follow.

8. Group 3: Design an Illustrated Album for Kids to Raise Awareness of the Water Crisis

The chosen theme was quite complex: how to make children aware of a crisis that even adults often do not fully grasp. No specific age range was intentionally mentioned, allowing students some flexibility in determining their target audience and, consequently, how to approach their work. The group chose to create an album with watercolor illustrations to appeal to "even the youngest". The album was entirely crafted using various artificial intelligence tools, from the "watercolour" images to the storyline. The group focused on providing the right instructions to the various tools used. Essentially, as stated by the students themselves, they designed the work and ensured that the artificial intelligence, or rather the artificial intelligences employed, executed their requirements correctly. This by no means implies that the students did not have to work hard. By their own admission and upon review, it was observed that, for instance, requesting certain images from the artificial intelligence took a considerable amount of time and numerous attempts before achieving the desired effect. Writing a good prompt proved indispensable, especially in image creation; the technical guidelines suggested by Professor Hurtado for prompt writing were essential.

Figure 1 - Cover and first page of "The Water Strike" - Group 3's assignment.

The outcome presented by the students was outstanding (Figure 1), so much so that the group received the highest possible score of 30 out of 30 from both reviewers. The chosen target audience, children between 8 and 10 years old who are capable of independent reading, was particularly persuasive. The use of colors to visually represent the issue addressed in the story, the narrative itself, and the application of artificial intelligence in the book's production were all commendable aspects. The training that the students provided to the artificial intelligences used, aiming to achieve the desired

product, was also particularly convincing. The book narrates a simple tale about Antonello, a raindrop who decides to go on strike after witnessing humans wasting water. One of the primary challenges encountered was the consistency, or lack thereof, exhibited by the artificial intelligences. To address this, the students listed a series of keywords that they consistently incorporated into various prompts. Especially when using Midjourney LLM, they were incredibly specific, even technical, regarding the setting. Lastly, they also employed artificial intelligence tools to convert the book into an audiobook, anticipating its use by even younger readers.

9. Group 4: Design a Twitter Stream on "Silenced Women"

Group 4 was tasked with amplifying the voices of women – writers, artists, scientists, architects, designers etc. – who historically were not accorded due recognition or were outright silenced solely due to their gender. The students had the discretion to select which women to feature in their Twitter stream.

The students became so engrossed in the assignment that, in addition to designing the Twitter stream, they also decided to create a dedicated website. They chose to spotlight six women, ranging from the poetess Sappho to Zelda Fitzgerald, Lee Krasner, Anni Albers, Artemisia Gentileschi, and Elizabeth Magie.

They titled their project SILEO and established a primary Twitter account under the same name, from which they directed content to 6 other accounts dedicated to the selected women (Figure 2). They employed artificial intelligence to draft their biographies. They also contemplated using artificial intelligence to craft messages for the various accounts, envisioning the entire endeavor as an artistic project. However, they ultimately refrained from this approach due to ethical concerns: historically silenced women to whom other women (the group consisted solely of female students) would impose words via artificial intelligence. This approach did not seem appropriate to them. Consequently, they chose to provide information about the works and histories of the aforementioned women, also fostering discussions on contemporary feminist issues. For them, the paramount objective was to give voice to these lesser-known stories. The use of artificial intelligence was confined to writing the biographies, as, according to their analysis, beyond the ethical issues, it introduced other challenges such as a lack of originality and limited creativity.

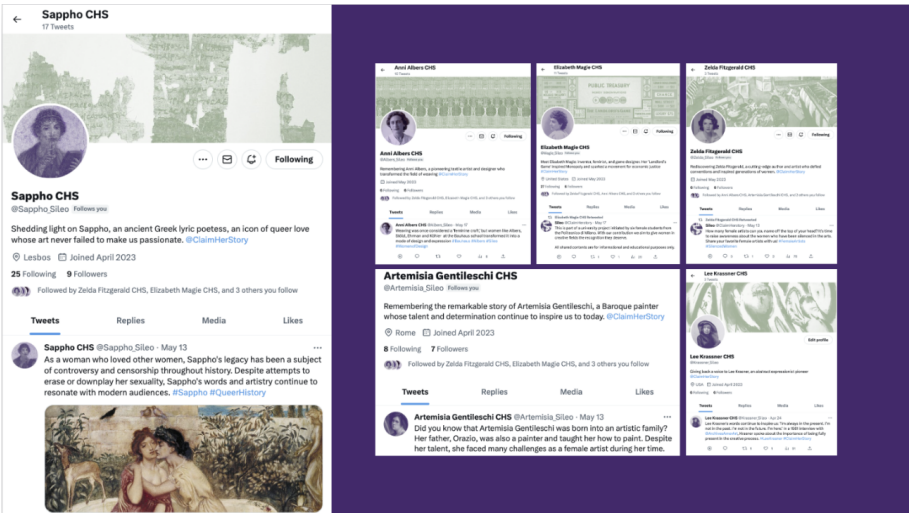

Figure 2 - Screenshot of women's twitter accounts - Group 4's assignment.

This project also received the highest marks from both evaluators. In this instance, artificial intelligence was employed only in limited circumstances and with a well-defined task to execute. The ethical concerns raised by the students not only curtailed the use of artificial intelligence but also sparked a debate on the subject itself.

10. Group 10: Design a Facebook Campaign for the Protection of Minority Languages/Dialects

The final student project among the ten that we will analyze here was undertaken by Group 10, which was tasked with designing a Facebook campaign for the protection of minority languages/dialects. The group, comprised of only Italian students from various regions, chose to focus on a campaign for the protection of Italian dialects. After designing the various phases of the Facebook campaign, planning to publish three distinct posts each week to raise awareness, they decided to infuse their posts with a touch of humor (Figure 3). They thus tasked artificial intelligence with crafting their slogan. After several prompts and refinements, the outcome was "Parla come Mangi", a well-known Italian proverb that translates to "speak as you eat".

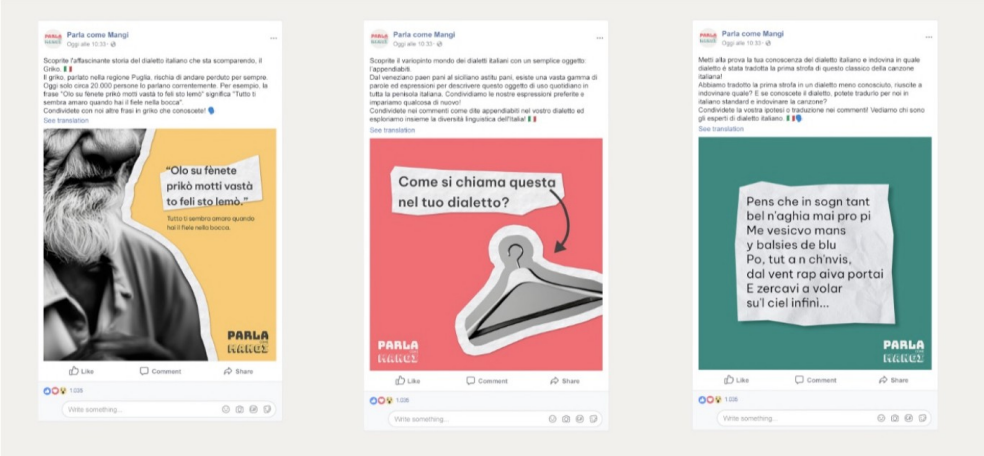

Figure 3 - Examples of 3 campaign posts to safeguard dialects - Group's 10 assignment.

Artificial intelligence was employed both to create images and to generate some of the post content (though not all, partly due to the sensitivity of the subject matter). This project also received the highest marks from both evaluators. The group's approach yielded intriguing insights. For instance, the group struggled considerably to have the artificial intelligence create a simple coat hanger that didn't imply a designer hanger or one with clothes hanging on it. Moreover, the intended humor that was purposefully designed into the campaign was challenging to achieve in the suggestions provided by the artificial intelligence.

11. An Overview on the Survey

In this concluding section, we will briefly examine the survey administered to students upon the completion of their tasks. The questionnaire was anonymous and participation was not mandatory; 47 out of 55 students responded. The questions posed pertained to the utilization of artificial intelligence in the execution of their assignments. Nine questions were structured using a Likert scale, while three were open-ended, seeking insights into the potential advantages and disadvantages of AI use. The results revealed a notable consistency in responses, with extreme ratings being almost invariably absent, except for a few rare instances.

The initial question inquired about which Artificial Intelligence tools the students employed. As anticipated, ChatGPT emerged as the most popular, with 76.9% of respondents using it. Other frequently used tools included Dall-e 2 at 68.5%, Text to Image AI at 30.8%, and Stable Diffusion at 23.1%.

Subsequent questions delved into the application of artificial intelligence in the execution of their assignments. For instance, in response to the query, "Did AI facilitate your research and acquisition process for obtaining information on specific topics related to your assignment?", the majority of

students either agreed or remained neutral. Only 15.4% strongly agreed, while none disagreed (see Figure 4).

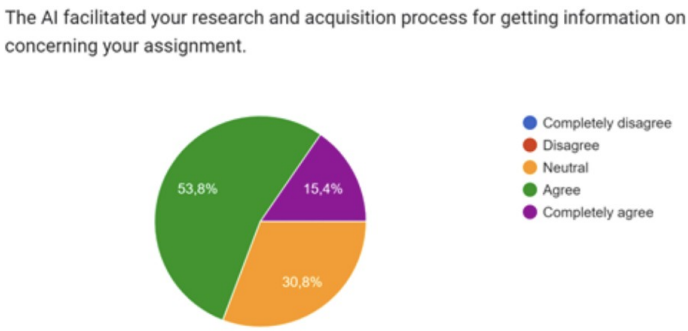

Figure 4 - Chart related to the results of the second question of the survey.

Regarding the question, "Did the AI provide relevant and useful answers in relation to your assignment?", 76.9% strongly agreed, while 23.1% remained neutral. Notably, none of the respondents either agreed or disagreed, even partially.

Intriguing insights also emerged from the open-ended questions. Many students noted it saved them a significant amount of time. However, another highlighted, "I generated images picturing people and AI wasn't really good in my opinion. It would have been much less time consuming to just use photoshop in some cases".

12. Conclusion

The study presented here is an ongoing project, and thus, the results remain preliminary. We plan to repeat the exercise in the Digital Culture course of 2024.

With respect to the theoretical framework adopted, the hypotheses of Tuomi (2018) are confirmed, specifically regarding the impact of artificial intelligence on teaching. In particular, the impact on the design and production of educational materials is confirmed, as well as the impact on the assignment of tasks and exercises, and on active tutoring of students: Tuomi items 1, 5, 6, 10.

When students are adequately trained, they are adept at leveraging the opportunities provided by Artificial Intelligence, discerning both its risks and benefits. The use of appropriate prompts has, by their own admission, expedited their work in many instances. However, in other cases, it became evident that the role of the designer was absolutely essential to achieve a high-quality and non-trivial product.

Hence, it remains desirable to conduct an empirical study, rather than a purely theoretical one, on the use of artificial intelligence in the educational context, in our case with Master's students, where the role of the instructor is to guide students in experimenting with the available technological resources.

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Formative assessment in Emergency Remote Teaching. Study of teachers' beliefs and practices

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Abstract

The contribution presents a multiple case study of three all-inclusive schools in Lombardy aimed at observing and describing their context, teachers' beliefs, and practice statements about formative assessment, learning, and student engagement in the Emergency Remote Teaching activated during the critical period of the Covid-19 pandemic, and the relationship between them and the context. Specifically, the qualitative-quantitative analyses carried out on the results emerging from the semi-structured interviews conducted with Headmasters, document analysis (the three-year plan of educational offerings, self-evaluation report, circulars, policy acts etc.), the questionnaire submitted to teachers, and focus groups conducted with the HM, the internal evaluation team and selected teachers by school order will be presented. The case study is part of a larger research project of which hints will be provided in the presentation.

Keywords: Formative Assessment, Emergency Remote Teaching, Beliefs, Practices, Teachers.

1. Introduction

Some research sees formative assessment as a useful tool to foster student engagement and inclusion, especially in online education. A study by Z. Chen, J. Jiao, and K. Hu (2021), carried out in the pandemic period for COVID-19, finds that temporally and spatially separated students and teachers are subject to long-term criticality typical of distance education.

It is appropriate to take up the distinction postulated by Hodges et al. (2020) between online Distance Learning (DL) and emergency remote teaching (ERT). Unlike educational experiences designed to be online, ERT is a temporary and alternative mode of instructional delivery due to crisis circumstances. It involves fully distance teaching strategies; instruction, which would otherwise be delivered face-to-face or as blended or hybrid teaching, will revert to the traditional format when the emergency has receded. In this context, the main goal is not to recreate a robust educational ecosystem but to provide temporary access to education and learning supports, while also preventing possible risks of disengagement typical of emergencies.

Research shows that students feel isolated in online education (Hammond, 2009), resulting in high dropout rates (Hodges & Kim, 2010), high boredom rates, and poor performance (Fredricks, 2015). According to Chen, Jiao, and Hu, the use of formative assessment in such contexts can be an effective solution. Implemented with forum discussion tasks, quizzes, and tests, it is effective in improving engagement and increasing learning. The studies mentioned explicitly refer to a mixed mode of teaching between online and presence, specifically concerning DL. According to the authors, there is limited evidence that this also works in the typical ERT mode.

Central to the management of such didactic has been the teaching profession, led by beliefs and transmuted into practice. The most problematic aspects emerging from empirical research (Richardson, 2002) concern the link between conceptions and effectiveness of teacher education (Balduzzi & Vannini, 2008). In this regard, there are studies inherent to Teacher Change (Floden, 2002; Richardson, & Placier, 2002) and how beliefs and practices change: do the former follow the latter (and vice versa) or are they mutually interacting and synergistic (Goffman, 1973; Peterman, 1993)?

This contribution aims to present a multiple case study of three all-inclusive schools (primary to high school) in the Lombardy Region, to investigate the context in which teachers operated during COVID-19, their beliefs, and practice statements about formative assessment, learning, and engagement during

ERT, what are the links between context and beliefs and practices. In the first stage, semi-structured interviews were conducted with principals, document analysis (the three-year plan of educational offerings, self-evaluation report, policy acts, circulars etc.), and qualitative analysis was conducted on them. In the second stage, a questionnaire was administered to all teachers in the identified schools, aimed at investigating the constructs examined, and the data were analyzed quantitatively and qualitatively. In the third phase and from a constructivist perspective, a focus group was conducted with the school headmaster, the Internal Evaluation Core, and teachers selected by order of school to jointly interpret the data that emerged in the first two phases, and the data were analyzed qualitatively.

Analyses show that teachers favored formative assessment convinced that it could support student learning and engagement in a context considered emergent. Specifically, statistical analyses show that beliefs and practice statements about formative assessment are related to constructivist learning and student engagement; they are found to be consistent and applicable in the ERT context. It is interesting to note that the age and experience of the teachers are a conditioning factor as well as the order of teaching and the emergency. Also, the school influenced the formative assessment and learning beliefs: the smaller one, identifiably stronger with accompanying practices and teacher training was decisive on the agreement averages. The primary school also proved to be a favorable context for FA, student engagement, and constructivist learning. Other hints of the analyses conducted will be given during the presentation of the contribution.

2. Materials and Methods

The multiple case study took place in the context of the Lombardy Region (Italy) – specifically in the metropolitan city of Milan – and involved, through a non-probabilistic sampling of volunteers, three all-inclusive school institutes (from primary to high school, from first to thirteenth degree). The first is in two cities in the province of Milan and has 147 teachers, the second is a state (girl's) boarding school in the city center of Milan and has 62 teachers, the third is a private institute of Catholic inspiration and is also located in the center and has 69 teachers.

The study aims to study the context, beliefs, and statements of practice of teachers during two specific periods, both of which are part of the broader ERT period: remote learning in March-June 2020 (RL) and integrated digital education in September 2020-June 2021 (IDE).

Three semi-structured interviews were conducted on the Institutes' premises, one for each school director and/or deputy, recorded and transcribed *verbatim*. The first of this one hour and forty minutes was held at the School 1 (S1) HM office in May 2022 in the presence of the deputy at the same time; the second, thirty-eight minutes in the School 2 (S2) faculty room, in June 2022, with the presence of the deputy alone; the third was more articulated in February 2023, and the first part of the interview was conducted with the rector's collaborator in his office in the presence of the principal of the junior high school (forty-four minutes), the second with the primary school principal in a school room (thirty-five minutes), the third with the secondary school principal in his office (thirty-two minutes), the latter was also rector *pro tempore* at the time of ERT.

The reflection group is responsible for sharing the analysis carried out by the researcher and based on this, for carrying out further investigations and reflections with the identified stakeholders. The analyses of the data collected are qualitative and are carried out using the MaxQDA software. The S1 focus group was 7 people, the S2 9, and the S3 11, and were conducted in spring 2023.

Transcribed interviews, focus groups, and documents were analyzed with the MaxQDA software using a code system (Table 1) structured ex-ante by reference to the variables identified for the questionnaire and ex-post because of the recurrence of certain themes important for the study of the context and the situations that occurred (Duverger, 1961; Rositi, 1971; Bruschi, 1999).

The questionnaire is subdivided into three blocks and aims to collect data on teachers' socio-professional status (16 questions) and, according to their point of view, the school context during the ERT period (9 questions). In addition, teachers' convictions and declarations of practice concerning the constructions and variables in question are recorded using eight scientifically validated and specially constructed Likert scales with four requests for examples. A first version of the questionnaire

was drafted, which was submitted to a tryout phase with teachers from different types of institutes and school orders who sent observations and suggestions. The questionnaire was administered online by sending a cover letter and using Qualtrics software, initially for two weeks, extended then for another; schools 1 and 2 were sent to winter 2022 and school 3 in spring 2023. The analysis of the data collected is quantitative, using SPSS-IBM software, and qualitative.

Table 1 - System of codes.

System of codes		*Annotation*	*Frequency*
System of codes			704
ENG		Beliefs and practices about engagement	0
	PRAXENG	Practices to support student engagement	19
	CONENG	Student Engagement Beliefs	8
APP		Learning beliefs and practices	4
	CONAPP	Beliefs about student learning	42
	INVALSI Tests	Discussions about the results for INVALSI tests	15
	PRAXAPP	Practices to support student learning	11
	APP post-ERT	Learning after ERT	13
VAL		Beliefs and practices about assessment	1
	TRAINING VAL	Assessment training	15
	CONVAL	Assessment beliefs	82
	PRAXVAL	Assessment Practice Statements	34
	Assessment in ERT	How to apply assessment during ERT	48
	VAL post-ERT	Post-ERT assessment modalities	8
EMOTIONS		Pandemic Emotions	13
	Emotions +	Emotions positives	16
	Emotions -	Emotions negatives	45
CONTEXT		Background information	83
	REL TER	School relations with the territory	20
	REL FAM	Relations between schools and families	44
	DS and collaborators' role	Management's role in the application of the FA	42
	PROJECTS	Projects developed during COVID	9
ERT		Emergency Remote Teaching	6
	ERT training	ERT training	9
	DIGICOMP	Digital competences	14
	CONERT	Teachers' beliefs during the ERT	33
	INDICMIN	Relationship to Ministerial or Policy Direction	10
	PRAX ERT	Teacher practice during the ERT	45
	STUD in ERT	Attitudes of students during the ERT	15

3. Results

For reasons of space, not all results from the analyses (including interviews and focus groups) are considered. This section presents the main results of the statistical analysis of the questionnaire data. You can find a reference in the discussion section (for more information contact the author).

3.1 Structural description of the sample

193 teachers responded to the questionnaire of which 105 (54.4%) teach in S1 (out of a total of 147; response rate: 91.30%), 41 (21.2%) in S2 (out of a total of 62%; response rate: 66.12%), 47 (24.4%) in S3 (out of a total of 69; response rate: 68%); mainly women (77.7%); seven (3.6%) chose not to answer In general, the response rate is higher than average (50%) with Computer Assisted Web Interviews (CAWI). Overall, the percentages remain unchanged for each school. Most respondents are between the ages of 36 and 50 (39.4%), with the smallest being 25 years or younger. It should be noted that the bands identified are not homogeneous. Most teachers are in the 14-25 age group (28.5%). Except for those who have been teaching for about a year – and who would not be on duty during Covid anyway – the other bands have almost the same number of teachers. 69.9% of the sample is held, 22.3% were on an annual mission and 2.6% were on temporary duty during the Covid period. Teachers have been teaching for the longest time since 1980 (S3) and 8 since 2022; the oldest holder of an annual office since 2007 (S1) and 15 since 2022. Most teach in High School (40.4%), and minor in secondary school level I (24.4). It should also be noted that two teachers in Secondary I also teach in Primary and five in HS. At the time of Covid, 22 worked in a different order (10 S1, 3 S2, 9 S3) and more specifically 7 in Primary (3 S1, 4 S3), 6 Sec. of 1 (3 S1, 1 S2, 2 S3) and 9 HS (S3). A little more than half (53.4%) have no missions other than teaching. The most common are class coordination, area or department coordination, instrumental function (pupils with disabilities and special educational needs, programming, and evaluation etc.), and project reference. 86.2% report having changed their teaching style during the ERT period. It is interesting to note that the remaining 13.8% admit that they have not made any changes, essentially reproducing the ordinary modalities in an extraordinary context. More specifically, the highest percentage (17%) is reported by the S3 and the lowest by the S2 (7.5%), and the S1 (14.9%). Those who have varied have acted: on the learning environment that has necessarily been transferred to digital platforms, exploiting their potential such as, for example, the division into small groups to promote interaction; on the duration of the lessons, mainly by reducing their length following the ministerial guidelines; on programming, by limiting the content provided and by choosing those which are most inherent to the daily life of pupils; on evaluation, by giving priority to training; on didactic methods and tools, focusing on the classical room to give more time to interaction and some digital applications to support student engagement; on didactic materials, digitizing all necessary documents and giving preference to audio-video material already present on the web. 72.4% (N 134) of teachers were present in the same institute even during the Covid period (31 S1 - 79.5%; 34 S2 - 72%; 69 S3 - 69.7%); the remaining 27.6% were not asked the context description questions.

3.2 Background description

Relationships with families have been maintained through a variety of tools and modalities: most teachers say they prefer video conferencing platforms that allow eye contact (36.98%), followed by email (28.30%) and electronic communication (21%). Note that 22 teachers (7.07%) also used the private phone. Specifically, those in S2 did not use two tools (face-to-face interviews and the school phone); those in S3 did not identify other instruments and used the electronic register less (10%), and S1 tended to match the average of the total sample.

The electronic register was used mainly to record votes (31%) and then to carry out bureaucratic procedures (28%). The percentage who used it to communicate with families (23% versus 21.86%) disagrees with the previous question. The number of people who used it to provide feedback to students is limited (15%); this figure is then considered when analyzing formative assessment practices.

Specifically, S2 teachers report targets that are consistent with the general sample; S3 teachers, although they used it less than others, used it primarily to record scores (43%) and less to complete

bureaucratic procedures (22%) and communicate with households (13%); S1 less to record votes (27%) and more to communicate with households (27%).

At the end of this section, teachers were asked to indicate some of the projects proposed by the school and considered significant for teaching management in the emergency period. We can distinguish some thematic cores: management of digital didactics and applications with support, STEAM and e-twinning methodology, review of assessment criteria, emotional and psychological support, book club production or architectural appetizers (aimed at student engagement), online dialogues with professionals from different parts of the world, lessons in common between professors from different disciplines.

3.3 Scales for detecting convictions and practices

This part of the questionnaire is intended to collect teachers' statements on the beliefs and practices of survey subjects. The scales were defined over four levels by reference to the theoretical constructions studied or to certain ministerial documents: convictions and declarations of practice on assessment, student engagement, learning, and ERT (the scales are shown in the English translation, the administration took place with the Italian one). In addition, exploratory factor analyses were conducted to identify latent factors. The hypotheses that guided this exploratory part of the research are oriented toward the analysis of the principal components and the verification of the validity of the scales for the next steps and analyses of the research. It is expected that the item batteries examined will be internally coherent so that they can be considered as valid scales concerning the theoretical background; They highlight some early correlations with other important research variables to support the assumptions made.

The VALFOR battery items (Table 2) come from a scale built and validated by A. Ciani and I. Vannini (2017) and are intended to measure formative and summative assessment beliefs. Descriptive battery statistics show medium-low agreement levels (not or not at all agree) with items 1, 3, 4, and 8, and medium-high (somewhat or very agree) with items 2, 5, 6, and 7. There is thus a polarization in two different typologies of evaluation designs that the researchers defined by factor analysis that identified two latent factors: formative function (VALFOR 2, 5, 6 7) and summative (VALFOR 1, 3, 4, 8) of the assessment. Descriptive statistics of the latent factors of the VALFOR battery indicate that this polarization is indeed related to the two different evaluation designs during the ERT in favor of the training function. Furthermore, it appears that there is no "very consensual" level for the summative function.

Table 2 - VALFOR scale (Ciani & Vannini, 2017).

Variable code	*Variables related to the hypothesized theoretical construct (VALFOR battery)*
VALFOR 1	Sometimes it is necessary to attribute lower marks to urge the student to commit more
VALFOR 2	The main role of assessment during the quarter is to identify the learning difficulties of the student to help him overcome them
VALFOR 3	There is attention and interest in a class only if the student knows that it will be assessed on the concepts expressed by the teacher during the lesson
VALFOR 4	The assessments during the quarter are used to identify not only what the student has learned but also what the teacher must deepen
VALFOR 5	The assessment of students during the quarter allows the teacher to verify the validity of his work
VALFOR 6	Assessment during the quarter should help the student to better understand his learning process
VALFOR 7	The attribution of low marks (or judgments) during the quarter helps the teacher to be better respected
VALFOR 8	The teacher should not let the students know his assessment criteria

The PRAXVAL battery items (Table 3) were defined based on research by D. Wiliam and M. Thompson (2007) and are intended to measure statements of the practical application of the five didactic strategies for the use of formative assessment. Descriptive battery statistics show medium-high agreement levels for almost all items except 8 and 9 that relate to peer review application practices. This could be due to the isolation of students and the didactic typology that limited peer-to-peer work in favor of predominant contact with the teacher. Practices aimed at promoting self-assessment have a medium level, unlike those where the teacher is a major player in which he is high.

Table 3 - PRAXVAL scale.

Variable code	*Variables related to the hypothesized theoretical construct (PRAXVAL battery)*
PRAXVAL 1	I shared with students learning goals before they started working
PRAXVAL 2	Before assigning a test, I clarified to the students what I would assess
PRAXVAL 3	In class, I used different methods of assessment (written, oral, graphic, practical, structured, and unstructured)
PRAXVAL 4	I made sure that the assignments could verify the progress of students' learning
PRAXVAL 5	In addition to the grade (rating), I gave feedback to students
PRAXVAL 6	If I gave feedback on it, I highlighted the strengths or weaknesses of the task
PRAXVAL 7	I provided tips to students to improve their learning
PRAXVAL 8	I asked the students to assess the work of the comrades
PRAXVAL 9	I asked students to provide feedback to fellow students to help them improve
PRAXVAL 10	I asked students to assess their work
PRAXVAL 11	I asked students to identify the strengths and/or weaknesses of their work
PRAXVAL 12	I asked students to propose strategies to improve their work

Initially, a confirmatory factor analysis of the hypothesis made during the construction of the scale was carried out but did not have the expected results. Subsequently, an exploratory factorial analysis (Varimax method) was performed showing that the Kaiser-Meyer-Olkin sampling adequacy measure is good (0.844), the Barlett sphericity test is significant (< 0.001) and indicates two latent factors (PRAXVAL 1 to 7 and 8 to 12) which saturate 53.39% of the total variance. The first covers the actions of exclusive competence of the teacher and combines the first three didactic strategies of Wiliam and Thompson, the second of the practices of the teacher that make the participating student active (peer and self- assessment) and combines the last two strategies. Finally, a reliability analysis of the scale was carried out which has a good Cronbach Alpha (0.842), and it is not necessary to delete any element since the result would always be greater than 0.8. Descriptive statistics of latent factors indicate that teachers have more frequently carried out actions within their exclusive competence and less those involving student intervention.

The CONENG and PRAXENG battery items are based on the research of G.D. Kuh (2009) and are intended to measure teachers' beliefs and statements of practice regarding student engagement.

The descriptive statistics of the CONENG battery (Table 4) show medium-high agreement levels for all items. Teachers are convinced that student participation in distance learning and self-employment activities has had less influence than those involved.

Table 4 - CONENG scale.

Variable code	*Variables related to the hypothesized theoretical construct (CONENG battery)*
CONENG 1	The participation of students in the didactic activities carried out face-to-face has influenced their learning
CONENG 2	The participation of students in distance learning activities influenced their learning
CONENG 3	Students' engagement in autonomous activities influenced their learning

Exploratory factor analysis (using the Varimax method) shows that the Kaiser-Meyer-Olkin sampling adequacy measure has sufficient value (0.668), the Bartlett sphericity test is significant (< 0.001) and extracted a single component that could be defined as teachers' beliefs about student engagement in ERT that saturates 62.37% of the total variance; item 1 correlates significantly with the other two (< 0.001). The scale reliability analysis shows a medium Cronbach Alpha (0.695) and if you remove the items in any case, the value will decrease. Descriptive statistics of the latent factor show a medium-high level of agreement with the beliefs of student engagement in its various forms.

The descriptive statistics of the PRAXENG battery (Table 5) show medium-high agreement levels (3) for all items except for the engagement practices promoted by the school (2). Teachers therefore say that they have done more than their school to try to engage students during the ERT period.

Table 5 - PRAXENG scale.

Variable code	*Variables related to the hypothesized theoretical construct (PRAXENG battery)*
PRAXENG 1	I have promoted actions aimed at engaging students in the learning process
PRAXENG 2	I have promoted actions aimed at making students responsible for the learning process
PRAXENG 3	I used didactic methodologies for active learning (flipped classroom, laboratory teaching etc.)
PRAXENG 4	I used teaching methods for cooperative learning (circle time, cooperative learning, peer education, role-playing etc.)
PRAXENG 5	In addition to the ordinary activities the school has promoted other actions aimed at supporting the engagement of students
PRAXENG 6	The school has promoted actions aimed at making students responsible for their learning process

Exploratory factor analysis (using the Varimax method) shows that the Kaiser-Meyer-Olkin sampling adequacy measure has sufficient value (0.690), the Bartlett sphericity test is significant (< 0.001) and extracted two components that could be defined as teacher practices (factor 1, PRAXENG 1 to 4) and school practices (factor 2, PRAXENG 5 and 6) that saturate 68.01% of the total variance. The reliability analysis of the scale shows an average Cronbach Alpha (0.748) and if you remove the items in all cases, the value will drop except for item 6 but the difference is 0.003, so it is considered appropriate to maintain it. Descriptive statistics of latent factors confirm the highest frequency of actions taken by the teacher to support engagement compared to those of the school.

The CONAPP and PRAXAPP battery items are composed by investigating the literature on the subject, including J. Dewey (1949), J. Piaget (1976), L.S. Vygotskij (1978, 1987, 2001), and are intended to investigate teachers' beliefs and practice statements about student learning.

The descriptive statistics of the CONAPP battery (Table 6) show medium-high agreement levels (3) in all items. More specifically, the first on the centrality of the student in the training process at higher levels with a greater number of answers 3 and 4 than the others.

Table 6 - CONAPP scale.

Variable code	*Variables related to the hypothesized theoretical construct (CONAPP battery)*
CONAPP 1	The student was at the center of the training process
CONAPP 2	Knowledge was the product of an active construction by the student
CONAPP 3	Knowledge has been closely linked to the concrete experience of the student
CONAPP 4	Knowledge is born from social collaboration and interpersonal communication between students
CONAPP 5	Knowledge is born from social collaboration and interpersonal communication between students and teachers
CONAPP 6	Different learning styles and rhythms have positively influenced learning

Exploratory factor analysis (by Varimax method) shows that the Kaiser-Meyer-Olkin sampling adequacy measure has a good value (0.885), the Barlett sphericity test is significant (< 0.001) and extracted a single component that could be defined as teachers' beliefs about student learning from a constructivist perspective in the ERT that saturates 61.72% of the total variance; item 1 correlates significantly with others (< 0.001). The scale reliability analysis shows a good Cronbach Alpha (0.873) and if you remove the items in any case, the value will decrease. The descriptive statistics of the latent factor confirm a medium-high agreement (3) with the belief that learning must be understood from a constructivist perspective. Analyses of the interviews and documents showed that this is the approach chosen by the institutes studied.

The descriptive statistics of the PRAXAPP battery (Table 7) show medium-high levels of agreement (3) in all items except the last one which aims to build a climate of trust open to dialogue and sharing (4). This level can be explained by the multiple attempts reported during the interview to achieve this condition even in response to the emotional difficulties encountered.

Table 7 - PRAXAPP scale.

Variable code	*Variables related to the hypothesized theoretical construct (PRAXAPP battery)*
PRAXAPP 1	I proposed teaching activities in continuity with previous experiences
PRAXAPP 2	I proposed educational activities aimed at engaging students
PRAXAPP 3	I proposed educational activities that are as close as possible to the interests and everyday life of students
PRAXAPP 4	I proposed educational activities based on students' knowledge and representations
PRAXAPP 5	I guided the discussions among the students that arose from the proposed teaching activities
PRAXAPP 6	I asked the students to make products (descriptions, projects, experiments etc.)
PRAXAPP 7	I proposed problem situations to enable students to look for solutions even creative
PRAXAPP 8	I have better learning conditions in place to achieve the learning goals
PRAXAPP 9	I have fostered a climate of trust, open to dialogue and sharing

Exploratory factor analysis (by Varimax method) shows that the Kaiser-Meyer-Olkin sampling adequacy measure has a good value (0.831), the Barlett sphericity test is significant (< 0.001) and extracted two components that could be defined as practices to support learning based on students' direct experiences (factor 1, PRAXAPP 1 to 4, 8 and 9) and active engagement in the process (factor 2, PRAXAPP 5 to 7) which saturate 55.61% of the total variance. The scale reliability analysis shows a good Cronbach Alpha (0.828) and if you remove the items in all cases, the value will go down except for item 6 but the difference is 0.001, so it is deemed appropriate to maintain it. Despite the identification of two latent factors and their conceptual similarity, it is judged appropriate to consider a single factor that corresponds to the entire battery. The descriptive statistics of the latent factor confirm a medium-high level (3) of declarations of practice aimed at supporting learning from a constructivist perspective. Analysis of interviews and documents showed that this was not only the approach considered appropriate by the institutions studied, but that they also stated that they had acted in this direction.

Finally, the items of the CONERT and PRAXERT batteries are constructed on the studies of C. Hodges et al. (2020) and on the ministerial documents (Note 318 of 11.3.2020 and DM 26 June 2020, n. 39). They study teachers' beliefs and practices in emergency remote teaching.

The descriptive statistics of the CONERT battery (Table 8) show medium-high levels of agreement (3) for items related to the urgency of the RL/IDE, the first where reference is made to the brevity and the extraordinary character of this didactic. The level for the remaining ten is medium-low (2), especially for the eighth concerning the development of transversal skills where there is no level 4, and the eleventh concerning the satisfaction of the needs of SEN students etc. where the average is less than 2.

Exploratory factor analysis (by Varimax method) shows that the Kaiser-Meyer-Olkin sampling adequacy measure has a good value (0.861), the Barlett sphericity test is significant (< 0.001), and extracted two components that could be defined as beliefs about the emergency of didactics (factor 1, CONERT 1 and 2) and the applicability of IDE as thought by the Department (factor 2, CONERT 3 to 11) that saturate 58.55% of the total variance. The reliability analysis of the scale shows an average Cronbach Alpha (0.791); the correlation matrix between the elements has a negative correlation between the first two items and the other nine, plus Cronbach Alpha if removed at a good level (0.838). For these reasons, the scale is divided into two distinct factors: CONERT and APPDDI. The descriptive statistics of the two scales identified confirm a medium-high level (3) of agreement with the emergency status of RL/IDE and a medium-low level on the effective applicability of IDE; the difference is about one point. This situation was also noted in the interviews and documents analyzed.

The descriptive statistics of the PRAXERT battery (Table 9) show high agreement levels (4) for all items except the second where reference is made to the demand and monitoring of individual or grouped digital processing.

Table 8 - CONERT scale.

Variable code	*Variables related to the hypothesized theoretical construct (CONERT battery)*
CONERT 1	RL/IDE or emergency remote teaching is a temporary transition to an alternative mode of providing education due to extraordinary circumstances
CONERT 2	RL involves the use of fully distance learning solutions and education will return to the traditional format once the crisis or emergency has subsided
CONERT 3	The IDE has effectively allowed the integration between teaching in presence and at distance
CONERT 4	The IDE has favored disciplinary and interdisciplinary insights
CONERT 5	The IDE has favored the customization of routes
CONERT 6	IDE has enabled the recovery from learning loss
CONERT 7	The IDE has encouraged the development of disciplinary skills
CONERT 8	The IDE has effectively fostered the development of students' soft skills (personal, social, citizenship, learning to learn etc.)
CONERT 9	The IDE has effectively improved the correspondence between the teaching action of the teacher and the different learning styles of the students
CONERT 10	The IDE has indeed made it possible to meet the requirements of SEN, linguistic disadvantages etc.
CONERT 11	IDE has favored the balanced combination of synchronous and asynchronous activity

Table 9 - PRAXERT scale.

Variable code	*Variables related to the hypothesized theoretical construct (PRAXERT battery)*
PRAXERT 1	I used e-learning and/or videoconferencing platforms
PRAXERT 2	I requested and monitored the processing of individual or group digital material
PRAXERT 3	Following the ministerial and college instructions I gave lessons of the appropriate duration (ca 45 min.), and I planned appropriate breaks
PRAXERT 4	Following what has been defined by the faculty, I have adopted the shared criteria for the design/implementation of RL/IDE
PRAXERT 5	Following what was defined by the teachers' college I adopted the organizational elements shared for the RL/IDE (duration of lessons, tools to use etc.)

Exploratory factor analysis (using the Varimax method) shows that the Kaiser-Meyer-Olkin sampling adequacy measure has sufficient value (0.707), the Barlett sphericity test is significant (< 0.001) and extracted two components that could be defined as the use of tools and the production of digital material (factor 1, PRAXERT 1 and 2) and the agreement with the college of teachers (factor 2, CONERT 3 to 5) which saturate 76.86% of the total variance. The reliability analysis of the scale indicates an average value of Cronbach's Alpha (0.748) and if items are deleted, the value will decrease anyway except for item 5 but the difference is 0.003. The descriptive statistics of latent factors confirm a medium-high level (3-4) of practices regarding the use of digital tools/materials and compliance with ministerial/college guidelines; More specifically, there is a higher average for seconds than for the first.

4. Conclusion

As seen in the literature (Goffman, 1973; Peterman, 1993), in general terms, it can be said that in the three cases considered, there is a correlation and sometimes a causal link between teachers' beliefs and statements of practice concerning assessment and the other constructions involved in the ERT and socio-demographic and contextual variables (Table 10).

Table 10 - Correlation between latent factors and other variables.

[*Summative assessment beliefs*: age (-0.171*, p 0.027), seniority of service (-0.184*, p 0.017), scholastic order (-0.184*, p 0.017); *formative assessment beliefs*: summative assessment beliefs (-0.199*, p 0.011), assessment actions of the teacher (0.320**, p < 0.001); *emergency of RL/IDE*: applicability of the IDE rules (-0.204*, p 0.014); *compliance with the ministerial indications*: use of digital tools (0.330**, p < 0.001).

Summative assessment beliefs: age F(4, 108) = 3.616, p = 0.008 (significative diff. between 26-35 [m = 1.99] and 51-60 [m = 1.51]) Institute F(2, 108) = 4.740 (significative diff. between I1 [m = 1.58] and I3 [m = 2]); f*ormative assessment beliefs*: Institute F(2, 156) = 6.449 (significative diff. between I1 [m = 3.54] and I3 [m = 3.13]); Order F(2, 156) = 3.418 (significative diff. between Primary school [m = 3.47] and High School [m = 3.18])].

	Latent factors (ERT)	***Other variables***
Beliefs	IDE applicability	Formative assessment teacher actions (0.190*, p 0.022) Beliefs on constructivist learning (0.204*, p 0.014)
Practices	Use of digital tools and materials	Beliefs on formative assessment (0.184*, p 0.03) Formative assessment teacher actions (0.304**, p < 0.001) Beliefs on engagement (0.279**, p < 0.001) Teacher practices for engagement (0.307**, p < 0.001) Practices on constructivist learning (0.316**, p < 0.001)
	Compliance with the ministerial indications	Beliefs on formative assessment (0.180*, p 0.033) Formative assessment teacher actions (0.291**, p < 0.001) Beliefs on engagement (0.205*, p 0.014) Teacher practices for engagement (0.272**, p < 0.001) Practices on constructivist learning (0.258**, p 0.002)

The socio-economic level of the territory to which the schools belong, and the characteristics of the institute have been decisive, because where there are more human, instrumental, and economic resources, the smaller size, and stronger relationships have enabled more processes of change and innovation to be activated than other more fragmented, less cohesive, and resource-poor areas, despite the efforts of teachers and school leaders.

It is interesting to note that the age and experience of teachers are a conditioning factor as well as the order of teaching and the emergency. More experienced teachers do not need to use summative assessment to control the class and gain student respect. Similarly, primary school was the framework in which it was possible to offer formative assessment, a constructivist type of learning and to involve pupils more than in other orders, because of the different training of teachers, the reform of assessment introduced in a pandemic period and, as the data from the focus groups show, the tacit belief that older students did not need special support or attention. The institution of belonging also influenced the convictions of formative assessment and learning: the institutes numerically smaller, stronger identity

with coaching and teacher training practices have been decisive on agreed averages. In all three schools, however, the management of integrated digital education has been complex but seen as an opportunity to innovate or improve certain teaching practices and to give new impetus to teaching professionalism.

From several visual angles (open responses in the questionnaire, reflections emerging in the focus groups) it emerges that convictions and practices are difficult to change, especially if they are conditioned by the experience of the students and because of short and urgent delays. Training is seen as useful for this purpose but often too far removed from the daily practice of teachers, weak in its applicability in didactics, and ill-suited to profound transformation. In this regard, teachers report that they have not received adequate initial training on the subjects covered by the research and on assessment, apart from those in primary education with a university degree, and on digital education; continuing training is also judged in the same way as it was during the pandemic period.

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The design and implementation of the Online Bachelor's Degree in Spanish Language and Literature at the University of Burgos and the new challenges facing ChatGPT

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Abstract

In the 2014-2015 academic year, the University of Burgos (UBU) launched online degree programs after the approval of the University Council and the positive evaluation of the Agency for the Quality of the University System of Castile and León (ACSUCYL). The UBU has been a pioneer in this methodology at state universities in the region. Despite initial success, the emergence of AI tools like ChatGPT has led to a much-needed overhaul of the evaluation process. This study focuses on analyzing the UBU's online teaching model, particularly for the course "Grado online en Español: Lengua y Literatura".

The UBU's pedagogical approach is student-centered, fosters active learning, and adapts to individual needs. The role of the teacher becomes that of facilitator, while the student becomes the protagonist of learning. Students must develop digital skills to learn anywhere and communicate via digital tools.

Online assessment is based on continuous activities that promote long-term learning. Tests include participation in forums, practical case-solving, and final exams. However, the break-in of ChatGPT has raised challenges in maintaining academic integrity. Students can use AI to cheat on assignments and tests. This required a review of the evaluation criteria and the adoption of measures to prevent plagiarism.

In conclusion, UBU has created a dynamic virtual environment for online learning, but the emergence of ChatGPT and the like has necessitated a reconsideration of online assessment and plagiarism prevention. Teachers must adapt to new challenges and develop strategies to maximize the benefits of AI without compromising academic integrity.

Keywords: E-Learning, Instructional Design, ADDIE, Online Assessment, ChatGPT.

1. Introduction

In the 2014-2015 academic year, the University of Burgos (UBU), after receiving verification from the University Council (Ministry of Education) and a positive evaluation from the Agency for the Quality of the University System of Castile and León (ACSUCYL), began offering degree courses online. This initiative was groundbreaking, positioning UBU as the sole public university in Castile and León to adopt this innovative teaching methodology. From the outset, student reception has been positive, with enrollment figures increasing annually. The success of this venture can be attributed to effective instructional design, the careful selection of learning activities, and, primarily, a fully virtual assessment approach. However, the emergence of ChatGPT and other AI tools has necessitated a reassessment of our model. This study aims to analyze the pedagogical model of online teaching at UBU, focusing specifically on the design, implementation, and evaluation of the *Online Degree in Spain: Lengua y Literatura* program.

1.1 E-Learning

Online learning or e-Learning can be defined as training in which teaching-learning processes take place through the Internet thanks to a virtual environment, usually an LMS platform, such as Moodle at UBU. In other words (Stokes, 2004):

> *It is a concept that encompasses teaching/learning activities in the cognitive and/or psychomotor and affective domains of an individual learner and a support organization. It is characterized by non-contiguous communication and can be conducted anywhere and at any time, making it attractive to adults with social and professional commitments (Holmberg, 1989, p. 168).*

Área and Adell (2009, p. 2) define e-Learning as:

> *A teaching-learning modality that consists of the design, implementation and evaluation of a course or training plan developed through computer networks and can be defined as the education or training offered to individuals who are geographically distant and who interact with the teacher at a deferred time, using computer and telecommunication resources. The characteristic of e-learning is that the training process takes place completely or partially in a classroom or virtual environment where the interaction between teacher and student takes place, as well as the students' activities with the learning materials.*

Distance learning (Cabero Almenara, 2006) is becoming increasingly widespread, especially in higher education institutions (Dumford & Miller, 2018). A pioneering case among Spanish public universities was that of the University of Burgos, which since 2014 has been offering five official degrees in online mode: Political Science and Public Management, Spanish: Language and Literature, History and Heritage, Computer Engineering, Tourism and from 2023/23 Psychology. All these degrees are verified according to the standards of the Ministry of Education and, therefore, lead to a 100% official degree. Slide (2020) refers to eLearning "as any learning experience that takes place on a digital device, such as a computer, a tablet, a smartphone, or some other device" and can be synchronous or asynchronous, active or passive. We conclude with Arshavskiy (2017) who states that e-Learning is a form of learning conducted through the Internet, intranet, network or CD-ROM. Successful eLearning courses are interactive, dynamic, and engaging for the learner's auditory, visual, and tactile senses.

1.2 Role of the teacher and the pupil in e-Learning

In online teaching, the role of the student and the teacher is very different from face-to-face teaching (Martínez, 2008). In the traditional university classroom, the teacher is generally the main mediator of learning, learning originates from him and takes place through a synchronous interaction between teacher and student through expository lectures supported by materials such as textbooks, photocopies etc. In this way, the student gains knowledge.

In a virtual context, on the other hand, the relationship is not direct, as the student interacts with a device or a computer. As a result, the teacher's role is that of a facilitator, communicating with students asynchronously (via email, forum, LMS platform etc.) or synchronously, via video conferencing with Teams, in the case of UBU. The materials will be multimedia resources such as texts, infographics, videos, podcasts etc. In this context, the student builds his or her knowledge. Of course, the role of the student also changes, now becoming the center of training. When we talk about virtual learners (Gros, 2011, p. 41):

> *We are not necessarily referring to a student in a fully distance course or training, but to a student who in the context of his or her educational path is in a digital environment, whether it is a single complementary activity in a face-to-face course or a fully virtual course.*

Students must develop skills to communicate and learn from anywhere through digital tools, but the role of the teacher must also adapt to face-to-face teaching, which usually takes place with expository lessons and therefore must develop the following skills (Alonso Díaz & Blázquez-Entonado, 2009):

- Technological: knowing how to effectively use the tools of the virtual platform.

- Didactic: have the ability to adapt to new teaching methodologies, design virtual learning environments, and create meaningful materials and assignments for students.
- Accompaniment: monitor each student's progress by providing *feedback* and knowing how to make changes (Castaño Garrido, 2003).

Regarding the latter aspect, we must add that in virtual contexts virtual tutoring must face new challenges and problems that would not arise in a face-to-face or traditional environment and depending on how they are approached they will have different effects on students. Online spaces are configured as places that facilitate interactions between the teacher and the student or participant in the training activity, where the role of the tutor or lecturer of the course changes compared to the traditional environment. Ultimately, the virtual tutor performs organizational, academic, technical, guidance, and social functions that are very important in an online learning environment (Cabero Almenara, 2004; Llorente Cejudo, 2007).

2. Objectives and methodology

Starting from the previous premises, the objectives of our work are to analyze the educational design, methodology and evaluation process of the subjects of the online degree program in *Español: Lengua y Literatura*. In addition, we will take care of a very important part in the implementation of these courses of study, namely the assessment that is carried out completely online since the physical presence of the student at the university is not required. Instead, if he/she wishes, he/she can discuss the thesis in person, otherwise it is done via videoconference. Instead, in the current situation, the entire evaluation process has been turned upside down and called into question with the advent of ChatGPT and other AI tools such as Bing, Copilot Gemini.

Compared to the same traditional degree, the online mode offers some differences in implementation. According to the Plan of Didactic Organization of the Official Bachelor's and Master's Degrees (Approved by the Government Council on 14/02/11 and modified by the Government Council on 13/02/13) at the University of Burgos, the subjects of the Language and Literature Course belong to Type 75, i.e. eminently theoretical and the subjects of External Internships and Degree Theses, which, due to their characteristics, are not likely to fall into a specific typology as they do not imply teaching). Therefore, type 75 means that, in the face-to-face mode, 75% of the activities correspond to the main or theoretical group and the remaining 25%, to the secondary or practical group; while, in the online mode, due to the characteristics of this mode, the typology of all subjects becomes 50, i.e. theoretical-practical subjects, with the activity load divided at 50%.

As far as the method is concerned, both the instructional design and the guidelines followed in the creation of materials and activities and the evaluation of the different subjects were analyzed. The teaching staff of the online courses receive thorough training from the Virtual Teaching Centre (UBUCEV) which standardizes the format of the materials and tests, as well as provides detailed training on methodologies applied to e-Learning, electronic tools for learning and, in general, the use of ICT, all geared towards management within the UBUVirtual Moodle platform. In addition, we considered the existing literature on the impact of AI in online assessment, of course, ChatGPT is a recent phenomenon, although, we must point out that *peer-reviewed* articles are still few.

In UBU's online courses, the educational model places the student at the center of the educational process, ensuring learning through skills as required by the European Higher Education Area (Martín Domínguez & Lavega Burgués, 2013; Mayorga Fernández & Madrid Vivar, 2010; Valor Yébenes, 2010).This model seeks to apply ICT to the educational environment to enhance students' digital competence and enable them to take an active role in their lifelong learning process. Being a dynamic and flexible model, it adapts to the needs of each student, since he is the protagonist of learning. In addition, innovative methodologies are used to foster active learning (Serna Serna & Sanz Manzanedo, 2022; Universidad de Burgos, n.d.).

2.1 Instructional Design: ADDIE

In the creation of a training proposal, it is essential to pay particular attention to the didactic design, as we can see in numerous studies (Chaves Hidalgo & Umaña Mata, 2017; Díaz Díaz & Castro Arévalo, 2004; Madoz, 2009; Martínez Rodríguez, 2009; Umaña Mata, 2010). *Instructional design* consists of the task of preparing and designing resources and environments, in this case virtual, necessary for learning to take place (Brunner, 1966). The teacher must plan the objectives, content and activities that he/she will propose to achieve the learning objectives (Tourón & Martín, 2019). Among the various *instructional design* models, we have the ADDIE (Military & Molenda, 2003), which is the one used at the University of Burgos in the design of online study courses. This instructional design with the phases of Analysis, Design, Development, Implementation and Evaluation and is based on an LMS platform, Moodle, called UBUVirtual (Abella et al., 2011), which allows us to create our learning environment. It is organized in blocks or study modules, the assessments are designed according to the objectives as well as the materials (videos, presentations etc.). UBUVirtual is the structure of the course and allows interaction between teachers/tutors and students/participants.

In the case of the subjects under analysis, the structure is usually organized in blocks, starting from the program that makes up each of them, as well as a generic or introductory one, in which the basic resources or activities in the development of the subject are present. In the online mode, the "forum" resource is in the foreground, with the news board, through which the teacher sends the weekly or monthly schedule; the question forum, where students can communicate with the teacher to ask any type of question on the subject and, at the same time, facilitate interaction with both the teacher and other learners; and the presentation forum, used exclusively in the first weeks for a first approach and acquaintance between all participants.

In addition, following the guidelines recommended by UBUCEV, the subjects include the resource "visualization sheet", in which the subject is presented through a series of cards detailing the methodology, assessment, study guidelines, and teacher lessons. Particularly relevant is the video presentation on all these issues, made with the assistance of UBUCEV and with the visual-narrative participation of the teacher, which allows the student, in about 5 minutes, to have a complete and effective vision of the subject he is about to address. Finally, this introductory block also includes the Calendar and the Initial Activity of the course, basic information for the personal organization of the learner on the one hand, and to start in the first days with first contact with the subject, on the other.

In any case, the need for interaction between teachers/tutors and students/participants becomes the cornerstone of online learning and is preferably achieved using forums. This design is complemented by the thematic blocks, in which the necessary materials are provided to acquire continuous and progressive learning by the students, allowing them to organize themselves more autonomously, but always under the supervision and interaction of the teacher.

2.2 Content Creation and Activities

It is important that the teaching staff of the online course develop activities and materials to make working in the virtual environment more stimulating and motivating. Concerning the creation and selection of materials, certain criteria should be considered in online teaching (Cabero Almenara & Gisbert Cervera, 2005; Camacho Zúñiga et al., 2014): first of all, select the content; choose the digital tool to present them; choose materials: videos, tutorials, links, texts, images, infographics and more; create coherent and uncluttered materials, use a script for videos; provide materials that involve practice and, as far as possible, collaborative activities etc. (Cabero-Almenara & Román, 2006; Iglesias Alonso & Lezcano Barbero, 2012). Concerning the activities that are part of the continuous and/or final evaluation of each subject, it is important to consider that:

> *E-activities will help us transition learners from a passive to an active role. Learning is not exclusively about memorizing information but rather about restructuring it. Ultimately, we need to engage in genuine e-learning activities, not merely e-readings (Cabero-Almenara & Román, 2006, p. 8)*

An analysis of the materials across various subjects of this degree course reveals certain shortcomings. For instance, many subjects predominantly rely on e-reading materials, with documents almost exclusively in PDF format. Conversely, other subjects incorporate instructional videos, gamification activities, presentations, and additional tools that significantly enhance both the delivery and the engagement with the course content.

2.3 Assessment Process in Online Degree

Online assessment refers to one that uses technology to assess a student's skills, knowledge, and abilities through digital platforms such as web applications, mobile devices, or computer-based tests (Al-Maqbali & Raja Hussain, 2022). Without a doubt, the huge innovation of this university lies in the fact that the entire evaluation process takes place online through assignments, exams and other tools to measure student participation and involvement, such as forums and debates that can be implemented in them (Rodríguez Gómez et al., 2015).

Assessment tasks should promote the type of learning relevant to the needs of the 21st century and contribute to the achievement of the goals that students seek to achieve. Therefore, it is essential that through the proposed tasks, students develop combinations of knowledge, skills, and abilities, as well as attitudes that will be essential for their future career path (Gulikers et al., 2006). The main goal is the creation of assessment tasks that foster the disposition and preparation necessary to cultivate lifelong learning (Barrientos Hernán & López-Pastor, 2017; Carless et al., 2006). For example, in authentic assessment tasks, which must meet the following essential aspects (Wiggins, 1998, p. 25):

a) Knowledge Building: involves students organizing information in a meaningful way.
b) Disciplined Research: knowledge of the fundamental contents of the subject and written communication to promote understanding and knowledge.
c) A value beyond the merely academic: connecting problems to the world beyond the classroom and engaging the public beyond the academic context (Rodríguez Gómez et al., 2015).

As far as the evaluation method is concerned, the UBU model is that of continuous evaluation, as stated in the Evaluation Regulations of the University of Burgos (UBU, 2019, p. 3):

> *The process of adapting to the European Higher Education Area requires a significant change both in the teaching methodology and in the evaluation of this teaching and its results. The examination of the contents as the only source of evaluation must be replaced by a continuous formative evaluation of a multiple nature over time by the teacher. The assessment of learning is broad-based, as it is not only a question of assessing the acquisition of knowledge, but also the acquisition of skills that are fundamental to the development of the profession to which the title leads.*

Defining continuous assessment (ivi, p. 4) as

> *"the systematic collection during the teaching period of relevant information for decision-making about the assessment of learning outcomes, as well as the attribution of assessments indicative of each student's academic progress".*

Assessment in online courses is educational, continuous, and competency focused. From the analysis of the guides of all the subjects of the degree in Spanish Language and Literature, we can see that 100% of the courses include continuous assessment tests with a weight of 60% to 70% and from 30% to 40% for the exam or final exam.

Continuous assessment tests usually include:

1. Participation in forums: in most subjects, meaningful and relevant interactions are evaluated with a weight of 10%, i.e. 1 point on the final evaluation.
2. Solving of practical cases: comments on texts, syntactic analyses, book reviews, theoretical questionnaires, essays, group work and some more innovative ones such as the creation of *Webquests*, video presentations etc.

The final assessment tests are generally of three types: practical, e.g. a final project; theoretical: a written exam with multiple-choice, open-ended, or mixed questions with a limited time, or oral exams via videoconference. To prevent fraud, there are mainly two systems: *Smowl* to prevent identity usurpation and *Turnitin* to avoid plagiarism from online sources.

2.4 The break-in of ChatGPT and its impact on online evaluation

ChatGPT appeared in November of 2022 and revolutionized education with both positive and negative aspects; As teachers we can explore its potential and make it our assistant to relieve us of some tasks that this chatbot can perform in a matter of seconds. The important thing is to design a good command or instruction (Esnaola, 2023; Morales-Chan, 2023; UNESCO, 2023). Of course, this had a disruptive impact on this type of evaluation and already in April the first cases of plagiarism occurred (González, 2023a) and then the first complaints were filed against the department (González, 2023b). We also find interesting studies on the effects of the appearance of ChatGPT and the effects on online evaluation.

The situation is not to be underestimated and requires urgent measures to re-examine all the criteria and the method of evaluation, but this is a problem not foreign to the rest of the universities, although there is no doubt that its impact on online assessment, due to its characteristics, can be more disruptive as the possibilities of deceiving the system increase, as ChatGPT and other AI applications are capable of performing some tasks in a matter of seconds. In a study carried out by Malinka et al. (2023), they analyzed the types of tasks and performance with and without ChatGPT, as well as the different uses that students make of them:

a) Copy and paste, where you are simply asked for an assignment and copy it as is.

b) Interpretation mode, where they interpret the AI's responses also using their point of view.

c) Assistant mode, the most advanced mode, where the user must fully understand the AI's responses, correct any errors, and ask specific questions to get the most value from the answers offered and maximize the potential of the AI system.

This option requires interaction with the AI and more time than other modes.

In addition, ChatGPT can be used in exams or final exams (Malinka et al., 2023), which, as we have said, usually correspond to 30-40% of the final assessment. For example,

1. developmental exams, in this case, ChatGPT can be used in copy and paste mode, the *Turnitin tool* does not detect it and remains at the discretion of each teacher's acumen.
2. multiple-choice tests or questionnaires: Since ChatGPT can provide us with both the answer and the explanation, it can be used in both copy and paste mode and interpretation mode. In the case of an essay-type final or intermediate test, you can use ChatGPT or AI to write it or even to help write it. In the latter case, the AI writes some parts and the student others.

The irruption of AI has negative and positive impacts on the assessment:

- *negatives*: Because it makes it easier to cheat than before, this is a problem, especially for less experienced students.
- *positive*: It can be used as an assistant for students and also for teachers, saving time on mechanical tasks such as creating programs, rubrics, corrections etc.
- *neutral*: in some activities the AI does not have valid results, in the case of links or bibliography it can produce plausible results, however, if verified, we can see that it invented them, we are talking about a phenomenon called "hallucinations".

3. Discussion

For the design of the subjects of the *online Degree*, the guidelines established by the UBUCEV were followed, which in turn collected the ideas summarized in the previous paragraphs. The instructional design of the platform's subject blocks accommodates various subject-related content so that the learner can actively participate in learning. There is a theoretical-conceptual part that the student must

necessarily acquire; In this sense, digital reading is a preliminary and inevitable step, since first of all it must know the context in which the rest of the theoretical-practical activities will take place, this step should always be facilitated not only with written documents but with other more engaging multimedia products such as presentations, videos, interactive activities etc. All topics present their theoretical contents based on the models provided by the UBUCEV which, as mentioned, provided all its materials based on the implementation of the ADDIE model. Subsequently, the practical content was designed, for which it is appropriate to select different tools to present it. In this case, these multimedia materials (videos, tutorials, links or images) may have been created specifically by the teacher or you may have resorted to available resources.

The method of delivery of the subjects of the degree is asynchronous, although in many of them, the tool of weekly, or monthly tutoring or at the student's request is usually used.

Regarding the irruption of AI and its impact on the evaluation of these online degrees, following some studies such as that of Malinka et al. (2023), some changes become necessary.

Detection: It is important to use tools to detect texts written by AI, however, currently some tools perform better in the English language. There are software such as (Amigot, 2023) *GPTZero* and *Crossplag* that do not detect if the text has been created by the AI in languages other than English, when tests are done in Spanish the results are often disappointing.

Prevention: perhaps, nowadays, it is one of the aspects on which we need to work the most, investing time and energy to make students understand the importance of academic integrity for their learning and their personal and professional future. Some form of restriction can also be introduced, although, in the online mode, it is difficult to implement since over the years it has been characterized by its flexibility.

Adoption: it would seem to be another of the best solutions, that is, to be aware that it will be used and design a type of task that, although they allow its use, oblige students to implement cognitive strategies that improve their learning since AI can produce certain advantages.

In light of this, urgent changes in the mode of assessment become necessary, prioritizing types of assignments in which the student's creativity and critical spirit are involved. We can mention, for example:

- creation of diagrams or concept maps (providing us with the tools because AI also has tools to create them in a matter of seconds).
- videos and oral presentations: here the student will have to have conducted preliminary research, perhaps he has used AI, but he will only have to use it as a guide because then he will have to make the slides and put his dialectic skills into practice; Other possible activities are the creation of infographics on a given topic; research papers that require comparisons between various dictionaries and sources, personal reflections, interviews to study a specific phenomenon or linguistic variety etc.

Another type of activity could be to ask the AI to carry out a task so that students can then critically evaluate it, identify errors and inconsistencies, or carry out oral exams via videoconference.

Finally, there are also concerns or perplexities about a "race" between AI detectors and generator companies as AI technology continues to improve. That said, OpenAI is exploring the possibility of introducing some sort of markup in the produced text. These marks would not be visible to humans but could be tracked by detectors to check if the content is entirely generated by an AI. In addition, let's not forget that currently, these software do not give high-performance results in languages other than English where they can identify if the text has been created with the help of Artificial Intelligence.

4. Conclusion

In summary, as we have been able to see in this work, in the implementation of online degrees it was essential to follow careful planning of the instructional design, activities and digital tools, always remembering that in technology *less is more* and that it is preferable to choose fewer tools, but with great performance of use. We also planned collaborative, contextualized, meaningful, and active

learning activities and tasks. In addition, we believe it is essential that students receive effective feedback in online activities (Avella-Ibáñez et al., 2017; Alonso et al., 1997; Huber, 2008), which is why we recommend video feedback to show students their strengths, weaknesses and how to improve. These fixes can and should be integrated and implemented to improve their future online activities. Another tool used to provide (Shute, 2008; Wiggins, 1998, 2012) *feedback* is tutoring video conferencing.

In the educational model of the online degrees of the University of Burgos, the student is at the center of the educational process, ensuring the learning by skills required by the *Espacio Europeo de Educación Superior*. In addition, it features a dynamic and flexible template that allows it to adapt to the needs of the student and any subject of the online degrees offered. It should be remembered that already in 2006 the Commission for Innovation and Methodologies of the University declared that "university teaching will have to respond to different teaching-learning situations, ranging from the most conventional and traditional to the most innovative, such as non-face-to-face teaching" and the online environment is the most suitable for innovation precisely because of its peculiarities and the different teacher-student roles (Serna Serna & Sanz Manzanedo, 2022; Universidad de Burgos, n.d., Ministerio de Educación, 2006).

There is no doubt that one of the strengths of the online degree courses of the University of Burgos and in particular of the Language and Literature degree course is the continuous evaluation process entirely online. But although the irruption of ChatGPT has disrupted this assessment model, it is possible to make some changes to the required subjects and activities that lead students to reflect on its use which, if it is used, must be in assistant mode to improve the student's activities and have *feedback* on the process of the assignment. This mode requires both the teacher and the student to negotiate with the AI to reach the desired solutions, usually takes time and is not as automatic as when we use it in copy and paste mode. In the case of the teacher, he can use it to carry out more mechanical tasks such as creating evaluation rubrics, scheduling adapted to our needs, translations, summaries, chatting with a PDF, creating a presentation in a short time etc.

In addition, to ensure authentic answers, students should be asked questions that require personal reflection or specific contextual information that requires the use of critical and creative thinking. However, other types of assessment can be considered, such as group discussions, oral presentations via video conferencing, and peer evaluation, to avoid the use of ChatGPT (Al-Maqbali & Raja Hussain, 2022).

It is very important, therefore, that the teachers of this virtual mode, but also those who carry out their role in presence, receive training on ChatGPT and other AI tools for several reasons: the first, is that it can be of great use for themselves as we have already mentioned, the second because it is necessary to know these tools in order to be able to teach students to use them responsibly and third, They need to understand some signs of their fraudulent use in order to be able to take the necessary measures.

Another aspect that deserves a separate study is the ethical aspects of using ChatGPT given the high risk of *bias* and misusing it (Al-Maqbali & Raja Hussain, 2022).

In this regard, rather than prohibiting it, we suggest using it to increase or improve learning, especially in asynchronous online degrees such as those of the University of Burgos that do not have the constant presence of the teacher. For example, students could use ChatGPT to generate ideas for their essay-type assignments by sending ChatGPT their prompts, and the AI tool should generate suggestions for the supporting topics, contexts, and arguments. This would help students overcome writer's block and produce high-quality assignments. This is especially useful when lecturers are not present to assist students qualitatively. Additionally, institutions such as UBU could provide students with access to ChatGPT for exam preparation. Lecturers would create mock exam questions, and students could send them to ChatGPT, which would generate answers based on the course content. This would help students assess their knowledge (Al-Maqbali & Raja Hussain, 2022).

Ultimately, the online mode, perhaps even more than the face-to-face one, needs an update of the evaluation and constant training of the teachers who participate in it given the numerous and rapid changes to which it is subject.

Finally, to conclude, we would like to emphasize that, according to some research conducted, so far no major differences have emerged between the face-to-face and the online mode, the choice between the

two modalities will depend on the preferences or situations of each learner and his or her situation. Therefore, a good (Allen & Seaman, 2016; Means et al., 2010) *instructional design* and the involvement of the teacher are always essential, as is often the case in face-to-face training. A professor "present" online, who creates personalized and quality feedback and monitors students' progress will make a difference as often happens in face-to-face courses, especially since ChatGPT cannot replace the work and guidance made by teachers.

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A Moodle-based decision support system to support school governance

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Abstract

This paper describes a decision support system for school leaders created by using the Moodle platform as a basis and making integrations and customizations such as to transform it into a system which, in addition to allowing the management and provision of training courses, can be to support the decision-making processes of an educational institution. Skills management ideas have been outlined, specific functionalities have been described that can meet the needs of managers, innovative ideas based on skills management have been proposed for staff allocation on activities and intervention planning professional update. The project idea was evaluated through a comparison with some school managers of the Campania Region and the positive feedback is encouraging for the start of a trial.

Keywords: Moodle, Decision Support System, Competence, School, e-Learning.

1. Introduction

Towards the end of the 70's of the last century we started talking about decision support systems (DSS) and soon a lot of interest and great expectations arose around them. With the technological evolutions mainly in the Information Technology sector in the following years, great enthusiasm arose due to the fact that DSSs had high analytical and information potential since they are capable of really contributing in decision-making processes. Clearly, in the years that followed, DSSs evolved by offering support of various kinds (structured information, analysis tools, unstructured knowledge) and in various contexts (operational management, financial management, strategic decisions). This type of systems, by their nature, being in general systems able to offer support services to decision-making problems typical of governance, goes well with the principles of service science for which providers (i.e. the system) and clients (i.e. the manager) interact each other, work together to create added value. The principle is to build a base that can act as a guide in solving problems, a base in which experience can be used at run time, stored and capitalized to be correctly archived and reused, an aid system in the task to make decisions that is often delicate.

The advantages of applying these systems in governance contexts are numerous and this can be true both in the business world and in the world of education where the figure of the School Manager is now increasingly close to that of manager-entrepreneur. Usually, in these contexts, information systems are completely absent or they are used to respond to specific problems related to accounting, inventory management etc. They are practically never used to archive all the cases dealt with, the problems encountered, the allocations and assignments, as well as the performances obtained.

Indeed, in these situations, when the starting point is limited and incomplete, the formalization of a "database of situations" requires, often through low-tech means such as meetings and interviews, interaction with the school manager and the director of general and administrative services, in order to verify and evaluate the specific background of experience.

In this sense, decisions concerning, for example, the assignment of teachers to classes, the assignment of school collaborators to complexes or specific tasks, the use of external companies or personnel, the use of resources and structures, could depend on subjective considerations and, in any case, from elements that are complex to extrapolate and difficult to formalize and codify in order to automate the steps of a decision-making process.

In these cases, the only evidence available is the actions performed, parts of them, or any decision taken, unfortunately, without having any trace of the situation, the context, the contingency that outlines the reasons.

Starting from these premises, the objective of this work is to propose an approach for the creation of a governance support service that can be effective and applicable in school contexts where the presence of information systems is limited, but where the greatest needs are in the education environment and therefore driven or towable by solutions in which e-Learning is one of the functions offered and where the basis on which reasoning can be carried out is incomplete, small or even non-existent. A further element to consider is the budget available for the purchase of technologies which, in most schools, is always limited.

2. Reference context

Data-driven decision making in education has received an increasing level of attention (Sergis & Sampson, 2015). This process refers to the stages of collecting, analyzing and interpreting data at the institutional level to generate knowledge, practices and interventions in educational contexts (Mandinach, 2012). More specifically, within these complex social systems that inevitably change and adapt over time (Snyder, 2013), this data is generated by a multitude of interconnected actors (e.g. teachers, managers, students, parents, territory, infrastructure etc.) and can be collected mainly at two institutional levels: a micro level and an intermediate level. The micro level refers to the teaching, learning and assessment practices within the school (Van der Kleij et al., 2015). At this level, the decision-making process mainly aims at collecting student performance data to improve students' learning experiences and help achieve better results (Schildkamp et al., 2014). Instead, the intermediate level refers to the organizational development of school processes (Kaufman et al., 2014) and mainly serves to strategically support the school leadership in organizational choices related to the professional development of internal staff (Schildkamp & Kuiper, 2010) or infrastructure resource utilization planning (Breiter & Light, 2006; Lai & Schildkamp, 2013).

The use of data-driven decision-making processes serves to increase organizational effectiveness (Pistilli et al., 2014), since it can provide a basis on which to gather information about the institution and articulate communication between the actors within it. Consequently, there is a lot of research that is being developed both at a national level (Paletta, 2015; Cavalli & Fischer, 2011) and at an international level (European Commission report ET2020) for the identification of effective analytical methods to support the governance of schools in decision-making processes through the collection and exploitation of data from the functioning of the whole organization.

In the educational context, this objective is addressed by two fundamental approaches: Learning Analytics (LA) and Academic Analytics (AA) (Long & Siemens, 2011). LAs are aimed at educational institutions, online training (for example, Massive Open Online Courses - MOOCs) and mainly aim at providing decision support for the micro level (Long & Siemens, 2011). The AA, on the other hand, mainly aim at providing decision-making support at the intermediate level and therefore on organizational aspects (Daniel, 2015), even if in the strictly scholastic context there are no successful cases. This is because school managers need holistic data-driven decision support to effectively engage in their complex tasks, given the complex nature of schools (Sergis & Sampson, 2014). More specifically, these activities require data collection and processing at both institutional levels (micro and intermediate). Furthermore, with school autonomy, managers are now attributed a decidedly greater role of responsibility (Cavalli & Fischer, 2011) compared to the functions foreseen until the end of the last century and, therefore, a broad spectrum of tasks that the existing systems are not able to support (Kaufman et al., 2014). In light of this, it becomes apparent that the two existing analytic threads do not offer the capacity for the holistic decision support required by school leadership, given their isolated viewpoints. Therefore, the contribution of this work is to propose an approach that aims at filling this gap and, therefore, to facilitate the governance of school complexity by providing school managers with a system capable of monitoring the progress of school processes and intervene where possible to satisfy the needs of the actors involved, including the staff themselves and therefore the teachers, but also students, parents and anyone else who can benefit from the consequences of the aid of this system.

3. The customization of Moodle as a decision support system

A decision support system (DSS) can be a vital tool to help educational organizations deal with the complexity of managing day-to-day issues. Probably, their value does not lie in the ability to analyse data to provide forecasts, but in the real support they are able to give to executives to solve a problem and in the speed with which this support becomes available in order to visualize a situation, identify a strategy to apply and correct course.

Taking into account the reference context, among the existing platforms in the open source world, the one that can best respond to the identified needs is the Moodle platform. The first question that arose was whether Moodle could be used as a DSS. Technically, the answer is yes, but the question is whether Moodle as DSS is an effective solution. However, this is true for most systems, including those explicitly designed as DSS which, moreover, are often prohibitively expensive. A further consideration is related to the fact that, today, the most successful DSSs are in the fields of health care, clinical research, engineering and there are rare examples in use in the world of schools, education and learning.

So what is the way to set up Moodle as a DSS? The literature (Miller et al., 2017) identifies some reference areas to which a DSS should provide an answer and, apparently, Moodle offers a wide variety of resources and functionalities that can respond to these needs. A description is given below.

4. Communication and collaboration

One of the most visible transformations of DSSs in recent years is their ability to analyze information and make decisions collectively. In the past, in fact, many approaches for a manager did not contemplate the idea of involving others in the decision-making process. On the contrary, today, having integrated systems that offer the possibility of sharing knowledge and the possibility of communicating and maintaining communications seems to be a competitive advantage (Claudiu & Didraga, 2014).

Moodle has always been a collaborative system and recent improvements have enriched its messaging and notification features, not to mention the many plug-ins that offer tools for live streaming, archiving and sharing of resources.

Moodle itself is therefore already a tool that offers numerous functions and has considerable potential from the point of view of communication and collaboration. The platform has always been full of synchronous and asynchronous communication tools, collaborative work tools and, recently, the interaction via tablet and smartphone has been perfected with advanced interfaces and specific applications that make it absolutely capable of responding to the needs more disparate and connected to the problems of the governance of an educational institution.

5. Data-driven decisions

The value of data is no longer in doubt. Data has necessarily become a concern for those who manage it. The collection is important, but the management is fundamental through the use of analytical tools that are capable of providing a reliable data interpretation key, an objective interpretation, real support in decision-making processes. In educational organizations, this means that users, from students to teachers, from secretarial staff to school managers, expect quantitative elements, clear feedback on the activities carried out, a basis to support choices for future actions.

Moodle offers functions for tracking online activities and a report that is already quite articulated and customizable. Additionally, there is a set of plug-ins that extend these functions by providing comprehensive and customizable analysis charts and dashboards. Among these, we have identified the Analytics plug-in which supports three methods of aggregation according to the Piwik specifications, Google Universal Analytics and Google Legacy Analytics.

Thanks to this plug-in (Figure 1) it is possible to observe large quantities of data that can be aggregated in a customizable way to make easier analysis operations in support of strategic choices of school managers. For example, it allows the performance comparisons achieved in the various classes or of the time actually spent in the various activities both online and in person, the activities with the greatest workload and so on. In this way, all details that can be viewed and monitored, so as this plug-in becomes a reference for guiding interventions and actions in institutional governance.

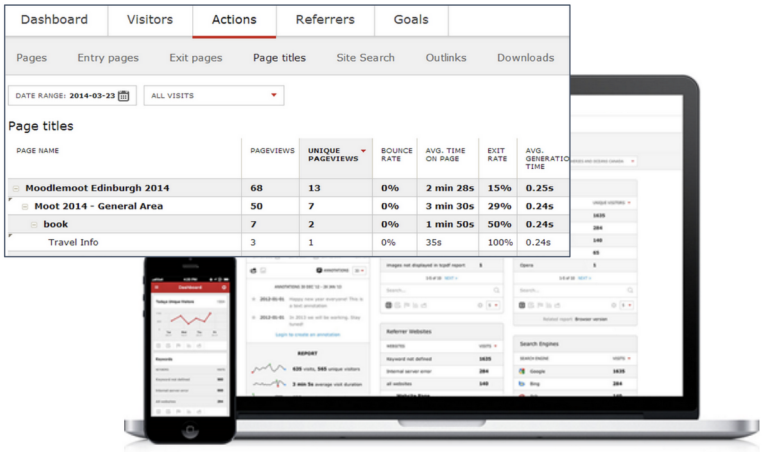

Figure 1 - Moodle Analytics plug-in for data analysis.

6. Competence management

The reference model with which to outline the skills needed by an organization requires a considerable initial effort. In particular, thinking a school allows thinking students, teachers, administrative staff, technical and auxiliary staff.

Naturally, when we talk about competences we think of different components: soft skills, abilities, skills, behavioral aspects etc. (Miranda et al., 2017). These are aspects for which the level of detail can be extreme and decidedly challenging. It is therefore essential to find the right compromise.

The skills then become a reference both for the training activities since they integrate and complete the learning objectives, and a prerequisite for carrying out the tasks since they help the governance in the choice of allocations. For example, they could refer to activities to be carried out for which specific skills are required. Having a clear and complete picture of the skills of the staff in service can allow the school manager to optimize the choice of "who does what" by minimizing the gap between the necessary skills and the skills possessed (skill gap analysis) and, for example, to be able to intervene with courses for professional development aiming at filling in the gap.

Moodle enables skill management. In the platform it is possible to activate the management of skills and create a reference framework for all the activities and actions managed online. This mainly for training activities, i.e. it is possible to specify for a course what skills will be acquired at the end of the course, what skills are expected to be possessed by those who participate if the evaluation is positive.

To integrate the framework, there are some plug-ins that enrich Moodle from the point of view of this kind of governance. To this end, two plug-ins Exabis Student Review and Exabis Competencies/ Competence grids have been identified and integrated. With these two integrations, the Moodle platform becomes able to offer functions and tools which, on the one hand, make it possible to declare the possession of skills and monitor their evolution over time, and on the other hand, represent tools for monitoring, comparing and managing tasks based on competencies (Figure 2). With this system and on the basis of the explicit competence framework, all users can express a self-assessment and outline their own competence profile, while the manager can also manage the activities (tasks), assign

them the necessary competences and numerically or graphically compare the profiles of people with the skills necessary to carry out these activities (skill gap analysis).

A last plug-in that has been used is Monitoring of learning plans, which offers functions for comparing people's profiles and the skills that can be acquired through participation in courses. In this way, the school manager who wants to program the professional updating of teachers or auxiliary and administrative staff, can evaluate the actual gaps and organize targeted interventions.

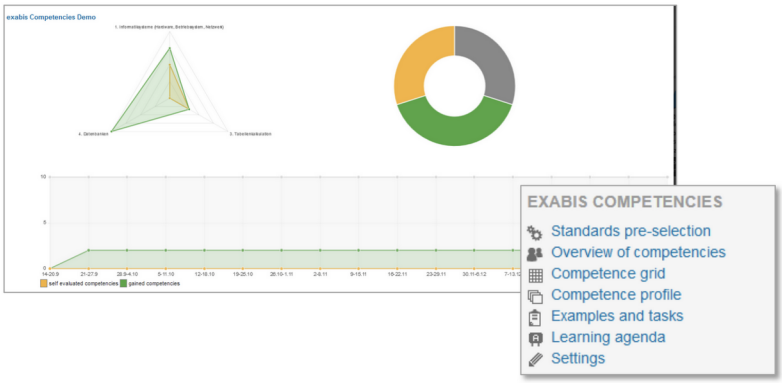

Figure 2 - Moodle Exabis Competencies/Competence grids plug-in for competence management.

7. Interface

Considering that the reference context has always been characterized by a low level of "technological specialization" (Legrottaglie & Ligorio, 2014), one last aspect that might seem marginal but which, for this context, is not at all, is the interface. The term interface identifies not only the aspects of graphics and visualization but also the aspects of usability connected to the available functions.

To improve the user experience, Moodle has enriched the graphic themes available in terms of design and made them work on devices other than computers, such as tablets and smartphones, as well as releasing specific applications for Android or iOS that complete the features of platform accessibility. But, in addition to improving features such as responsiveness, speed, ease of use, the Moodle community has always worked on customization. Being able to take advantage of this last feature, access to monitoring, controlling and planning tools has been made easy and direct. What has been created (Figure 3) is therefore a sort of dashboard for the school manager that can be customized on the basis of specific needs but which, in general, guarantees effective access to the functions and services that can really support it in the difficult decision-making processes in management and in organizing activities.

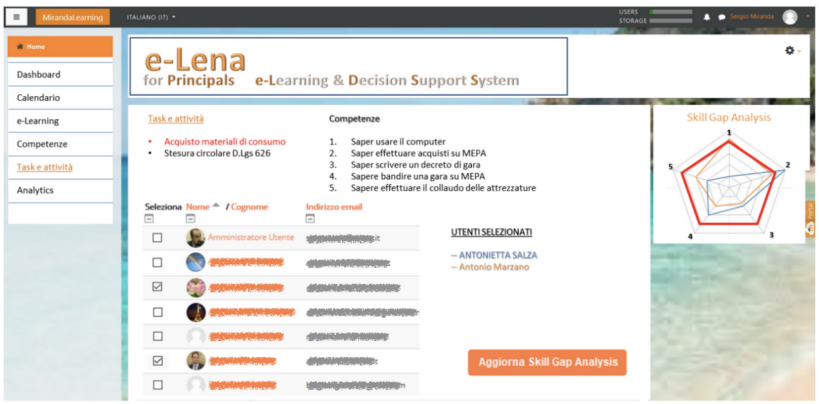

Figure 3 - Customizing Moodle as a DSS for Principals: e-Lena for Principals.

8. Conclusions and future developments

The prototype of the DSS described in this paper was presented to some school managers of the Campania Region (in province of Salerno and in province of Avellino) and the first evaluations are very positive. Obviously, being a prototype still being perfected, no feedback was formally collected, but through informal comparisons, we tried to identify needs and problems that could be addressed to improve the prototype. The greatest perplexities and therefore, consequently, the greatest criticalities are linked, on the one hand, to the modeling of skills and, on the other, to updating the database on which the system works.

In both cases, a considerable effort is required. In the first, for the modeling and preparation within the system of the semantic representation of the skills to which to refer. In the second, to always keep data, activities and allocations updated. It should be emphasized that the first is a one-off effort that remains valid for a long period of time. In the second, the effort can be distributed by delegating much to the users and therefore to the personnel in service through monitoring actions (questionnaires, self-declarations etc.). In any case, the opinions received are encouraging to the point of paving the way for the formalization of the intentions of some schools in Campania to start an initial trial.

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Online application for the early detection of students at risk of failing through Artificial Intelligence

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Abstract

A worrying trend that recently affected the university system is characterized by the students' drop-out. Universities usually link the problem with some aspects as study program, structure, and organization of the examinations, that require more involvement from students, that negatively affect their motivation. Even if universities make some improvement actions, as tutoring, to provide students the best approach for their studies aimed at promoting academic success and avoiding university drop-out, sometimes they don't seem to achieve the results expected. It can happen that the factors which led students to drop-out cannot be related to their approach in the study but can be due to the students' engagement and social interaction. Universities find out these factors only after students' drop-out, checking their activities and attendance only at the end of the academic year, too late for avoiding severe consequences. This work reports a possible solution to this problem by exploiting Artificial Intelligence methods based on machine learning, firstly applying clustering to group students according to their behavior and then implementing a classification model to predict students at risk. Once checked the accuracy of the machine learning models, the application designed and realized in this work has been plugged in an online platform to allow the universities' staff to easily execute the software supporting the students to achieve their goals in terms of engagement and learning outcomes. This is a contribution to reduce university drop-out, with possibility to improve the proposed application by user feedbacks and large amount of data collected.

Keywords: Drop-Out, Clustering, Classification, Machine Learning, Artificial Intelligence.

1. Introduction

Students' drop-out is a problem that has recently affected several universities and has had issues in terms of enrollment, revenue (for institutions and their hosting cities) and social issues (for the students and their families). University drop-out, especially after the covid-19 pandemic, has increased reaching percentages around 24% in Italy (Piazza & Rizzari, 2020), 31% in Netherlands and around 50% in Latin America (Opazo et al., 2021) that led to negative consequences in the students. The unsuccessful learning and consequent interruption of the educational path, indeed, can cause dangerous emotional states as depression and sense of inadequacy that identify a real psychological trauma (Kim & Kim, 2018). The university system usually tends to focus on the improvement of specific aspects when they try to find a solution for the drop-out, such as study program, structure, and organization of the examinations. Indeed, the motivation of a student often depends by the design of the teaching activities (Valerio, 2012) that have an important role in the achievement of learning outcomes. Several strategies have been implemented by universities to try to reduce the drop-out, such as the tutoring, which is a process aimed at supporting the different aspects of a student's learning development (De Santis et al., 2021) and that guides students to face the critical stages of their studies (Da Re, 2018).

Recently different type of activities have been performed to reduce this phenomenon as the peer tutoring for students with disabilities (Kowalsky & Fresko, 2002), e-Learning solutions (Sulčič & Sulčič, 2007) using also machine learning models (Nalli et al., 2021), software applications for improving students' performance (Amendola et al., 2023; Androutsopoulos et al., 2018) and online tutoring systems that provides automatic feedbacks to help students to write programming code (Nalli et al., 2023).

Even if universities make actions to provide to students the best approach for their studies, aimed at promoting academic success and avoiding university drop-out (Da Re, 2018), sometimes they don't seem to achieve the results expected. The reasons that can led student to leave the university studies could be indeed due to other factors as socio-economic condition (Guzmán-Castillo et al., 2022) and academic and social integration (Tentshol et al., 2019).

Universities identify these factors only after students' drop-out, checking their activities and attendance only at the end of the academic year, too late for avoiding severe consequences.

In this work we would like to propose a solution able to predict in advance students that tend to leave the university program providing them some actions aimed to provide a better engagement that can help them to improve its wellbeing and consequently its learning experience.

A new software has been developed, consisting of machine learning models aimed at identifying students at risk of failing based essentially on the students' engagement features.

Two research question have been considered:

1. Is it possible identify students at risk of drop-out based on historical data, using only students' engagement features?
2. Is it possible realize a model that predict accurately if new students can tend to university drop-out during the term?

2. Materials and Methods

This pilot study was conducted on a group of 146 students, consisting of Europeans, Africans, Arabs, Indians and Asians, engaged in several scientific undergraduate and master program at the University of Camerino. The collected data, extracted from questionnaires delivered online at the end of the last academic year, was properly anonymized before being processed. We considered, as relevant variables for this problem, the following features: academic behavior and several socio-economic conditions as degree course, student status, first enrollment year, accommodation on campus, meals on campus, scholarship, completed surveys, interested in topics, attendance to lectures, acquired CFU. Sex has been also included as a variable.

The data were entered into a dataset, characterized by one record per student, which represents the input file for Machine Learning processing.

Unfortunately, the dataset had some gaps, such as missing values and unstructured data, and needed to be pre-processed to be acceptable and executable by a machine learning model. It was adopted a process able to identify and replace missing values for each column in the input data, that is called missing data imputation. A popular approach for data imputation is to calculate a statistical value for each column (such as a mean) and replace all missing values for that column. Specifically the specific python method ("fillna()") was used, that permits to give an attribution method as an argument of each feature.

Once filled all the empty values, data was then normalized in a range from 0 to 1. To normalize the data, min-max scaling was applied to each column of characteristics.

Pre-processed the dataset, two machine learning methods, after a comparison between different clustering and classification algorithms (Brezočnik et. al., 2023) were developed in order to predict the students at risk of drop-out.

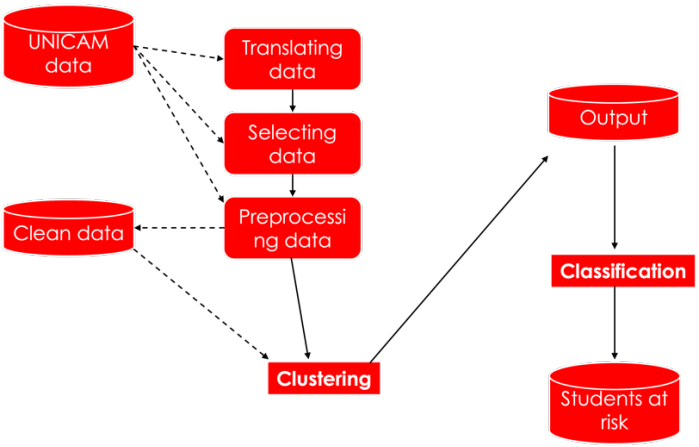

Figure 1 - Flow of the step needed to develop the online prediction tool.

Silhouette analysis was used to check the performance of clusters. The silhouette value represents how similar an object is to its own cluster (called cohesion) compared to other clusters (called separation). The Silhouette Coefficient is measured using the formula below:

$$S(i) = \frac{b(i) - a(i)}{\max a, b(i)}$$

where: *a(i)* is the average distance of the point "i" from all other points in the same cluster and *b(i)* is the smallest average distance of the point "i" to all points in the closest cluster (Yuan et al., 2019).

Classification models were instead compared using the accuracy metric, that represents the number of correctly predicted data points out of all the data points.

For binary classification, accuracy can also be calculated in terms of positives and negatives as follows:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

where TP = True Positives, TN = True Negatives, FP = False Positives, and FN = False Negatives (Favole et al., 2020).

3. Results

Is it possible identify students at risk of drop-out based on historical data, using only students' engagement features?

The clustering technique was used to identify groups of students with similarities in terms of engagement activities. The dataset used for the clustering process involved all the features, except for "acquired CFU", to avoid that students' performance could affect the creation of clusters.

The clustering algorithm was selected after a comparative analysis that involved four different algorithms to find the best one:

- K-means;
- Agglomerative Cluster;
- Density-based spatial clustering of applications with noise (DBSCAN);
- Gaussian Mixture Models Clustering.

The analysis highlighted the Agglomerative Cluster as the clustering algorithm with the best performance based on the dataset provided, achieving a silhouette value of 0.267 higher than all the other algorithms. It returned 3 main clusters, as shown by the Figure 2.

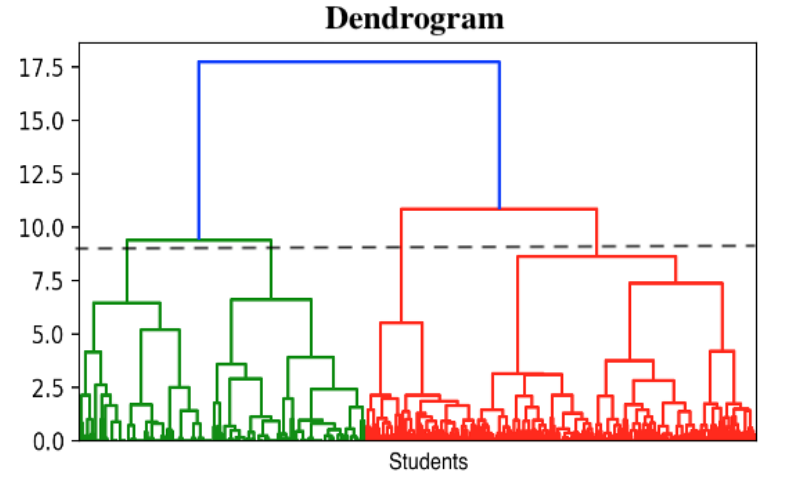

Figure 2 - Dendrogram that shows the 3 cluster returned by agglomerative cluster.

Once obtained the clusters, an analysis of the values related the students' features related to each cluster was analyzed to find out useful info in terms of engagement.

Specifically, it returned interesting outcomes that highlighted three different students' involvement in terms of social interactions:

- Low engagement;
- Good engagement;
- High engagement.

These results are supported by the results of the quantitative analysis, where cluster 2 represents students highly active in terms of social interaction, linked mainly to their presence in the university activities and facilities. This is confirmed by the high attendance at lectures during the academic year (97%), high use of university canteen (95%) and accommodation at university campus (scholarship) (100%). Cluster 1 represents instead students with a good level of engagement obtaining results that reflect the trend of cluster 2, even if with lower percentages. Specifically it returns good results in terms of attendance at the lectures (82%), use of the canteen (57%) even if none of the students in this cluster got the scholarship. However, the good impact of the social interaction is confirmed by the percentage related to repeating students (0%).

Cluster 0 instead is characterized by an opposite situation compared to the other clusters. In fact, even if the 4% of students got the scholarship, none of them attended lectures, and only the 12% used the university canteen. This cluster is also composed by 57% of repeating students.

The project continues with a comparison between the clusters and the CFU obtained at the end of the Academic Year (average) to check if the students' engagement can affect the university drop-out.

As shown by Figure 3, the students' engagement contributed to affect the final performance, with cluster 2 and cluster 1 that obtained higher average in terms of CFU acquired compared to cluster 0. Cluster 0 indeed not only obtained the low value of CFU achieved (67 CFU) but also for a significant percentage of students that didn't get any credits for a year, around 20%. Cluster 0 was the only one that involved students that didn't get any credits and this data was essential to identify the cluster at risk of university drop-out. The records belonged to this cluster were then labelled in a new dataset with the class "at risk", while the records related to cluster 1 and cluster 2 were labelled "not at risk".

Is it possible realize a model that predict accurately if new students can tend to university drop-out during the term?

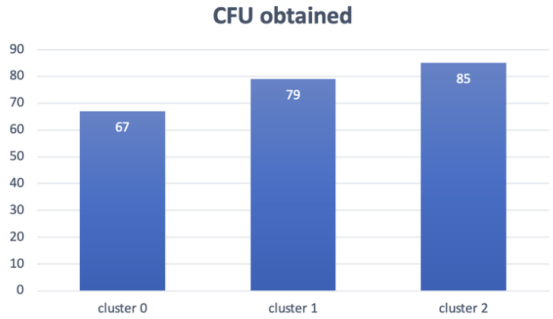

Figure 3 - Average credit acquired per cluster.

The new dataset was then used to implement a classification model to predict students at risk, which was then integrated into an online platform accessible to university staff.

The classification algorithm was selected after a comparative analysis that involved three different algorithms to find the best one:

- KNN;
- Decision Tree;
- Naïve Bayes.

The comparisons between the 3 classification algorithms returned Naïve Bayes as the best one, achieving the highest value with the 97% of accuracy that confirm the effectiveness and reliability of the model here proposed.

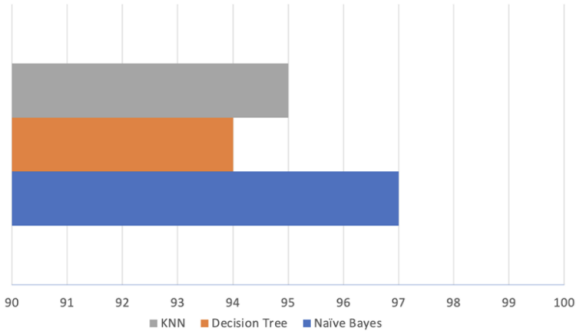

Figure 4 - Comparison between 3 classification model.

The classification model, developed in python, was then included in a web server, and plugged in an online platform to allow all the universities' staff, even if specific computational skills, to easily execute Machine Learning models and predict possible students at risk of drop-out.

The online platform takes as an input the students' data (file filled with the same features used in the dataset) and returns the prediction of students at risk.

With this support, university staff are able not only to obtain the prediction of students at risk, but also to monitor student data, providing the most appropriate support and helping them to successfully achieve their learning outcomes.

4. Conclusion

Students' drop-out can affect universities causing the decrease of the enrollments that impacts also negatively in social and economic terms for the institution where the most of budget comes from the tuition fees and from financial support correlated with the enrollment and the percentage of drop-out.

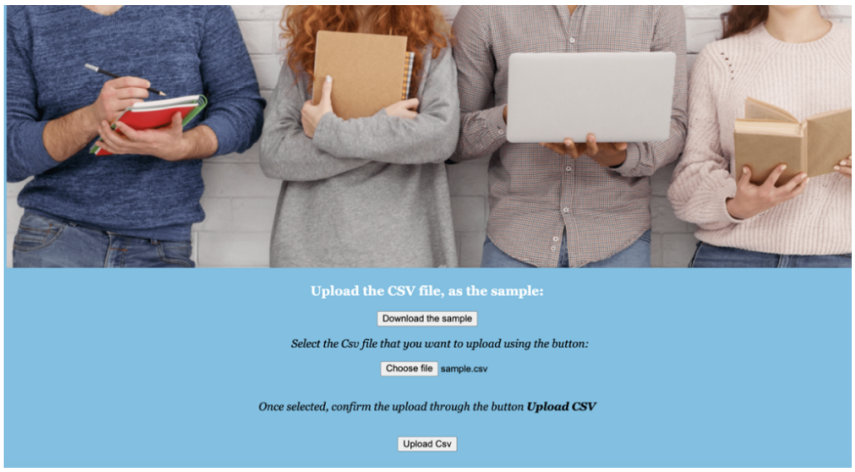

Figure 5 - Online platform for student at risk prediction.

Drop-out is a real problem that universities staff can't early detect, because of the lack of specific tools that identify students at risk of failing before the end of the academic year. Early prediction and warnings on the students' drop-out and identification of the factors that affect this phenomenon became a challenge for universities to avoid the students' leaving and the interruption of their educational path (Lye et al., 2010). In this work, we have designed and created two machine learning models aimed to assist the university staff with an on-line tool able to predict the students that are considered "at risk" of drop-out, based on their engagements and social interaction in the academic environment. The accuracy returned by the classification model confirms the effectiveness and the reliability of the software proposed. After the testing phase, an online platform has been implemented to allow the universities staff to easily execute the machine learning models to identify the students that tend to drop-out, to analyze the weaknesses and provide some actions that help the students to achieve their learning outcomes and successfully proceed their university pathway.

The next step could be characterized by the implementation of an Artificial Intelligence recommendations system, able to automatically provide specific adaptative solutions based on the needs of the students at risk of failing.

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Blending iVR with AI in teacher training for language educators

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Abstract

Increasing developments in educational technology have called for redefinitions of language pedagogies introducing the use of digital tools enabling multi-user interactivity and content creation. Given the increasing use of Artificial Intelligence (AI) to support collaborative work practices, it is expected that this technology will steadily shape students' language output in task-oriented learning activities. Therefore, there is the need to train language teachers to use AI in task-based language activities granting students' engagement and participation in contextualized linguistic practices. These competences can be supported by preparing language teachers to use AI with immersive Virtual Reality (iVR) for conducting classroom-based language activities based on hands-on collaborative practices in virtual spaces. However, the current literature lacks enquiries on language activities grounded on AI and iVR-based collaborative group work. Attempting to bridge this gap, this study presents the results of interventions conducted at the University of Arizona on language educators attending a teacher training on educational technologies and using the iVR platform Workrooms and ChatGPT. Data collected from observations of teachers' activities and a post-activity questionnaire will provide methodological suggestions for the integration of VR and AI in language learning contexts. This contribution will also give indications on the technological skill sets necessary to teach and learn languages with AI and iVR in order to socially and professionally interact in an increasingly digital world.

Keywords: Immersive Virtual Reality, Artificial Intelligence, Language Education, Teacher Training, Digital Literacy.

1. Introduction

The use of immersive Virtual Reality (iVR) and Artificial Intelligence (AI) has gained momentum in language education research, calling for redefinitions in the teaching practices targeted at students' development of collaborative digital communication. To promote the linguistic practices necessary to attain such skills, students can be involved in collaborative tasks where they co-create digital materials. In fact, such design practices in a foreign language can heighten language retention and involve students in co-constructing linguistic structures (Johnson & Johnson, 2005). To help the development of these skills, it is necessary to incorporate digital tools that afford the development of higher-order thinking skills and interactivity while using interoperable virtual systems breaking physical classroom barriers. However, due to the evolving nature of iVR) and AI, teachers need to keep their technical knowledge up to date and adopt pedagogical methods supporting students' digital collaboration. The present pilot study aims to answer the following question: which methodological indications can be retrieved from training teachers to use and experience iVR and AI to boost students' collaborative interactions? It is hypothesized that participants' possession of the technical knowledge facilitates their collaborative interactions in class planning, as it is necessary to conduct iVR activities with interactional fluidity and navigate ChatGPT with some degree of autonomy. The study attempts to identify the impact of the combined use of iVR and AI in devising language activities to boost students' collaborative interactions. It displays the results associated with teachers' exposure to iVR and AI through involvement in a task-based language activity conducted with the platforms Horizon Workrooms and ChatGPT. Data was collected through a mixed-methods analysis hoping to cast light on teachers' acquisition of pedagogical and methodological information necessary to boost students' collaborative skills in language learning scenarios combining the use of iVR and AI tools. Promising results will show overall high scores attributed to acceptance and usability of iVR

and AI for language learning purposes and provide useful information on the skill sets and instructional guidelines necessary to teach and learn languages with AI-supporting iVR tools.

The study was underpinned by a literature review of pedagogical and methodological considerations related to VR use in language education. In fact, the widespread implementation of highly interactive technologies has revolutionized interpersonal communication as individuals rely on computer-mediated communication (CMC) to successfully achieve professional and educational outcomes. From a CMC perspective, the deployment of iVR and AI tools has enabled individuals to attain high levels of realism in conducting collaborative virtual interactions and solving task challenges. Part of the reason behind such effective collaborative affordances can be found in the nature of iVR and AI tools. In fact, while the former is defined as an "advanced form of human-computer interface that allows the user to interact with and become immersed in a computer-generated environment in a naturalistic fashion" (Eichenberg, 2012, p. 3), AI is intended to broadly incorporate "computational systems involving algorithms, machine learning methods, natural language processing and other techniques operating on behalf of an individual to improve a communication outcome" (Hancock, Naama & Levy, 2023, p. 90). Amongst AI tools, ChatGPT has gained worldwide interest since its release in November 2022 as a large language model (LLM) trained to assist users in optimizing communication goals, solving and processing assigned tasks and sourcing information (Baidoo-Anu & Owusu Ansah, 2023; Bitzenbauer, 2023; Adiguzel, Kaya & Cansu, 2023). In late 2021, Meta released Horizon Workrooms, a highly interactive iVR platform allowing people to interact through avatars in a virtual meeting room equipped with a whiteboard, projectors and three options of desk configuration (Hendrick et al., 2022). The environmental affordances of this iVR space make it usable as a virtual language learning classroom. Implementing these tools in language education has redefined the pedagogical underpinnings behind collaborative language learning. In fact, with the increasing permeation of VR and AI in language education, researchers have enquired about the kind of skills students may develop in educational contexts that are increasingly blending in-person and remote learning practices. This implies considerations on the kind of competences that students should develop to interact in a foreign language with human and virtual agents. In fact, interventions have shown that critical skills development facilitates good judgement in group dynamics to assist users in making the best decisions to achieve specific target goals whilst valuing contributions from all group members (Lipman, 1988). This is relevant from language education perspectives as to collaboratively conduct group activities with the use of technology, individuals need to be able to establish criteria validity and consistency criteria to assess digital materials, as well as being cognitively accountable and intellectually responsible of communicative and interactional decisions. Distributive collaborative situations of this kind imply the necessity to use iVR and AI technologies to help students develop the technical and linguistic skills to develop a social vocabulary of communication strategies with avatar-embodying peers and AI interfaces to search, optimise, question and select task-oriented output (van Gelder, 2005; Sharma et al., 2022). According to the Common European Framework of Reference for Languages (CEFR) by the Council of Europe (2020), developing this kind of foreign language competence is key to foster mediation strategies, critical thinking, creativity, collaboration, information, media and technology literacy as well as communication and social skills (González-Salamanca, Agudelo & Salinas, 2022; González-Pérez & Ramírez-Montoya, 2022). Facilitating the acquisition of these competences has often been challenging for teachers since it involves careful lesson planning and knowledge of the technologies to achieve language-based task goals (Sulaiman & Ismail, 2020; Haug & Mork, 2021). The situation is further complicated by rising concerns in the use of iVR and AI as language learning tools. In fact, whilst iVR has been deemed as increasing cognitive load and distraction. Moreover, students need to be aware that the information sourced via AI interfaces may not be trustable, hence demanding teachers to consider pedagogical as well as technical aspects when introducing AI in classroom activities (Calabrò & Naro, 2019; Makransky, Terkildsen & Mayer, 2019, Hou, 2020; Bozkurt et al., 2021; Kasneci et al., 2023). Therefore, thorough investigations on evolving language teaching practices may help to better understand system interoperability and social cooperation through iVR and AI interfaces.

From a task-based perspective, the introduction of AI in digital education has called for thorough investigations on the collaborative affordances of using artificial agents to assist students in

conducting assigned language tasks (Hockly, 2023). However, it has also raised issues of resource reliability, AI-based prompt provision and critical evaluation of information provision, enabling users to elicit pertinent responses and fine-tune questions and commands (Markauskaite et al., 2023). Training and assessing such competences amongst language teachers might help to shed light on crafting learning experiences fostering students' development of information sourcing and critical thinking to collaboratively source task-oriented information. However, further research is needed on integrating AI with iVR technologies in language education to compensate for a lack of multi-user engagement in using LLMs for learning purposes. A technology that might facilitate interventions of this kind is iVR. In fact, iVR language learning applications were shown to benefit students' collaboration and facilitations of teachers' class planning through classroom management tools and avatar interactions (Pirkkalainen et al., 2021). However, to integrate iVR technologies in language education, teachers must possess self-awareness and accountability, developed through prolonged exposure to the target technologies (Holly et al., 2021). Studies on iVR-based language education have highlighted its benefits for education and goal-orientation, including cognitive load reduction through avatar real-likeness, facilitations of group behaviors and increases in entitativity and enjoyment (Han et al., 2023; Makransky & Petersen, 2023). Therefore, for the successful implementation of these technologies, it is believed that teachers need to experience students' learning situations through collaborative class planning. In fact, teachers often lack awareness of how collaborative learning activities unfold through iVR/AI use, hence the need to increase their exposure and hands-on experiences. However, whilst recognizing the need of pedagogical enquiries on distributed collaboration with immersive technologies, the majority of research has been student-centric instead of focusing on teachers' exposure to collaborative learning situations prior to classroom implementation of iVR and AI technologies. Hence the need of tailored collaborative teacher training activities blending the use of AI and iVR in language learning education.

2. Materials and methods

2.1 Participants

The participants consisted of 3 language teachers aged between 33- and 45- years-old, working and studying at the University of Arizona. Whilst 2 of them taught English as a foreign language outside the United States, the other was a Japanese instructor at the University of Arizona. The participants were non-native English speakers with a background in language education and previous iVR exposure as attendants to a semester-long study group on integrating virtual technologies in language teaching. Hence they were familiar with wearing VR headsets and using hand controllers, as well as navigating the application manager of Meta Quest 2. In the pre-task assessment, participants stated to possess previous experiences with VR games and conduction of technology-assisted language classes.

2.2 Research tools

Each participant was given a Meta Quest 2 headset and joined a virtual office space on Horizon Workrooms after being sent an invitation form the researcher's Meta account. The space consisted of a shared virtual desk, chairs, a blackboard and windows overlooking a city landscape. The participants accessed iVR virtual pens, sticky notes and a keyboard pressing designated buttons on the hand controllers (Figure 1). ChatGPT was imported in the space through Horizon Workrooms's passthrough function and used by one of the participants.

2.3 Lab setup

The interventions were conducted at the DIALL lab of the University of Arizona on 29th March 2023. The researcher was assisted by an educational IT specialist in monitoring the recording process. To maximize audio quality recording, two standalone microphones were connected to a ZOOM meeting recorded on the researcher's computer. Two additional cameras were directed towards the centre of the room where in-person meeting was filmed. One camera was microphone-fitted, the other was embedded in a TV monitor. The Horizon Workrooms meeting was recorded through screen-casting on the researcher's Meta account. The participants sat at a table where 4 Meta Quest 2 headsets were

located, as a spare one was used by the researcher to join the Horizon Workrooms space to troubleshoot potential issues and observe iVR interactions.

Figure 1 - Participants interacting in a virtual office space through the digital affordances of Horizon Workrooms.

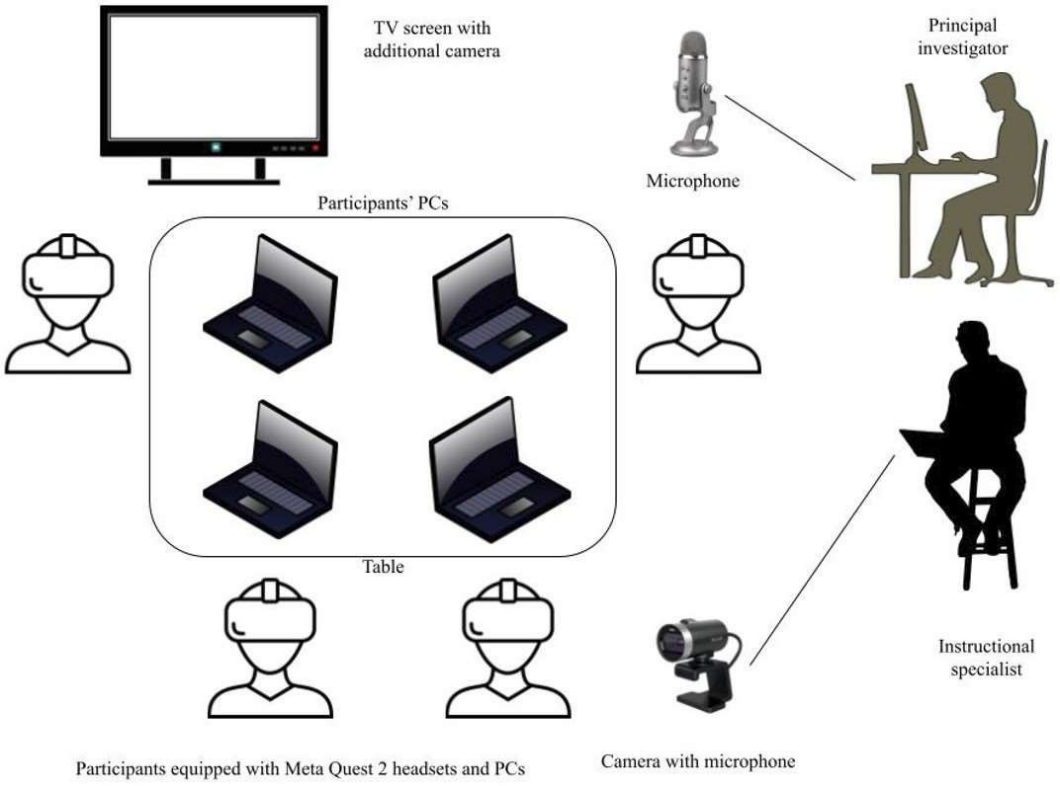

Figure 2 - Spatial overview of the intervention space.

2.4 Intervention structure

Before beginning the intervention, data approval to conduct the activities was received from the institutional review boards. The intervention lasted for 2 hours, of which 45 minutes were spent in iVR. Before participating to the session, participants signed a consent form outlining the research aims, potential side-effects of iVR exposure, data collection and storage methods as well as privacy protection procedures. Upon returning the signed consent forms, participants were sent email invitations outlining the date and time of the meeting. A questionnaire embedded in this email prompted participants to indicate their knowledge of the platform ChatGPT and willingness to use it in the activity. The intervention was conducted in a blended modality, alternating iVR exposure with in-person interactions. Initially, the participants conducted a role assignment task where they selected group roles based on their inclinations and preferences, and filled potential gaps through group discussion. The meeting was structured according to a task-based methodology involving participants in using the AI tool ChatGPT whilst planning a fictitious conference trip in English on the iVR platform Horizon Workrooms pretending to have won a budget of 10,000$ to travel to a conference of their choice. Initially, the participants were debriefed on how to safely wear iVR headsets and use hand controllers. In order to understand platform affordances and familiarize with iVR interactions, the participants personalized their avatars upon joining Horizon Workrooms and were given time to adjust to it. Participants spoke in English and muted themselves in Horizon Workrooms to avoid sound overlap as they sat facing one another wearing the headsets. They used ChatGPT to select their destination, draw an expense plan and identify suitable lodging as they wrote their decisions on a virtual blackboard. At the end of the planning process, teachers pitched their work in Horizon Workrooms to the researcher, who embodied an avatar while observing the activities. Upon real-world emersion, the participants answered questions in a focus group interview and responded to an online questionnaire.

Table 1 summarises the activity, whilst Figure 3 consolidates its interactional profile.

Table 1 - Activity contents, platforms and time partitioning.

Intervention structure			
Task phase	*iVR space*	*Contents*	*Duration*
Pre-task	None	Role assignment, brainstorming and tech debrief	30 minutes
Task cycle: task	*Horizon Workrooms*	Avatar setup, familiarization with Workrooms affordances	5 minutes
Task cycle: planning	*Horizon Workrooms*	Itinerary planning using *ChatGPT*	30 mins
Task cycle: report	*Horizon Workrooms*	Itinerary recap and pitching of budget plan	10 minutes
Post-task	None	Focus group interview and online questionnaire completion	45 minutes

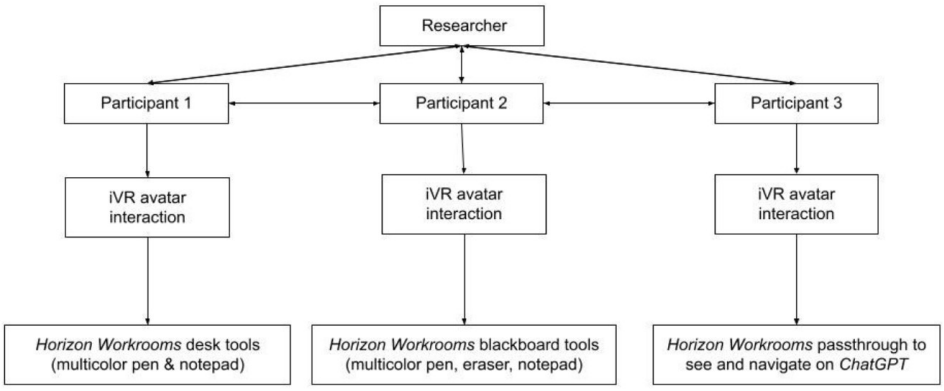

Figure 3 - Consolidated model of iVR/AI interactions.

2.5 Data collection methods

Data was collected via a mixed-method design consisting of observations, a focus group interview and a post-task survey focused on participants' perceptual experience of collaboration enhancement, avatar interactions and group planning. Teachers' experiences were monitored using usability and acceptability parameters (Davis, 1989). The meeting was recorded on ZOOM and later transcribed with the software Descript whilst questionnaire data was collected via Google Modules.

3. Results

The analysis of the results departs from assessing participants' interactions, a post-task survey and excerpts from focus group interview related to their experiential understanding of iVR and AI affordances for collaborative language learning.

The analysis of survey results shows general agreement on the ability of the iVR platform Horizon Workrooms to boost participants' collaboration. Moreover, the participants expressed positive intention to utilize the platform for future collaborative learning activities (Figures 4 and 5).

In terms of assessing the impact of avatar interactions on collaboration enhancement, perceptual data indicated participants' enjoyment in interacting with their peers, deeming it interesting and fun. Despite this enjoyment, their perceptions in terms of collaboration enhancement were polarized (Figure 6).

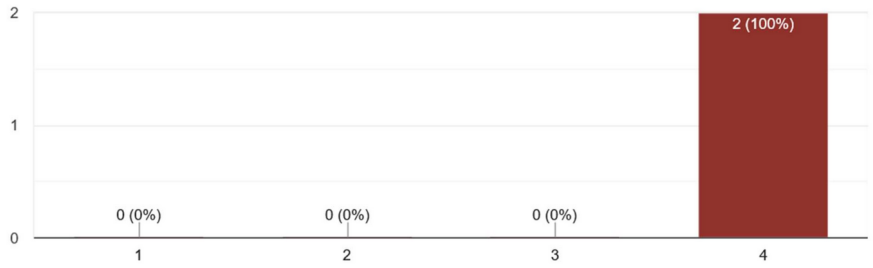

Figure 4 - Participants' responses to the question: "on a scale from 1 to 4, how much did the VR activity on Workrooms boost collaboration between you and your partners?".

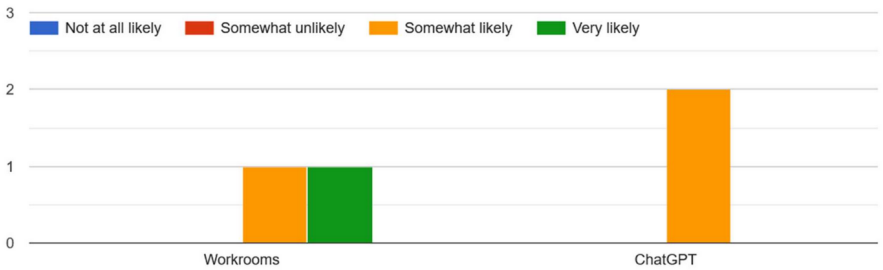

Figure 5 - Participants' responses to the question: "How likely are you to use the platforms and applications below for collaborative learning purposes if you possessed a VR headset?".

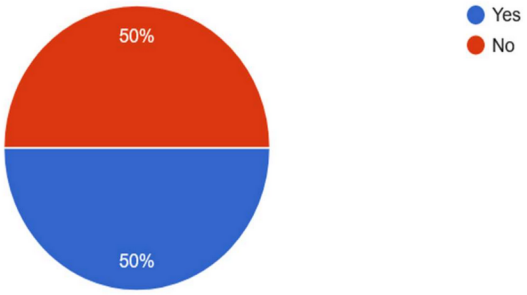

Figure 6 - Participants' responses to the question "In your opinion, does the use of avatars enhance student collaboration?".

When prompted to justify why avatar interactions could hamper or prevent iVR collaboration, the participants responded as follows:

It might enhance collaboration, providing there is a correspondent task.

Some students hesitate to turn on video for zoom, but avatar could remove the barrier, which will enhance their involvement. But it might be difficult to agree on some aspects, as some people insist on his/her suggestions only.

Collaboration was observed through participants' iVR interactions which unfolded in the planning process of the digital tour. Transcriptions revealed how the participants assigned roles to each other so that one of them utilized ChatGPT to source information, whilst the other transcribed group decisions on the virtual whiteboard (Excerpt 1).

Excerpt 1: transcript from participants interactions in *Horizon Workrooms*

a. ***O:*** *Some of the things I need to consider budgeting for a trip are transportation. Local transportation. Then there is budget.*
b. ***V:*** *Yeah. Budget. To go to Hawaii.*
c. ***O:*** *Okay, Hawaii?*
d. ***V:*** *Yeah, why not?*
e. ***T:*** *So, we have to decide travel dates. Then where to stay. When would we would like to go?*
f. ***O:*** *The end of April and let's look for three days. Cause we don't have ideas on what the budget actually looks like, they could have the budget rate of $ 10,000 for the three of us, or each guess. But if we use $ 10,000 for each of us then things change.*
g. ***Researcher:*** *It is 10,000 for each of you.*
h. ***T:*** *Oh. So, if we reached two weeks it would not be a problem for budget. (uses ChatGPT to confirm his statement)*
i. ***V:*** *Wait, depending on the price of the hotel.*
j. ***A:*** *Make this fun and say there are no restrictions on grant money being given!*
k. ***Researcher:*** *Ok, You can spend as much time as you like.*
l. ***T:*** *So, we need five days before the conference to get settled. Why don't we decide like a conference date so we know, like, when we are leaving? I think chat GPT needs to know our exact dates.*
m. ***O:*** *April. That's the conference dates. Let's say to April 4th. First to third. All right. So, we have to travel at least one day before, so we are settled.*
n. ***T:*** *So, when we are leaving? When would we like to leave?*
o. ***V:*** *I guess whichever the beginning of April, or do you want the first one?*
p. ***O:*** *It's like spending the whole month of budget in the whole April. Okay. That's, so the first day, April, it's summertime, right?*
q. ***Researcher:*** *So, can you tell me one more time when you went the conference and were you leaving?*
r. ***V:*** *We leave on the first and come back from the 30th. April 4th, we, are we leaving April 4th and when are we coming back?*
s. ***O:*** *On the 30th.*
t. ***T:*** *Okay.*
u. ***O:*** *We've got April.*
v. ***T:*** *[using ChatGPT to find budget information] So, it would be three thousand per person I think just for staying depending on the hotel range. That's 4500 to 7,500.*
w. ***O:*** *What's that? It's a lot! (starts writing on the whiteboard the prices mentioned in the conversations to draw a budget plan)*
x. ***T:*** *And maybe we need to consider how to get some food. So, we need to add around 5,000 to eight. There is also the consideration of the conference fees. If they give you a hotel conference rate, it could be 14,000 to 21,500, and maybe we can play it safe and say, yeah, why we decide that location, where we would you like to stay and why. That's kind changing and applies to each one of us. If we then decide to take a break or whatever we need to add more.*
y. ***O:*** *I know that. How do you spell the location you are seeing?*

z. ***T:*** *K A U A I. Like we can just write an idea of our personal knowledge.*
α. ***O:*** *All right. So, a few hundred bucks more for from home to Hawaii.*
β. ***V:*** *3000 is ok. Hawaii means sunny days.*
γ. ***T:*** *Where would you like to stay? Hotel or residence?*
δ. ***O:*** *Hotel.*
ε. ***T:*** *It would then be 300 per person.*
στ. ***V:*** *We are talking about $10,000 per person and it would be cheating.*
ζ. ***O:*** *Budget is $10,000 overall. And what about the other parts? You reckon that would me ask for 30,000 per person?*
η. ***T:*** *Okay. yes. Overall, that's how much we will spend.*

The focus group interview unfolded from participants' answers to the question "how did you feel while interacting with one another in *Horizon Workrooms*?". Parts concerning the effects of iVR exposure to the development of cooperative skills in iVR were highlighted in Excerpt 2.

Excerpt 2: transcript from participants' focus group interview.
a. ***O:*** *I enjoyed setting up the avatar, choosing the way you look, seeing each other in the immersive reality space. Seeing gestures and the movements and the calibration when moving. We were constantly wondering how to use the tools e were given. The interaction was really cool, but just a bit slow for me because I was trying to figure out how to write on the whiteboard, like how to do this, how to do that. So, it takes some time to get used to that. And then I guess interaction and collaboration would be more effective and not that time consuming. So yeah, the experience is a new one. That's amazing. Before cooperating, it is important to think about the logistic portion of it, how to set up the space and how we are being physically in the same location. So, you and A who have more expertise knowledge about virtual things or all kind of technology can help us. If we are on a different location each time, that's gonna be really hard to do, but otherwise it is really interesting.*
b. ***T:*** *And also, I try to research information [on ChatGPT] but it's really hard to type on that keyboard with the headset on because I cannot really see anything on my computer. I can clearly see my screen, but I cannot see my keyboard well. Then when I look at my screen in the real world, the whiteboard is gone. Then I have to re-connect the screen. So that's a more technical side.*
c. ***V:*** *Yeah, I can relate to that. It's the same, I guess people are discussing how VR can look really well. I think the idea of collaborating, like virtual collaborating or feeling that you are in one space, although you are not, is the next step of how to virtually work and teach.*
d. ***O:*** *This is just the beginning. The perspective, the future, our future collaboration.*
e. ***V:*** *Yeah. Yes. That's the way it would look like but I don't know how many years it will take though.*
f. ***T:*** *I think we can do like two students coming here. So, they can help maybe on the other side, such as one Japanese student, the in Japan university student, they can come to university and if they have a technical expert, to help on the tech side. But if it's up to each individual to figure these things out, it's really hard at this moment. I would say a technician could be somebody that troubleshoots or maybe does the activity ahead of time and test it. And stays there for the initial setup. I would say in perspective just having somebody test your gear ahead of time, maybe with a dedicated person would be perfect.*

4. Discussion

The analysis of the effects of iVR on teachers' collaboration stems from observing participants' interactions, answers to a post-task questionnaire and a focus group interview. Excerpts revealed facilitations of collaborations as they asked each other opinions and questions on decisional processes (Excerpt 1, c, d, e, n, o, p). Moreover, collaboration was enhanced as participants used the first-person plural pronoun "we" instead of its singular counterpart "I", hinting at acknowledging the importance of members' roles in decisional processes. Moreover, pronoun choice fostered virtual realism of interaction flow as participants co-constructed their ideas and contributed to select tour destinations

and draw budget plans (Excerpt 1, f, h, i). Noticeably, the emergence of collaboration was subject to individual dispositions. For instance, one participant was prone to lead the team by stating opinions without asking for contributions from their teammates. Leadership was emphasized by the decision to use the first-person singular pronoun "I" to make decisive statements affecting group decisions (Excerpt 1, a). Conversely, the participant who volunteered to manage ChatGPT interactions seemed more inclined to ask his partners for opinions and clarify his AI findings so that group decisions could be effectively mediated amongst all members (Excerpt 1, h). This participant also used ChatGPT to emphasize key elements affecting successful task attainment (Excerpt 1, x). Close observations of avatar interactions also revealed that participants self-explored the environment and learned to use virtual pens and notepads. This iVR familiarization favored the appearance of subsequent task-oriented interactions combining the use of ChatGPT with iVR capabilities. For instance, a teacher commented on the price range of lodging in hotels sourced by ChatGPT, which prompted another member to write the amounts on the whiteboard so that the whole group could see it (Excerpt 1, w). Being immersed in group interactions implied higher concentration on task demands and potential enjoyment of the virtual experience that distracted participants from tech troubleshooting. This is confirmed by the fact that participants did not ask for clarifications on how to interact in Horizon Workrooms but attempted to solve technical issues on their own and continue to collaborate. The results obtained from interaction observations were further confirmed by analyzing teachers' responses to online questionnaires. In fact, participants concurred that being involved in an iVR activity facilitated collaborative participation provided the existence of a clear task design (Figure 4). Additional results consisted in participants' willingness to use Horizon Workrooms and ChatGPT for future collaborative learning processes (Figure 5). Through these answers, participants recognized the collaborative affordances of iVR and AI technologies in support of task-based group experiences. These positive attitudes might increase teachers' willingness to adopt these technologies in language curricula. During the focus group interview, participants highlighted the necessity of pre-experiential training with Horizon Workrooms and the AI platform ChatGPT (Excerpt 2, a). They also recognized the importance of understanding and experiencing the dynamics of virtual teamwork for professional development, although they stated that more time would be required to implement these practices in educational scenarios (Excerpt 2, c, d, e). When prompted to answer questions on the best pedagogical practices combining iVR and AI, the participants highlighted the key role of institutions in providing the equipment and technical support to involve students in collaborative cross-national activities (Excerpt 2, f). This prompts considerations on the cost that such operations would entail and suggests the necessity of pre-activity budget planning and curriculum plan.

Several factors need to be considered when evaluating the limitations of the current study. Firstly, the research question was tested on a small population sample, which highlights the need to widen the study to a wider number of participants. Moreover, results were collected during a one-off intervention, emphasizing the need to replicate the study to better assess the correlated effects of iVR and AI on teachers' educational practices. From a behavioral standpoint, it was observed that the participant in charge of using ChaGPT lifted his headset multiple times to better view his desktop, highlighting a major limitation of Horizon Workrooms in visual rendering. Further limitations were detected from technological affordances, as participants claimed to have been severely distracted by the blurred vision caused by desktop interfaces. Additionally, data collection logistics prevented screen casting, hence losing evidence of ChatGPT prompts related to budget planning. Since structuring AI prompts is likely to influence information reliability with consequences for successful goal attainment, it is believed that further research should consider to train teachers with prompt engineering to further explore the interdependent relationships between human beings and machines. Due to their academic and professional background, it is likely that participants possessed strong team-working skills which facilitated their iVR interactions, hence the necessity to future iVR and AI testing with teachers with less group work exposure. It is also believed that collaboration was influenced by uneven tool distribution amongst study participants, whose agency largely depended on iVR tools. Further interventions on the combined use of iVR and AI on teachers' educational practices should focus on parameters of equity and accessibility, ensuring that all study participants have AI access whilst involved in the iVR space. Finally, attention should be placed on interpersonal relationships of trust of AI agents and avatar-embodying teachers in virtual task collaboration and study its overall effects on group efficiency.

5. Conclusions

This paper outlines the result of a pilot study conducted during one study group session focused on learning how to combine iVR and AI to involve students in collaborative learning activities. The data was collected during one iVR session with three teachers, one of whom used ChatGPT to source information necessary to conduct a group activity on budgeting for a fictious conference trip. Results suggested positive effects on collaboration enhancement between participating teachers efficiently attaining task goals. Despite some technical issues hampering participants' capability to clearly see the ChatGPT interface in iVR, teachers deployed collaborative skills and appeared to be willing to integrate iVR and AI in language curricula. Whilst examining the results from only one intervention, this study showed positive results in the possibility to integrate iVR and AI to enhance students' collaboration. Further investigations would need to be conducted on a wider population sample, hence triggering further investigations in using iVR and AI to foster task-based collaboration in deploying highly immersive and unimodal tools for group goal attainment. Investigations should also be conducted across different subjects taught by participating teachers to understand whether the combined exposure to iVR and AI affects students' collaboration. Investigations of this kind are deemed to be important in the upcoming years where iVR and AI are expected to evolve towards enhanced interactivity and design affordances favoring participants' collaboration.

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· Section 2 ·
Design

Development of a first draft prototype of 360 Synchronous Interactive Telepresence

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Abstract

This contribution presents the first results of an extensive research, in particular of a first step that focuses on an important technological development useful for educational purposes.

Based on the distance education paradigm and considering the challenge of the development of education-driven applications, this research aims to enhance the use of synchronous 360-degree videos for an interactive telepresence environment in the higher education context. More accurately, this contribution aims at evaluate and validate a novel didactic interaction paradigm, based on a VR360 telepresence application and experienced through Head Mounted Displays (HMD). This application allows for the inclusion of students who cannot participate in face-to-face activities, giving them the opportunity to participate in an immersive and interactive connection with both the teacher and peers, and the environment in which they operate. Unfortunately, there is currently no telepresence system that allows synchronous interaction. With this project we want to contribute to fill this gap by developing a prototype solution called Immersive synchronous learning 360 (ISL360 - ImmerSyncLearn360) project.

With a view to total interdisciplinary reciprocity, the research team, consisting of pedagogical and IT experts, shares an equal working approach. This article presents the first result of the research path, from a technological and pedagogical point of view: the analysis and design have been completed with the definition of the architecture and components to be used, from the VR360 cameras to the streaming protocol and the streaming server considering the main teaching requirements. The development of the first prototype is still in progress. The work concludes with the first draft of some application scenarios.

Keywords: Immersive Education, Vr360, Telepresence, Didactic Interaction, Distance Learning.

1. Introduction

This contribution presents the first results of an extensive research, in particular of a first step that focuses on an important technological development useful for educational purposes. Based on the distance education paradigm and considering the challenge of the development of education-driven applications (Laurillard, 2012), this research aims to enhance the use of synchronous 360-degree videos for an interactive telepresence environment in the higher education context

In distance learning it is important to recognize how the introduction of a digital medium within the educational triangle (Chevallard, 1985) profoundly transforms the relationships between teacher, student, and cultural content. It was especially during the pandemic period that teachers and trainers from all fields were able to experience the great potential of distance learning. Unfortunately, this forced distance period has also highlighted some limits. The first limitation concerns the difficulty of involving students of all grades in the teaching and learning process (Bucholz & Sheffler, 2009) and creating the right conditions to help them actively participate in all didactic phases (Garavaglia & Terrenghi, 2022; Carenzio & Ferrari, 2021; Trentin, 2019). A second limitation concerned the complexity for teachers in proposing situated learning experiences that have a clear contextual meaning and support students not only in theoretical learning acquisition but also in concrete learning situation involvement.

According to Hodges et al. (2020), it's crucial to design online learning experiences that address the main problems that have arisen. Particular attention should be paid to procedural training tasks, where learners are not only engaged in theoretical acquisition, but also trained in procedural tasks that are

also motor and performative (Gagne, 1984). In this case, the limitation relates to the difficulty of assisting students in tasks that involve them motorically and procedurally at a distance. While video tutorials and asynchronous simulators are commonly used for the acquisition of procedural and motor skills, they may prove inadequate for more complex tasks that require application, reflection and analysis. In addition, these methods cannot guarantee the freedom to explore or interact with the instructor, as Blattgerste et al. (2021) noted.

Another essential element in the teaching and learning process is the one related to the interaction between students and teachers, which is crucial in both traditional and distance learning settings. The interaction between teacher and learner can only take place in synchrony, and it is essential because it ensures the regulation of the didactic action and the alignment of the teaching and learning process (Laurillard, 2012). Regardless of the accuracy of instructional design, there will always be something unexpected in the classroom that requires the teacher to implement tactics in response to such events (Garavaglia, 2010). The activation of this skill can occur synchronously when the teaching action allows interaction between the subjects. Interaction must also promote the activation of feedback, information provided by an agent on aspects of one's performance or understanding (Hattie & Timperley, 2007). Feedback is bidirectional: thanks to feedback from teachers and peers, students can improve their engagement and motivation; thanks to feedback from learners, teachers can regulate the teaching process, taking into account students' responses and understanding.

When thinking about learning environments, there are two main educational contexts, usually proposed in a presence mode, that are particularly affected by some of the limitations mentioned above (Pirker & Dangel, 2021): the first refers to laboratory environments, where students involved in workshops have to observe specific practices and techniques, and observe the characteristics of the environment and the instruments; the second refers to outdoor environments, where it is often necessary to reach places that are not always easily accessible. In these two contexts, we believe that it is essential to ensure a synchronous type of interaction between the teacher, the student and the environment. In addition, it is important to give the students the opportunity to carefully observe all the peculiarities of the environment, to compare them with their peers, to formulate hypotheses, to experiment and to observe the results of their own interactions, while receiving continuous feedback from the teacher. For this reason, the research group is developing 360 video and telepresence technology.

Considering the potential of high-tech Head Mounted Displays (HMDs), it is crucial to explore the idea of presenting 360-degree videos (also referred to as immersive or spherical videos), as immersive and synchronous experiences, in a particular way because they offer users the opportunity to experience many settings in a fully immersive format. Research in this area has shown how the proposal of immersive environment in supporting learning is certainly challenging but it appears to be useful and effective as well. A recent study (Jensen & Konradsen, 2018) confirms that learners who used an immersive HMD were more engaged, spent more time on the learning tasks and acquired better cognitive, psychomotor and affective skills, instead of peers who enjoyed a desktop learning experience. Many studies have also shown that the use of immersive technologies supports the students' sense of presence (Makransky & Mayer, 2022) and the memorization and execution of procedural knowledge (Makransky et al., 2021). In 2003, Burdea and colleagues explain that if these experiences are also interactive, students can improve both their motivation and retention. Unfortunately, while there are many systematic literature reviews for the potential of virtual for education (e.g. Hamilton et al., 2021), only a few studies have been found for 360 videos. Moreover, the interaction within 360 videos is often minimal: the experiences are generally designed to be offered as a video experience, where the viewer's only interaction is the possibility to move the head. Instead, the ability to interact and socialize despite being physically separate is a critical aspect for the efficacy of virtual reality experiences. There is currently no telepresence system that allows synchronous interaction. With this project we want to contribute to fill this gap through the development of a prototype solution called Immersive synchronous learning 360 (ISL360 - ImmerSyncLearn360) Project.

By proposing this research project we want to achieve the following objective: a) to design innovative student centered "post covid" didactic paths, aimed to develop skills in different subject areas and professional contexts, allowing the inclusion of students who cannot participate in face-to-face

activities; b) to realize advanced and open source technology applications for synchronous online teaching, specifically, applications and methodologies for the synchronous transmission of 360 video in education; c) to evaluate and validate a novel didactic interactive paradigm, based on a VR360 telepresence application and experienced through Head Mounted Displays (HMD).

2. Materials and Methods

The project consists of three main phases: 1) preliminary analysis of the application requirements; 2) development of the technological platform; 3) pilot study.

The first part of analysis covers the 360 videos workflow, in particular the characteristics of setting, the stitching, encoding and transcoding, protocol, upload and delivery (server streaming) and the viewing.

In the second phase, the first prototype of the technological solution is developed.

The third phase concerns the pilot study. It will be carried out on a sample of didactic activities which includes the didactic interactions of the research object. Laboratory activities from universities will be selected and assigned into experimental and control groups. Each laboratory session will be filmed. At the end of each session, the participating students will be asked to fill in a survey on the quality of the didactic interaction and the feedback received. At the end of the experimental sessions, a focus group will be proposed to the teachers involved to obtain useful information on the technological solution and the validation of the paradigm.

3. Results

The results presented here concern the outcome of the analysis carried out in phase one and the first results of phase two, dedicated to the development of the prototype.

The current status is well represented in Figure 1. The Analysis and design has been completed with the definition of the architecture and of the components to use, starting from the VR360 cameras to the streaming protocol and streaming server, were identified. The development of the first prototype is still in progress. It is based on Ant Media server streaming connected to two 360 cameras. The development is focused on three main applications: the publisher, the windows player and the cardboard player. A future development of a player for Meta Quest 2 device (or eventually for the new Meta Quest 3) is scheduled for next year. Once the development is complete, the research group will begin the pilot study, in which teachers and students from both the experimental and control groups will experience the same educational program.

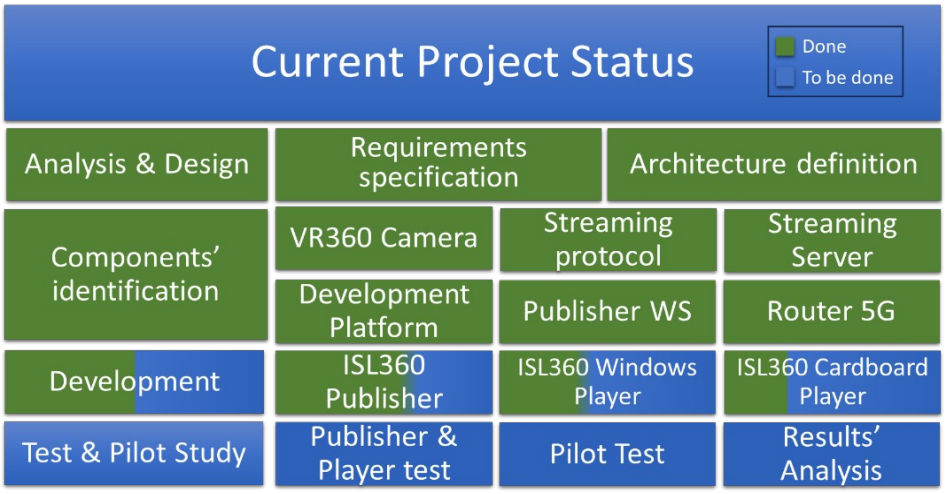

Figure 1 - View of the Project Status.

From a technological perspective, the idea behind the project is to enable an extended distance learning experience that offers remote learners the opportunity to experience an immersive connection with both the teacher and the environment in which to collaborate, while allowing students to interact with the teacher at various levels (Montagud et al., 2020; Tsai et al., 2020).

The technological platform necessary to support this interactive learning paradigm must be able to enable and adequately support the acquisition of VR360 video streams on the site where the lesson takes place, their streaming via the internet (Hodroj et al., 2021), and their use in various ways by remote users with the possibility of interacting with the teacher.

A fundamental feature that the system must have is the interaction between teacher and student. It is essential that all participants are able to provide meaningful and understandable feedback, which can facilitate good regulation of the teaching process (Laurillard, 2012).

The characteristics required by the system from an educational point of view are described below:

1. *USER-REQ-001*: The system must provide verbal communication between participants. As tested by Wang et al. (2017), verbal communication is essential for mentoring. Learning experiences within AR or VR without two-way verbal communication with an expert is generally considered less effective for learning.
2. *USER-REQ-002*: The system must include features that allow the teacher to moderate communication and manage conversation turns between students; however, it must also ensure the possibility of quick and easy intervention for students who need clarification so that they would be able to fully understand the process before it ends.
3. *USER-REQ-003*: The system must provide a participation mode both with or without a VR headset so that students who do not have such a device can also do so.
4. *USER-REQ-004*: The system must allow students to point to an object remotely, in order to clearly direct the focus of their attention to, for example, an object or tool in the environment.
5. *USER-REQ-005*: The system shall manage multiple VR360 video streams (at least two omnidirectional cameras, depending on the characteristics of the network infrastructure and available bandwidth);
6. *USER-REQ-006*: The system must allow a simultaneous connection of a high number of students (50 at same time for preliminary test with a target of 200 for thee feature)
7. *USER-REQ-007*: It must be possible to decode and playback the stream in live or on-demand mode;
8. *USER-REQ-008*: During a live session, the teacher must be able to add 3D object in the VR360 environment and to place it in the space changing the position, the rotation and the scale; the teacher should have the possibility to prepare and to place in the environment space, the 3D material needed for the lesson and save this configuration in a file that can be loaded during the live session;
9. *USER-REQ-009*: The system must be used both for indoor and outdoor live sessions;
10. *USER-REQ-010*: The teacher must have the possibility to load other VR360 image and video that will replace the video stream source coming from the connected VR360 camera.

In the proposed framework, the perceptual aspects of user experience and interaction will be the fundamental guiding elements for the design, implementation and testing of the platform. In this context, the resolution of the video stream (number of megapixels of each frame) and the latency are extremely important. Experiments on the impact of latency show that motion-to-photon (MTP) latency becomes acceptable at sub-second levels. Therefore, appropriate streaming strategies must be investigated to handle high resolution video and reduce all latencies associated with network infrastructure components.

Based on the described requirements and on the fundamental guidelines defined above, it was defined the ISL360 architecture as reported in the Figure 2.

In addition to the ISL360 Publisher and ISL360 Player software that are under development, the system includes other three main components: the VR360 camera, the streaming protocol and the streaming server. For these three components, it was conducted a deep analysis comparing the main characteristics, in order to identify and to select each component of the system.

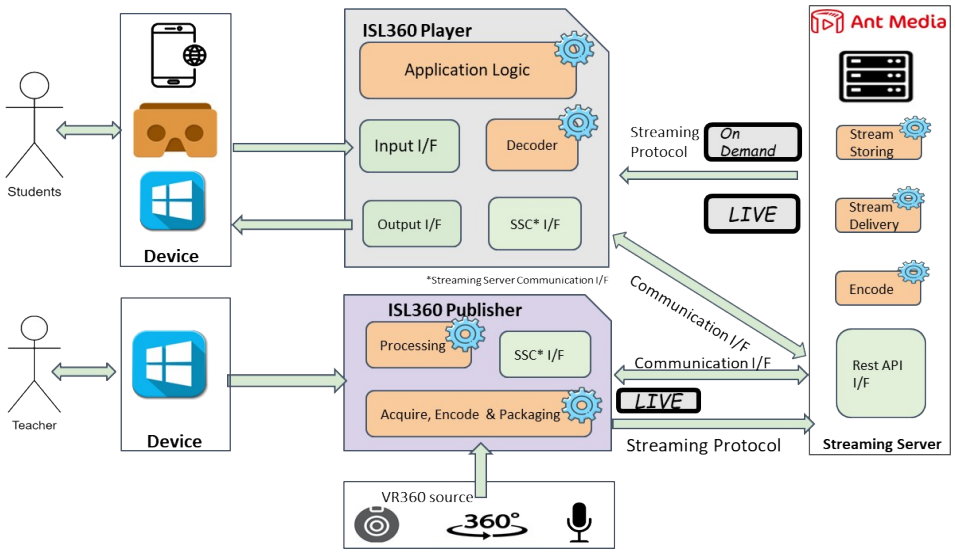

Figure 2 - ISL360 Architecture.

For the selection of each components, we used the same method that consists of identifying four main requirements with a priority order and then, based on this list, starting the state of the art research with the objective to collect the specifications of a number of candidate components between 5 and 10.

3.1 VR360 Camera selection

The criteria used to identify the camera, in order of priority, are the following:

1. *Video resolution*: It should be noted that the framed area is only part of the full VR360 frame. For example, for the Meta Quest 2 device, the resolution per eye is 1832x1920 with a horizontal FOV of 97° and a vertical FOV of 65°, i.e. approximately 1/3 horizontally and 1/5 vertically of the entire VR360 image. Therefore, to achieve a horizontal resolution of at least 1920 pixels, a camera with a resolution of at least 8K (7680x3840) at a minimum of 30 Hz is required.
2. *Battery Life*: To meet the requirement of being able to hold a lesson outdoors, it is necessary to have a battery life of at least 2 hours
3. *Price*: Considering the project budget and also considering the management and maintenance costs to be incurred when the system is used fully, it was established a maximum price of 5K€.
4. *Lens Quality*: The lens used for the VR360 camera is a fisheye lens, which typically introduces distortion to capture 180 degrees. Reducing the distortion can improve the quality of the final image.

Based on these criteria, 7 cameras were compared as reported in Figure 3 and the QooCam 8k Enterprise was selected for the project although a future activity is planned to experiment with a 3D cameras like the Insta260 Pro2.

Model	Video Resolution	Photo Resolution	Lens	Sensors	Battery	Price
Kandao Obsidian R	8Kx8K@30fps 4Kx4K@60fps	8K (7680x3840)	6 fisheye of 190°	6 Sony IMX269 of 12MP	5000mAh (removable)	6.000€
QooCam 8K Enterprise	8K@30fps, 5.6K@60fps 4K@120fps,	8K (7680x3840)	2 fisheye of 200°	2 Sony IMX117 of 12MP	3000mAh (removable)	2.000€
Insta360 Pro 2	8Kx8K@30fps, 4Kx4K@120fps	12K (12288x6144) (3D)	6 fisheye of 200°	6 Sony IMX269 da 12MP	2 batteries of 5100 mAh (one is removable)	6.000€
Labpano Pilot Era	8K@24fps, 6K@30fps, HD@120fps (3D)	32MP (8192x4096) (3D)	4 fisheye of 195°	apertura F2.2 e sensori da 12 MP	Integrated battery of 7200 mAh	2.500€
TECHE 360Starlight	7680 x 3840 a 30 fps o di 3840 x 1920 a 60 fps	7680 x 3840	fisheye @ 10 bit	4 CMOS sensors backlits	Integrated battery of 5000 mAh	7.000€
Kandao Obsidian Pro	Fino a12K@60fps, HD@240fps (3D)	Fino a12K (12288x6144) (3D)	11 lens with a FOV between 180° and 360°(3D)	11 CMOS sensors of 1/1.7"		27.000€
DETU F4 Plus	8K@30fps 4K@120fps	48MP (7680x3840)	4 fisheye of 200°	4 Sony IMX117 @12MP	4800 mAh (removable)	2.500€

Figure 3 - Camera comparison.

3.2 Streaming protocol selection

A streaming protocol is a set of rules that defines how data is communicated from one device or system to another over the Internet. Video streaming protocols have standardized the method of segmenting a video stream into smaller blocks that are easier to transmit.

Each protocol serves a purpose and has a set of strengths, such as low latency or high adaptability. The criteria used to identify the streaming protocol, in order of priority, are as follows:

1. *Latency*: The latency is extremely important. To maintain the end-to-end latency below the second, considering that in addition to the protocol latency there is also the latency introduced from all the other components (camera, streaming server, publisher, player and Internet) it was considered for the protocol a maximum latency less than 500 ms.
2. *Supported Video Codec*: The distinction between codecs and container file formats is often blurred, and they are often used interchangeably. To avoid confusion, we refer to the codec as the part of a video streaming protocol that reduces the size of files by eliminating redundant or unimportant information. For example, when a codec processes video with a fixed background that remains the same for a period of time, after the first frame it discards redundant visual information for each pixel and only keeps a reference to reduce the amount of information it needs to store. On the other hand, the container format, such as MP4, defines how video stream data, typically video files, audio files and metadata, are stored once the protocol has transmitted them. Our analysis considered support for the following codecs (in order of priority) VP9, H264, VP8.
3. *Supported Audio Codec*: In this case, we also consider the part of the streaming protocol that reduces the size of the audio data. In our analysis we took into account the support of the following codecs (in order of priority) OPUS, MP3. OPUS is an open-source, royalty-free audio codec designed for interactive audio applications and has one of the lowest latencies among audio codecs by design.
4. *Compatibility*: In order to be able to insert virtual and interactive three-dimensional elements into the framed scene, it is necessary to use a 3D graphics engine. Currently, the best and most popular 3D graphics engines are Unreal and Unity3d. For this reason, the protocol must be compatible with at least one of these two engines.

Based on these criteria, 6 protocols were compared as reported in Figure 4 and the WebRTC protocol was selected for the project.

Streaming Protocol	Pro	Contro	Video Codec	Audio Codec	Latency
HLS (HTTP Live Streaming)	•Compatibility •Security •Quality	•high Latency •Ingest poor	H264, H265	MP3, AAC	30s
MPEG-DASH	•Adaptability •Efficiency •Flexibility	•Compatibility •Complexity •Resource consumption	ALL	ALL	15s
RTMP (Real Time Messaging)	•Adaptability •Flexibility	•Latency •Limited Support •Bandwidth	H264	MP3, AAC	>5s
RTSP (Real Time Streaming)	•Segmented streaming •Configurability	•Low popularity • incompatible with HTTP	H264	MP3, AAC	>1s
WEBRTC	•Adaptability •Low Latency •Compatibility	•Maturity •Instability •Limited Support	VP8, VP9, H264	Opus	<1s
SRT (Secure Reliable Transport)	•Security •Low Latency •Compatibility	•Limited Support	ALL	ALL	<1s

Figure 4 - Streaming protocol comparison.

3.3 Streaming server selection

The criteria used to identify the streaming server, in order of priority, are the following:

1. *End to End Latency*: less then 1s
2. *SDK/API*: Compatibility with Unity3d or Unreal engine
3. *Protocols*: WebRTC for live session and HLS for on-demand streaming
4. *Price*: The target is to find a free streaming server

While 360° live video streaming offers an enriched viewing experience, it is difficult to guarantee the user experience against the negative effects introduced by startup delay, the delay between the occurrence of an event and its reception by the viewer's eye, the low frame rate, and the need for resolutions of at least 8K and therefore high transmission and reception bandwidth. It is therefore essential to understand how the different elements of a 360° live streaming system contribute to reducing these negative effects.

Although previous works have already studied commercial 360° live video streaming systems, and some of them have also delved into the end-to-end pipeline and explored how time consumption at the task level affects the user experience, at the time of writing no work has been found that applies the measurement of these delays to the streaming servers analyzed. To fill this gap, we defined the metrics, setup and procedure to perform an end-to-end latency measurement study of 360° live video streaming systems, and then performed the test on some streaming servers.

The setup defined for end-to-end measurements is represented in *Errore. L'origine riferimento non è stata trovata*. where:

1. On the monitor where it is running the Publisher (the monitor on the left), there is an online clock with the resolution of milliseconds (see https://time.is/).
2. On the Player side (the monitor on the right), is visualized the same online clock of the Publisher. In the *Errore. L'origine riferimento non è stata trovata*. it is possible to see that between the visualization of Publisher and Player timer, there is a difference less than 9ms; this difference is due to the unsynchronized refresh of the monitors and it is negligible.
3. With this configuration, the computer where it is running the Player, will show both the on-line timer acquired by the publisher and its own on-line timer; the difference is the end-to-end latency.
4. Screenshot of the Player monitor are saved at 5, 10 and 15 minutes after the start of the live streaming. The average of the 3 measurements will be considered as the average latency time.

Based on the selection criteria, 7 protocols were compared and for 3 of them the end-to-end latency measurement was conducted. The final results are reported in Figure 6 and finally the Ant Media streaming server was selected for the research project.

Figure 5 - Test setup for end-to-end latency measurement.

Server	Deployment	Protocol		End to End Latency	Recording	SDK / API		Price
Youtube	Cloud	•RTMP •RTMPS	•HLS •DASH	>15s	Internal Storage	API youtube		free
Owncast	Self hosted	•HLS •RTMP		Not Available	External storage			Open source
Dolby.io	Cloud	WebRTC		2.5s	Internal Storage	•Unity 3D •Unreal •IOS	•Android •OBS	•Free (limited) •From $495 to $4995 for month
Dacast	Cloud	•HLS •RTMP		Not Available	Internal Storage			From €36 to $153 for month
Wowza	•Cloud •Self Hosted	•WebRTC •RTMP		Not Available	None	•RESTful		Da $25 a $499 al mese
AntMedia	•Cloud •Self Hosted	•WebRTC •RTMP •HLS	•SRT •RTSP	1.5s	Mp4 or webm	•RESTful •Unity 3D •Unreal		•Free if Self Hosted •Pay-as-you-go on cloud
SRS	•Self Hosted	•WebRTC •RTMP •HLS	•http-FLV •SRT	Not Available	None			Free

Figure 6 - Streaming Server comparison.

3.4 Simulation of operational scenarios

Six operational scenarios has been investigated in this first stage of the research:

1. *Use 3D Objects as lessons' elements*: in this scenario it is foreseen to load 3D models, that can be of different file format (obj, fbx, stl and ply also organized in a zip file), inside the VR360 environment and place them in the scene by moving, rotating or scaling them appropriately (see the blackboard in Figure 7).
2. *Use 3D pointers to indicate unreachable parts*: loading and placement of 3D pointer to indicate objects in the scene that aren't reachable, are far from the teacher position or that cannot be touched (3D arrow in Figure 8).
3. *Do a lesson using a digital twin*: in this scenario it is foreseen to use a digital twin as the topic of the lesson. For example, as shown in Figure 9, the digital twin of an ancient tomb is used to explain its history and the purpose and motifs of its paintings.
4. *Teleport to a real location*: when it is useful to show an experiment, a laboratory or, more generally, a location that cannot be seen directly, due to limited or prohibited access to the area, it is possible to have a live streaming session with only the teacher and the VR360 camera placed in this location or just take a VR360 picture or make a VR360 video of the location and use it during a live session or to register an on-demand lesson. The video format used is mp4 and the image format is jpg. Figure 10 shows a test frame made with a VR360 image of the underground laboratory of LNGS (Laboratori Nazionali del Gran Sasso).
5. *Teleport to a virtual location*: This is the case when it is useful to show an event, an experiment, a laboratory or, more generally, a place that cannot be seen in reality. In the test case, we used the virtualisation of an optical laboratory with an optical bench to explain quantum entanglement by showing Alain Aspect's experiment.
6. *Outdoor Lesson in a dangerous place*: There are many situations in which it is essential to hold a lesson outside. Let's think about the case in which we need to study an archaeological site or show a book in a historical library or study the stratification of a rock. This is a small and limited list of the cases where an outdoor lesson can improve the teaching. In many cases it is complicated and difficult to access these external areas or it is only possible to access them for a limited number of people (see Figure 12). In all these cases, using the ISL360 system, it is possible to teleport a high number of students where it is necessary without any risk.

Figure 7 - 3D objects as lessons' elements.

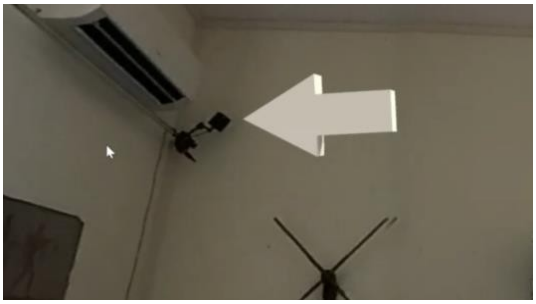

Figure 8 - 3D pointers.

Figure 9 - Digital Twin.

Figure 10 - Teleport to a real laboratory.

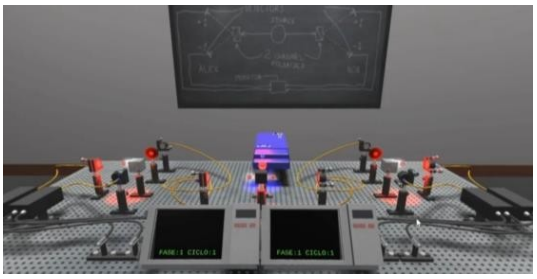

Figure 11 - Teleport to a virtual laboratory.

Figure 12 - Outdoor lesson in a dangerous place.

4. Conclusions

The development of the prototype, which is currently underway, continues with the utmost attention to educational needs. The pre-implemented scenarios will be the subject of further discussion and analysis with the teachers participating in the pilot study. In this way, the didactic and educational needs guide the technological development, and in a reciprocal logic, the technological development brings suggestions and further guidance, as well as stimulating the teachers' creativity.

The results achieved so far on the technological level are a solid basis for the continuation of the project and the implementation of the pilot study.

Authors' contributions

This article was written jointly by the authors. Andrea Garavaglia and Ilaria Terrenghi wrote paragraphs "Introduction", "Materials and methods", while Maurizio De Nino wrote the "Results" paragraph. "Conclusions" was written jontly by all authors.

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A framework for Learning Design and Self-Regulated Learning: first results of SuperRED Project

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Abstract

Supporting Self Regulated Learning in Digital and Remote Education (SuperRED) is an Erasmus+ funded project involving researchers and school partners from four European countries (Italy, Spain, Belgium, The Netherlands). One of the main results of the project is the development of a theoretical framework, including guidelines for Learning Design and Self-Regulated Learning – named "SuperRED framework" – aimed to support teachers in designing and implementing effective and engaging learning activities leveraging on students' self-regulation processes. This study describes the activities carried out for the development of the SuperRED framework, including the literature review, the administration of a survey for teachers, and the expert validation of its draft version. The framework is one of the tools, developed by the project, to support teachers in an effective design of learning activities to support self-regulated learning.

Keywords: Learning Design, Self-Regulated Learning, Distance Education, Digital Technologies.

1. Introduction

Supporting Self-Regulated Learning in Digital and Remote Education (SuperRED) is an Erasmus+ funded project (2021-2024), involving researchers and school partners from four European countries (Italy, Spain, Belgium, The Netherlands). This project has been conceived during the Covid-19 pandemic that, for long periods, forced students and teachers behind a screen for educational purposes. One of the main challenges in facing this situation was the low level of digital competences of students and teachers in using digital technologies for teaching and learning (Carretero-Gomez et al., 2021; Ranieri, Gaggioli & Borges, 2020). Moreover, according to recent studies on the Italian context, in the online environment teachers have mainly reproduced face-to-face classroom dynamics with mixed results causing, as a general outcome, a loss of contact with 6-10% of students (Giovannella, Passarelli & Persico, 2020; INDIRE, 2020; SIRD, 2020). This was mainly due to their lack of competences for blended/remote Learning Design (LD) and in the scarce capacity of supporting student's motivation and Self-Regulated Learning (SRL), especially in digital contexts (Carretero-Gomez et al., 2021).

To address these limitations that, besides the emergency period, may constitute a significant barrier to the adoption of effective teaching strategies in remote/blended environments, SuperRED aims at increasing the digital readiness of the school ecosystem to manage an effective shift towards digital education and fostering the resilience to tackle unplanned events of the teachers and students at the lower secondary schools. To this purpose, in the first phase of the project, the Consortium developed a framework – named "SuperRED Framework" – to support teachers in designing and implementing effective and engaging learning activities with a focus on digital and remote education, LD and SRL. The aim of this study is to illustrate the activities carried out for the development of the SuperRED framework's development, with a focus on the different steps from the literature review to its final validation.

2. Methods

The SuperRED framework was conceived as a compendium of pedagogical guidelines aimed at facilitating the implementation of LD and fostering the advancement of students' SRL across diverse

educational contexts. The process of its development included a literature search and the integration of the scientific evidence with a survey aiming at collecting teachers' knowledge, experiences and needs on the main themes of SuperRED, namely LD and SRL. Firstly, it has been defined the structure of the framework (see Figure 1), considering the main themes of SuperRED (LD and SRL) from three different perspectives (Methods/Models; Tools/Technologies; Learning Ecologies) within three different contexts, that is Remote (Re), Blended (Bl) and Face-to-face (F2f). The six blocks (A1-3; B1-3) at the intersection of the different dimensions correspond to the six conceptual areas in which the guidelines have been organised.

		Perspective		
		Methods/Models	Tools/Technologies	Learning Ecologies
		What are the indications for a most effective **methods and models** to support the learning design and/or self-regulated learning in Re, Bl F2f contexts?	What are the most effective tools and technologies to support the learning design and/or self-regulated learning in Re, Bl F2f contexts?	What are the indications about the **learning ecologies** aspects to considered for supporting the learning design and/or self-regulated learning in Re, Bl F2f contexts?
Themes	Learning Design	A1	A2	A3
	Self-regulated learning	B1	B2	B3

Figure 1 - The Structure of the SuperRED Framework.

The process of selection and analysis of the papers for the literature review was structured into three phases and involved all the project partners:

- *Phase 1* – Identification of the seminal papers: in this phase the research partners identified the seminal papers on the main themes of SuperRED, LD and SRL, according to the three perspectives (methods/models, tools/technologies and learning ecologies) and in the three different contexts (remote, face-to-face, blended). The papers identified were 8/10 for each area.
- *Phase 2* – Selection of the papers to be included in the analysis: the papers identified in the previous phase were subjected to a further selection process, involving all the research partners according to each expertise. At the end of this phase, 32 papers were selected for the final analysis.
- *Phase 3* – Analysis of the papers: the analysis was guided by the following question "What are the indications for the most effective methods and models/tools and technologies/learning ecologies aspects to support the LD and/or SRL in Re, Bl F2f contexts?". The drawn information was structured as guidelines to create the first draft of the framework.

Furthermore, to enhance the applicability of the framework and assess its relevance, a survey tailored to the needs and practices of teachers was delivered to the partner schools, and the results were integrated into the draft of the framework. The main purpose of this survey was to collect teachers' experience, knowledge, and needs for the implementation of LD and SRL in classrooms. This step was conceived to link the theory with the practice, to develop a framework that better suits teachers' requirements. Thus, a questionnaire was created and administered to the teachers of the SuperRED school partners between the 20th June 2022 to 10th July 2022. It was organized into three main areas: General information, questions on LD and questions on SRL. The questions were implemented into Qualtrics and delivered in four different languages according to the country involved in the project (English, Italian, Catalan, and Dutch).

Finally, the last step included the validation of the framework, with the involvement of an international panel of teachers and researchers, selected outside the SuperRED consortium to ensure independence of validation. These experts express their opinions on the framework through a Google form, evaluating its clarity, understandability, consistency, and significance to be adopted by teachers and researchers as guidelines for an effective LD and SRL.

3. Results

The integration of the literature evidence and the survey results led to the first version of SuperRED Framework, that considers LD and SRL dimensions, each declined in the three different perspectives mentioned in the previous section, resulting into the following set of guidelines:

3.1 Learning Design

Methods and models: this perspective focuses on the process of the learning design and the relative steps, starting from the consideration of the design level teachers are working on, the attention to the context of the learning activities, the consistency between the defined learning objective and the teaching strategies to reach them, the integration of the resources (i.e. human, digital) and the evaluation aspect. For methods and models to support effective LD the following guidelines are suggested:

1. clarify the focus of your learning event and define the design level you are working on: micro level, few hours of learning; meso level, usually a semester's work, macro level, an entire course program (Conole, 2012; Goodyear & Dimitriadis, 2013).
2. pay attention to the context in which the intervention takes place: the background and peculiarities of the actors involved as well as the affordances of the learning environment. The learning environment influences learning itself. Also, it is important to consider the nature of the relationship between learners and teacher, what should be learnt and how it should be achieved (Conole, 2012; Goodyear & Dimitriadis, 2013).
3. define the teaching strategies in accordance with the learning objectives in order to increase the effectiveness of the learning experience. Teaching strategies should be defined appropriately while considering the type of learning objective to be pursued (Pozzi, Manganello & Persico, 2022; Bond, 2020; Pozzi, Ceregini & Persico, 2015).
4. highlight relevant resources and tools and integrate them in a time sequence. Resources may be human, technological or artifacts designed for learning (such as models, diagrams or lesson plans). When you choose resources and tools, take into consideration students' level of competence (Mor, Craft & Maina, 2015; Conole, 2012; Bond, 2020).
5. run the learning intervention: provide differentiated activities and ensure that tasks are not assigned above or below students' abilities. The teacher may give students the freedom to choose digital and/or analogic tools they want to work with (e.g., tablets, books), or students may be told who they have to work with (e.g. in teams of four, or in a work group) and allowed to choose their own learning project (Goodyear & Dimitriadis, 2013; Conole, 2012; Bond, 2020).
6. monitor and evaluate the effectiveness of the intervention providing different forms of assessment, traditional and digital. Remind the consistency between objective, learning approach and evaluation strategies, including formative and summative assessment, peer assessment and self-assessment (Conole, 2012; Bond, 2020).
7. adapt the intervention on the basis of the feedback received: take into account the learning outcomes (new knowledge, skills, abilities) manifested in students' artifacts and pupils' daily work. This feedback could lead the designer to a revision of the initial idea of the learning intervention: design and redesign are intimately related (Bower & Vlachopoulos, 2018; Mor, Craft & Maina, 2015; Goodyear & Dimitriadis, 2013; Conole, 2012).

Tools and Technologies: this perspective focuses on the use of tools and technology in general for the learning design process, paying attention to the aspect of sharing teachers' design with the community, and, when possible, to use the data to inform the design process. For tools and technologies to support effective LD the following guidelines are suggested:

1. use a LD tool both to reflect on teachers' way of thinking and behaving or to foster a different approach. The use of a LD tool can foster a smoother and more organic design experience for novice teachers or for teachers who usually design in a rough fashion (Pozzi et al., 2020).
2. share your design for sustaining the online collaboration and peer-review. It is important to share the learning designs among teachers thus supporting collaboration and peer-review, in order to build a pedagogical knowledge community (Laurillard et al., 2018).

3. when possible, exploit the data for informing the learning design process and community building, according to the GDPR. The use of educational data for the LD process was encouraged, to improve the LD competencies (Hernández-Leo et al., 2019; Kurvits, Laanpere & Väljataga, 2015).

Learning Ecologies: this perspective focuses on developing learning strategies in terms of individual learning ecologies taking into account the learner's intention and motivation, and in the importance of integrating ICT resources both as elements and as training strategies to improve teachers learning ecologies and the pedagogical, technological and contextual areas during the design process. For learning ecologies to support effective LD the following guidelines are suggested:

1. take into account the student agency, learner intentions and motivations as well as past trajectories in developing learning strategies for the individual learning ecologies perspective. The central components of an individual's learning ecology interplay with attributes of learning, including student agency, learner intentions and motivations as well as past trajectories in developing learning strategies (Peters & Romero, 2019).
2. incorporate ICT resources both as elements and as training strategies to improve teachers learning ecologies in the perspective of continuing professional development. The online resources are key for teachers' current learning ecologies, for this they should be included in the teachers' training system and in a wider perspective in the continuing professional development (González-Such et al., 2021).
3. pedagogical, technological and contextual areas are the most important to be addressed during the learning design. These areas must be taken into account for reflection and appropriate decision-making in order to promote the optimal construction and adequate development of learning ecologies (Santos-Caamaño, Vázquez-Cancelo & Rodríguez, 2021).

3.2 Self-Regulated Learning

Methods and Models: this perspective focuses on the multifaceted nature of regulation, encompassing motivational, emotional, behavioral, and cognitive aspects, with a focus on engaging learners based on their purposes, intents, and goals. It emphasizes the importance of enabling learners to connect theory and practice through personal goal setting or personalizing course goals. For methods and models to support effective SRL the following guidelines are suggested:

1. being regulation multifaceted involving motivational, emotional, behavioral, and cognition aspects, engage learners considering their purposes, intents, and goals. Since engagement is multidimensional, all types of interaction should be considered when planning media use, including traditional media printed, broadcast, or recorded-and newer teleconference media (Zimmerman, 2002; Panadero, 2017; Hadwin, Jarvela & Miller, 2016; Zimmerman, 2008; Pelikan et al., 2021; Edisherashvili, 2022; Moore, 1989).
2. enable learners to link theory and practice by setting personal goals, or personalizing course's goals. Such practices contribute to making learners more engaged and motivated in the learning process. Researching regulation also requires an understanding of the beliefs, self-perceptions, and mental models that shape and are shaped by these observed actions and reactions over time and events (Zimmerman, 2002; Hadwin, Jarvela & Miller, 2016; Zimmerman, 2008).
3. since regulation involves cyclical adaptation between three phases (forethought, performance and self-reflection), emphasize regulation as a temporally unfolding process emerging from, and continuing to shape, future beliefs, knowledge, and experiences. Support learners to continually monitor their learning to determine its ultimate value beyond their immediate learning experience (Zimmerman, 2002; Panadero, 2017; Hadwin, Jarvela & Miller, 2016; Zimmerman, 2008).
4. prepare your learner to adaptively respond to new challenges, situations or failure since regulation is socially situated involving dynamic interplay between learners, tasks, teachers, peers, parents, context, and cultures. Regulation emerges when learners engage with personally meaningful learning activities and situations infused with personal meaning, outcome utility, task value, and past experiences (Zimmerman, 2002; Hadwin, Jarvela & Miller, 2016; Zimmerman, 2008).

Tools and Technologies: this perspective focuses on the importance of choosing a tool that prioritizes a clear goal setting, and emphasizes self-assessment, and feedback. The need to opt for tools that support visual mechanisms, interactivity, social comparison, and help-seeking, and, finally, the importance of taking into account the cognitive load and employing strategies to balance it when selecting the appropriate tool. For tool and technologies to support effective SRL the following guidelines are suggested:

1. choose a tool that gives importance to clearly setting the goals, to self-assessment and feedback. Use tools in which learners can set their learning goals such as the selection of skills to develop or the definition of activities to be developed on certain dates (Jivet et al., 2021; Broadbent, Panadero & Fuller-Tyszkiewicz, 2020; Pérez-Álvarez, Maldonado-Mahauad & Pérez-Sanagustín, 2018). Use tools that offer textual feedback to the learners through motivational messages, presenting the correct answers to an exercise, time invested, or sending notifications (Jivet et al., 2021; Pérez-Álvarez, Maldonado-Mahauad & Pérez-Sanagustín, 2018).
2. use tools supporting visual mechanisms, interactivity, social comparison and help seeking. This implies to prefer tools which have progress or interaction of the learner with the activities (Taub, et al., 2021; Araka, et al., 2020; Broadbent, Panadero & Fuller-Tyszkiewicz, 2020; Pérez-Álvarez, Maldonado-Mahauad & Pérez-Sanagustín, 2018), that enable shared spaces, forums, chats or by integrating social networks, wikis or blogs, that allow the use of notebooks or support the generation of concept maps for content organization (Jivet et al., 2021; Pérez-Álvarez, Maldonado-Mahauad & Pérez-Sanagustín, 2018).
3. when selecting the suitable tool, consider the cognitive load and apply strategies to balance it. The affordances of self-regulation thus will cause cognitive load amplified by tool learning curve. Consider instructing and providing feedback to students about watching their learning curves (Taub et al., 2021; Broadbent, Panadero & Fuller-Tyszkiewicz, 2020; Pérez-Álvarez, Maldonado -Mahauad & Pérez-Sanagustín, 2018).
4. Use tools that allow users to note their comments, recommendations and inputs. Those tools recommend learning objectives or activities, learning routes, strategies, or tips for SRL or the use of the tool itself, and use some mechanism for allowing data entry by the learner (Broadbent, Panadero & Fuller-Tyszkiewicz, 2020; Pérez-Álvarez, Maldonado-Mahauad & Pérez-Sanagustín, 2018).
5. when choosing a tool, take into consideration not only aspects such as usability and satisfaction, but also accessibility and its impact on learners' self-regulation behavior. Try also to focus on the impact of tools on learners' self-regulation behavior (Urbina, Villatoro & Salinas, 2021).

Learning Ecologies: this perspective focuses on the importance of promoting tools and attitudes fostering the development of a Personal Learning Environment (PLE) and of guiding students in constructing a Personal Development Planning (PDP). Additionally, the indications encourage the use of web resources and technologies that support learner autonomy and self-direction, such as current awareness techniques and social networks. For learning ecologies to support effective SRL the following guidelines are suggested:

1. promote those tools and attitudes that lead to the development of a Personal Learning Environment (PLE). Create a personal learning space, with social media and apps enabling students to engage in SRL processes such as goal setting and planning; promote the use of social media to engage in collaborative activities; promote the use of social media to aggregate information in order to reflect on their learning experience (Dabbagh & Kitsantas, 2012; Queiruga Dios, 2021).
2. guide your students in the construction of a Personal Development Planning (PDP). PDP practices encourage self-directed and SRL and also embrace the idea of learning ecologies, because students embrace their own learning plan, following these activities: "thinking and planning, doing, recording, reflecting, evaluating, using the personal knowledge gained to change thinking" (Jasckson, 2015).
3. make a link between formal and informal learning environments with Enterprise Social Network Systems (ESNs). ESNs can create learning environments and support learning also in informal

environments: “ESNs can allow students in a formal class group to easily interact with others who are not enrolled in the class but can contribute to their learning” (Scott, Sorokti & Merrell, 2016).

4. encourage the use of web resources and technologies that support learners’ autonomy and self-direction. There are web-enabling services and technologies supporting learning ecologies that permeate formal, non-formal and informal learning, such as: Current awareness techniques, Social networks and communities (Maina & González, 2016).

Finally, the results of the validation process showed that there is a large agreement between the responses on the clarity and understandability, consistency and significance of the LD and SRL guidelines from all the perspectives considered (methods and model, tools and technologies and learning ecologies). More in detail, the results revealed a substantial agreement among the experts concerning the clarity and understandability of the LD guidelines, with predominant agreement or strong agreement in all sectors: methods and model, tools and technologies, and learning ecologies. The same widespread agreement is observed in terms of the consistency of the LD guidelines and the significance of the LD guidelines (see Figure 2).

Regarding the SRL guidelines, the clarity and understandability again received a high level of agreement among respondents across all areas. The significance of the SRL guidelines reflects similar results, with respondents majorly expressing their agreement or strong agreement. Additionally, the responses showed a large consensus on the significance of the SRL guidelines, further confirming the broad alignment and satisfaction with the guidelines in every aspect (see Figure 3).

The survey highlighted also an area of improvement, particularly referring to the addition of practical examples for each indication (Expert 1: “*I think that the work is clear and gathers all the important theoretical elements to be taken into account for the learning design. However, I think it is developed from an academic point of view. To serve as a basis for working with teachers I would add practical examples where the theory expressed is put into play. Even images, graphs, diagrams, that help to better visualize what is intended to be said. This would prevent the proposal from being seen in an abstract way with difficulties to see how it works in reality*”). These examples will be added at the end of the testing phase of SuperRED activities in order to provide further support to teachers.

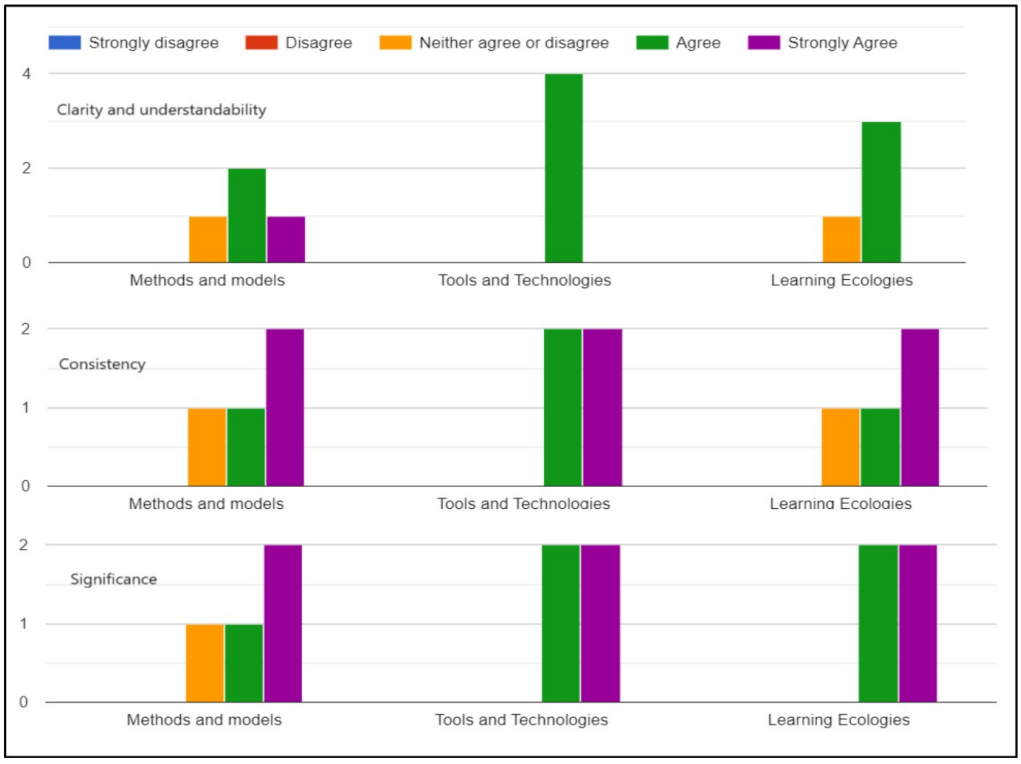

Figure 2 - LD Guidelines’ clarity and understandability, consistency and significance.

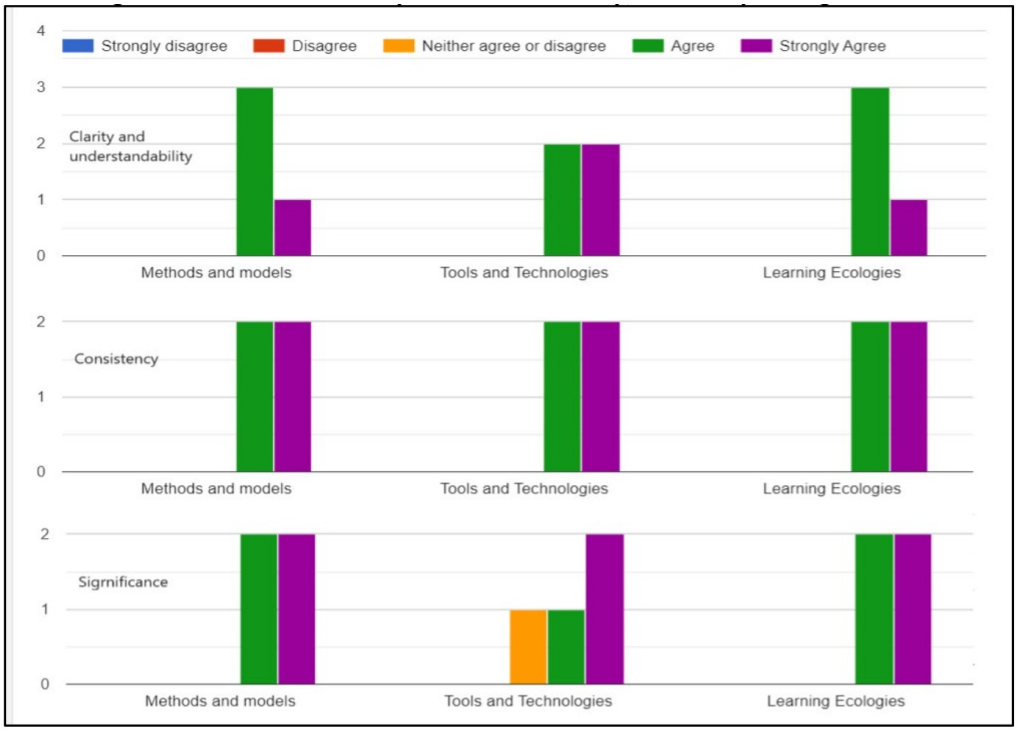

Figure 3 - SRL Guidelines' clarity and understandability, consistency and significance.

4. Conclusions

In light of the presentation of the SuperRED Framework and its genesis, it's clear that it holds a multi-faceted, integrative approach to bolstering education in the digital arena. With its insights into methods and models and tools and technologies, it advocates for a holistic approach to learning design, underscoring the importance of LD for fostering coherent and effective design experiences for teachers. Moreover, the emphasis on sharing designs for enhancing online collaboration and peer review echoes the commitment to building a robust pedagogical knowledge community. Furthermore, the SuperRED Framework's focus on SRL delineates its learner-centric orientation and shines a light on the multifaceted nature of regulation, underlining the need to engage learners based on their unique purposes, intents, and goals. The emphasis on linking theory and practice, setting personal or personalized course goals, and the adaptive, cyclical nature of learning regulation underscores the framework's dedication to fostering a dynamic, interactive, and supportive learning environment.

Therefore, the SuperRED Framework emerges as an encompassing guide for navigating the intricate terrain of digital education. The comprehensive detailing into each aspect of learning, from the use of methods and models and tools and technologies to the nuanced facets of learning ecologies, demonstrates the framework's robustness and adaptability. It stands as an important reference for educators seeking to enhance their learning design competencies, improve collaboration and community building.

The meticulous process behind the development of the SuperRED framework, involving a comprehensive literature analysis, teachers' involvement, and an expert validation of the draft version, underscores the commitment to delivering a robust and reliable tool for the educational community. It stands as a demonstration to the collaborative efforts of researchers and school partners from four European countries, driving forward the agenda for enhanced digital education and learning experiences.

In conclusion, the SuperRED project may provide a contribution to the evolution of digital and remote education, particularly in enhancing the competences of teachers and students in navigating

the multifaceted landscape of online learning environments. By developing the SuperRED framework, the project may support educators and learners in facing the several challenges of the digital world, offering practical solutions for effective LD and SRL.

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Academic integrity in online assessment: towards the development of a proposal for guidelines and education resources

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Abstract

In recent years, the use of digital platforms, applications and tools for assessing learning has increased significantly, in part due to the impact of the COVID-19 pandemic. The availability of digital resources allows for the creation of assessment tests that can be administered remotely as well as face-to-face. Furthermore, monitoring tools such as e-proctoring systems, which are particularly well-suited for summative assessments, can be employed in both scenarios. However, merely relying on different technology solutions cannot ensure the establishment of a "safe" assessment setting that is suitable for maintaining academic integrity and ensuring assessment quality. In the context of online assessment, faculty members' main needs include the need to prevent student plagiarism and the possibility of developing an authentic culture of academic integrity. Against this complex background, an analysis was conducted on selected guidelines and frameworks promoting an authentic culture of academic integrity in domestic and international academic contexts. The selected guidelines and frameworks were proposed by organizations such as the Teaching and Learning Centres and/or the Centres for Academic Integrity. The research was conducted in two phases. The first phase involved an analysis and mapping of guidelines, frameworks, and digital resources designed within the university context to promote academic integrity. The second phase involved the development of an initial proposal for guidelines based on the resources found and analyzed in the previous phase. These guidelines were to be applied in blended or distance learning degree programs and will be defined after an analysis is conducted on student and teacher perceptions and needs regarding online assessment and academic integrity. A summary of the results of the first phase is presented in this paper.

Keywords: Online Assessment, Academic Integrity, Academic Dishonesty, Guidelines, Digital Technology.

1. Introduction

The utilization of digital platforms, applications, and tools for the assessment of learning has significantly increased in both on-campus and online university contexts. This growth is largely attributable to the proliferation of distance learning pathways, such as MOOCs and online degree programs, and in part to the experiences developed during the COVID-19 emergency (Chiang et al., 2022; Holden et al., 2021; St-Onge et al., 2022). Consequently, research on topics such as digital assessment tools, peer assessment, and online feedback has become increasingly relevant (Sannicandro, 2023). The online assessment of learning is defined as "the use of digital tools to assess or measure learning outcomes, both face-to-face and in distance-learning environments" (Bartley, 2005, p. 6). In the various contexts of online learning, assessment "is created, written, delivered and marked with technology, typically a specialist assessment platform" (Gibson, n.d., p. 1). The availability of digital resources allows for the creation of assessment tests that can be administered remotely as well as face-to-face. The landscape of online assessment has undergone significant changes and is now widely acknowledged as a permanent practice (Jha, 2021). It provides an ecosystem for sharing knowledge and learning through collaboration, comparison, and interaction, utilizing both formative and summative strategies for assessment (Conrad & Openo, 2018; Sannicandro, 2023). The relationship between assessment, technologies, and digital resources has the

potential to transform teaching practices and redefine assessment in various ways. Recent studies have identified five essential design considerations for online assessments: "ensuring academic integrity, providing quality feedback, supporting a positive learning experience for students, maintaining the integrity of student information, and ensuring equal opportunities for all students to complete the assessment successfully" (Huber et al., 2024, p. 3). Among the principal needs identified by instructors in the context of online assessments is the necessity to prevent plagiarism (and related phenomena) among learners, as well as the potential for developing an authentic culture of academic integrity (Robinson et al., 2017; Tatum, 2022). Indeed, key themes in research on online assessment in university contexts include studies and research that have focused on academic integrity and/or academic misconduct (Sannicandro, 2023).

It is noteworthy that the topic of academic integrity and academic dishonesty in studies on online assessment is a constant (Garg et al., 2022; Surahman et al., 2022; Holden et al., 2022; Hartnett et al., 2023). It is inevitable that these aspects will impact the attitudes and opinions associated with online assessment from instructors and students (Bahar et al., 2018; St-Onge et al., 2022). Such attitudes and opinions can affect the quality of online assessment and the correct performance of testing in a positive or negative manner. In such instances, monitoring tools, such as e-proctoring systems (particularly for summative assessment), can be used. Nevertheless, the deployment of distinct technological solutions alone cannot guarantee the creation of a secure assessment environment that can ensure academic integrity and the quality of the assessment process. It is of paramount importance for teachers to establish a reliable relationship with their students. Verifying their identity and authenticating the authorship of their academic work is a crucial aspect in online assessment (Amihud et al., 2017).

Academic dishonesty can manifest in "a number of ways, including the use of unauthorized materials, facilitation (helping others to engage in cheating), falsification (misrepresentation of self), and plagiarism (claiming another's work as one's own)" (Holden et al., 2021, p. 2). In some cases, it can even involve the use of ghostwriters (Hill et al., 2021). There is no consensus in the literature on whether cheating is more frequent in online or face-to-face assessments (Reedy et al., 2021). These issues are also common in traditional learning contexts but may sometimes be amplified in the online experience (Akimov, 2020). The quantity and intricacy of these definitions demonstrate how academic conduct encompasses numerous, frequently interrelated, elements. For example, when discussing research on the assessment of learning in university settings, including both online and face-to-face contexts, a number of critical issues arise, such as academic dishonesty, contract cheating, the use of unauthorized resources, fabrication and collusion. These issues are in addition to the previously mentioned facilitation, plagiarism and ghost-writing. The term e-dishonesty has been employed to describe behaviors that deviate from academic integrity in the online environment, prompting the consideration of novel issues that may not have been addressed in previous studies (Holden et al., 2021). Glossaries have also been compiled on these topics, with the objective of differentiating and clarifying the various phenomena.

The assessment approach developed in the training courses (as control and vigilance) often relies on retrospective inspection of student-generated content to identify and address instances of plagiarism, cheating, and other academic dishonesty. Alternatively, anti-plagiarism software such as Turnitin, Originality.AI or iThenticate may be used to check for plagiarism in articles, theses and other documents. An alternative approach, which emphasizes development, collaboration, and reflection, should be embraced. This approach goes beyond mere oversight and should be embraced collaboratively by both educators and learners from the outset of training activities. For instance, as illustrated in forthcoming sections, the creation of guidelines, models, and best practices can promote a culture of academic integrity and transversal skills (critical and innovative thinking etc.). Although there has been an increase in the number of activities aimed at training on academic integrity issues, such as online courses, guidelines, and video-tutorials, these actions do not directly involve lecturers and students in the design and development process. A study conducted at the University of Auckland (Stephens et al., 2021) investigated the effects of introducing mandatory Academic Integrity Courses (AIC). The study revealed that students who had completed the Academic Integrity Course (AIC) exhibited lower levels of understanding, support, and effectiveness regarding the University's academic integrity policies (Stephens et al., 2021). Furthermore, the study demonstrated that the levels

of peer disapproval of academic misconduct were statistically equivalent between the two groups, while the levels of peer engagement in academic misconduct were significantly higher among those who had completed the AIC (Stephens et al., 2021, p. 7). It is understandable that students may experience anxiety and stress during assessments. However, adequate preparation can alleviate these feelings. The study by Sanchez-Cabrero and colleagues (2021) revealed that stress levels appear to decline rapidly once the exam begins and then again once it is over. The study found that "most students consider that there is little difference between on-site and online evaluation, and both prompt the same amount of stress, if not less for remote exams" (Sanchez-Cabrero et al., 2021, p. 11). Holden and colleagues (2002) identified a number of potential causes of academic dishonesty, including individual and psychological factors, institutional factors, and factors related to test delivery instruments.

The factors influencing academic dishonesty vary according to the specific type of infraction. It is therefore beneficial to distinguish between instances of spontaneous cheating, which may be driven by panic, and those that are the result of forethought and deliberate preparation, which we term "planned cheating" (Dendir & Maxwell, 2020, p.2). For this reason, we have decided to focus more on the concept of academic integrity, which is defined as the commitment to uphold six fundamental values: honesty, trust, fairness, respect, responsibility, and courage (International Center for Academic Integrity, 2021, p. 4). It is assumed that mere literacy and training on these topics may not be sufficient to affect the elements that characterize the complex construct of academic integrity and the need to demonstrate such values (see Table 1). Focusing the analysis and development of activities on these principles allows for a positive approach to the evaluation process and the concept of academic integrity (the positive expression of integrity is often overlooked). It is evident that prior to examining the topic of academic integrity, researchers and educators have primarily concentrated on the issue of plagiarism and the methods of its prevention or detection.

Table 1 - Six fundamental values proposed by International Center for Academic Integrity (ICAI, 2021, p. 5-10, our summary).

Ways to demonstrate honesty	*Ways to demonstrate trust*	*Ways to demonstrate fairness*	*Ways to demonstrate respect*	*Ways to demonstrate responsibility*	*Ways to demonstrate courage*
· Be truthful · Give credit to the owner of the work · Keep promises · Provide factual evidence · Aspire to objectivity, consider all sides and one's own potential preconceptions	· Clearly state expectations and follow through · Promote transparency in values, processes, and outcomes · Trust others · Give credence · Encourage mutual understanding · Act with genuineness	· Apply rules and policies consistently · Engage with others equitably · Keep an open-mind · Be objective · Take responsibility for your own actions	· Practice active listening · Receive feedback willingly · Accept that others' thoughts and ideas have validity · Show empathy · Seek open communication · Affirm others and accept differences · Recognize the consequences of our words and actions on others	· Hold yourself accountable for your actions · Engage with others in difficult conversations, even when silence might be easier · Know and follow institutional rules and conduct codes · Create, understand, and respect personal boundaries · Follow through with tasks and expectations · Model good behavior	· Be brave even when others might not · Take a stand to address a wrongdoing and support others doing the same · Endure discomfort for something you believe in · Be undaunted in defending integrity · Be willing to take risk and risk failure

It is important to note that punishment and prevention are distinct concepts. "It is a mistake to believe that threats of the former (if only severe enough) equates with the latter" (Stephens et al., 2021, p. 3). In many cases, countering these phenomena with surveillance strategies alone (Verhoef et al., 2021) is not an effective option. In digital learning environments, many of the described critical aspects can be

overcome. In blended or distance learning degree programs, it is possible to have an impact on the phenomena of academic dishonesty (Abubakar et al., 2022) through detailed guidelines, adequate training, and test practice sessions to familiarize students with how online assessment works. This is not only from the perspective of control. The proposal of guidelines, including at the institutional level, shared with faculty, students, and other professionals appears capable of significantly impacting the processes under examination (academic integrity, cheating, e-dishonesty). In the context of online assessment, it is important to recognize the unique needs of both instructors and learners. While there are certain objectives that can affect the assessment experience for both parties, such as preventing plagiarism and promoting academic integrity, learners expect to receive fair and impartial treatment and recognition during assessment. This aligns with the need of instructors and universities to ensure transparent and collaborative assessment. It is important to recognize that students may face challenges and areas for improvement when it comes to online assessments. These assessments require a high level of digital proficiency, which can be difficult for some students. To ensure academic integrity and prevent academic misconduct, it is important for students to prepare thoroughly for exams and have a clear understanding of how online assessments function (Abubakar et al., 2022). In order to improve academic integrity, it is strategic to focus on training and developing skills related to the culture of academic integrity, rather than only intervening on critical issues related to academic misconduct. The question then arises as to who should be responsible for these training and development processes.

Against this complex background, an analysis was conducted on selected guidelines and frameworks promoting an authentic culture of academic integrity in international academic contexts. The selected guidelines and frameworks were proposed by organizations such as the Teaching and Learning Centres and/or the Centres for Academic Integrity. Section 2 presents the research methods and outlines the stages of the study. The main results of the analysis of good practices are detailed in the subsequent Section 3. The concluding section presents a summary of the key findings of the research and offers insights into potential future developments and relevant implications for academic integrity processes.

2. Materials and Methods

The study forms part of a larger research project that engaged the process of assessment online learning in distance university courses (Sannicandro, 2023). A mixed-methods approach was adopted (Creswell, 2014, p. 341) that:

- plans to compare different perspectives using both quantitative and qualitative data. This will be achieved through the administration of semi-structured questionnaires to students and teachers, as well as conducting focus group;
- aims to incorporate the perspectives of individuals and institutions, such as best practice analysis and digital asset sharing on academic integrity;
- develops a more comprehensive understanding of the necessary changes, combining qualitative and quantitative data. This can be achieved through the use of semi-structured questionnaires, focus group and triangulation of data collected from the course delivery platform.

The research involved the following phases:

1. *First phase*: analysis and mapping of guidelines, frameworks and digital resources developed in the university context to promote academic integrity. The selected guidelines and frameworks were proposed by organizations such as the Teaching and Learning Centers and/or the Centers for Academic Integrity;
2. *Second phase*: development of an initial proposal for guidelines based on the resources found and analyzed in the previous phase, to be applied in blended or distance learning degree programs, preceded by an analysis of student and teacher perceptions and needs regarding online assessment and academic integrity.

A summary of the results of the first phase is presented in this document. This contribution focuses on the analysis conducted in the first phase to develop guidelines for four mixed-mode and/or

predominantly distance learning courses that three Bachelor's degree courses and one Master's degree course, with 150 instructors and tutors and over 4000 students enrolled in the courses hosted on the distance learning portal for the academic year 2023-2024.

To develop and implement guidelines, training, and honor codes, universities must reduce the cheating culture, particularly, in online courses (Holden et al., 2021), and develop policies and procedures for the promotion of a culture of academic integrity. As anticipated, the analysis of selected guidelines and frameworks promoting an authentic culture of academic integrity in international academic contexts has been developed and which in many cases directly involve the design of the assessment. Rethinking evaluation involves both instructors (we think of the training necessary to develop evaluation redesign processes) and students (from a student-centered perspective), for this reason the research includes several phases and the use of different data collection tools (the submission of semi-structured questionnaires addressed to students is currently underway as part of the second phase). The objective is to develop and enhance a culture of academic integrity, particularly in the context of distance university courses. This requires a collaborative effort at the macro-planning level. The hypothesis is that involving lecturers and students in the design of training activities and digital resources is necessary for their effectiveness. This is supported by research and studies analyzed in the first part of the contribution. Furthermore, it is important to note that isolated activities in individual courses or lectures may not have a significant impact on students' competences and perceptions in the long term. This is especially true when considering cases of assignment cheating, test cheating, or exam cheating (Dendir et al., 2020; Stephens et al., 2021). Therefore, it is useful to inquire about the resources and models that have been developed in similar experiences, such as degree courses, distance learning, instructional design, and online assessment. Additionally, it is important to consider the strategies, guidelines, or checklists that have been employed. The first step is to create a map of resources to be integrated into a blended portal (LMS) (for summary reasons, not all resources and systems analyzed can be presented in detail).

However, a summary of the resources relevant to our study and subsequent research phases will be offered. In addition, at this stage we have focused more attention on guidelines and checklists. In other contributions, we will describe the research activities conducted to develop guidelines and checklists for academic integrity. These guidelines and checklists will be shared with students and lecturers of identified courses of study in the second phase.

3. Results

The focus of educational research is shifting, necessarily, "towards an approach that is preventative, educative and positive in promoting student success" (Center for Teaching and Learning, UC Berkeley). As indicated we conducted an analysis of some of the guidelines and frameworks proposed in the academic context and internationally (e.g., by the Teaching and Learning Center and Center for Academic Integrity) used to promote the dissemination of an authentic culture of academic integrity and digital resources related to these activities. The use of digital resources and a well-designed evaluation process can enhance the development of skills and competencies related to academic integrity. This can be achieved by adopting a sharing-based approach (Sannicandro, 2023), rather than relying solely on invigilation or online proctoring systems. Developing an alliance between different professional figures is crucial in this process. This involves not only instructors and students but also instructional designers, tutors, and other professionals.

In our preliminary analysis, we identified several levels of integration of resources dedicated to academic integrity in the university context. These resources include guidelines, regulations, and software, among others. We classified these resources as follows:

Level 1 includes general indications on the rules for conducting examinations and conduct by the lecturer. Consequently, these resources are linked to individual teaching and not shared at the degree course level.

Level 2 comprises general indications on the conduct of examinations and conduct by a Department or Degree Course, which may therefore be shared and applied for a complete degree program or larger groups of courses, lecturers and students.

Level 3 involves the development of dedicated and articulated sections with different resources in the pages of the Teaching and Learning Centres of Universities, which are often linked to the areas of instructional design and assessment of study courses (regulations, teaching guidelines, digital resources that contribute to the construction of thematic sections on academic integrity policies). These interventions may therefore involve didactic, design and methodological aspects.

Level 4 refers to institutions and/or associations concerned with academic and research integrity that, in collaboration with universities and other bodies, develop policies and resources to foster and disseminate a culture of academic integrity.

With respect to the levels identified, we present some examples of institutions, non-profit organizations and/or universities (including through the Teaching and Learning Centres mentioned above) that have developed activities and sections dedicated to academic integrity, diversifying resources with respect to the recipients (teachers, researchers, students, designers). This aspect highlights the need to streamline processes in order to enhance flexibility in the integrity/conduct equation, prioritizing actions that focus on academic integrity over verification and punishment measures. This does not negate the value of levels 1 and 2, which remain instrumental in developing personalized teaching activities.

We will now analyze some case studies (as previously indicated, the key findings of our analysis will be highlighted).

A number of measures have been implemented in Canada with the aim of promoting academic integrity. One such measure is from the Council of Canadian Academies (CCA). In addition, individual institutions bear responsibility for promoting research integrity practices and monitoring infractions. Consequently, the interpretation of guidelines and policies may vary across disciplines and institutions. In response to this, a research integrity group was established, namely the Canadian Council for Research Integrity (CCRI). The CCRI's objective is to develop a unified, interdisciplinary strategy that engages all stakeholders in the research community, including those in the university context. To promote transparency and accountability, the CCRI provides training to address identified gaps in the system (Council of Canadian Academies, 2010). Two key gaps have been identified in the policy framework. Firstly, there is currently no system-wide approach to information management and research. Secondly, there is a shortage of education and training programs and materials, and no independent source of advice. In the Council of Canadian Academies' proposal, we find a reference to the values of honesty, fairness, trust, accountability, and openness, which contribute to the construction of a positive integrity environment based on promotion, prevention, and sanction (Council of Canadian Academies, 2010).

In the specific context of universities, we highlight the case of the University of Calgary and Brock University. The University of Calgary, through the Taylor Institute for Teaching and Learning, has developed a program based on Indigenous Principles of Academic Integrity. Canada differs from the United States in its approach to academic integrity and educational ethics (Eaton, 2022). Resources developed include student handbooks, videos and visual storytelling specifically focused on Indigenous academic integrity.

Brock University has developed teaching and design guidelines for faculty and other professionals. These include academic integrity workshops and guidelines for inclusion in course syllabi and academic integrity policies. For faculty, for example, it is suggested that course syllabi include (1) a statement of academic integrity, (2) clear and explicit assignment requirements, and (3) well-defined guidelines for group work and collaboration (Brock University, n.d.). As shown in Figure 1, a dedicated section can be structured and differentiated for both teachers and students. This allows resources to be customized and guides each user group to the most relevant materials. In addition, these sections serve as repositories for useful digital resources, often including common definitions and guidelines for academic integrity and related behaviours.

Among the other examples of institutions dealing with academic integrity at an international level, we find both the International Center for Academic Integrity (ICAI), which we have already mentioned in the first section when proposing the definition of academic integrity, and the European Network for Academic Integrity (ENAI). The ICAI, founded in 1992 by Professor Don McCabe, promotes academic integrity and ethical behavior. Its members include not only public institutions but also companies and agencies that are involved in these issues in various capacities.

The European Network for Academic Integrity (ENAI) is described as "an association gathering educational institutions and individuals interested in maintaining and promoting academic integrity" (ENAI, n.d.).

Relevant to our analysis are the numerous materials and sections made available by both institutions, which can serve as a starting point for developing further educational resources aimed at both faculty and students for the development of pathways dedicated to the culture of academic integrity. As emphasized earlier, the culture of academic integrity also involves the sharing of clear definitions of phenomena related to integrity. In this regard, ENAI has developed a Glossary for Academic Integrity comprising 212 terms (the complete document can be consulted on the website section).

Both institutions also have dedicated sections for educational resources in the university context. For example, they provide guidelines and useful documents for developing academic integrity policies, training modules, video resources, apps or checklists. Figure 2 shows an example of an application found in the "Educational Materials on Academic Integrity" section of ENAI, namely Seneca's Integrity Matters application.

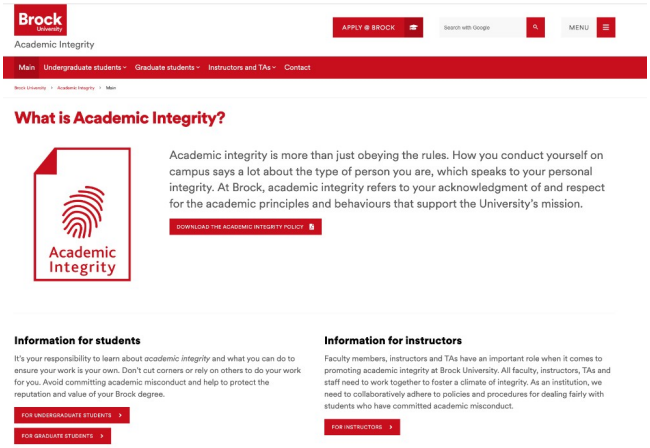

Figure 1 - Section Academic Integrity of the Brock University (https://brocku.ca/academic-integrity/).

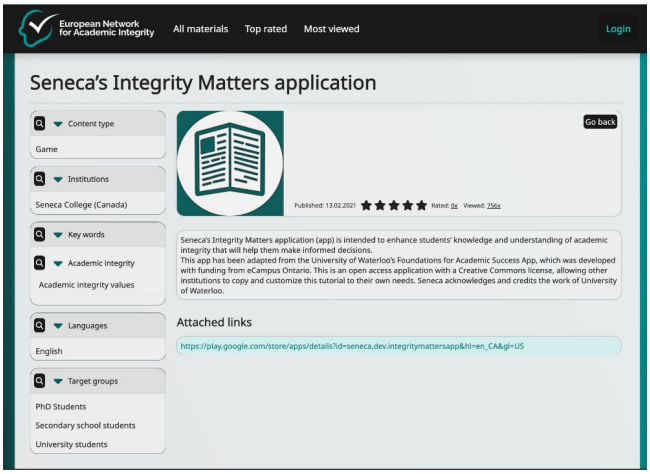

Figure 2 - Example of a resource in the section Educational Materials on Academic Integrity (ENAI - https://www.academicintegrity.eu/materials/265)

Below, we also present two examples of checklists: the *Academic Integrity Faculty Checklist* (Figure 3) (ICAI, n.d.) and the *Checklists for Supervisors* (Figure 4) (ENAI, 2022). Each focuses on different processes related not only to individual courses but, for example, to the type of assessment and resources used, highlighting the importance of direct engagement with students on these issues. Among the various available resources, we also find examples of honor codes or conduct that can be useful in providing students with examples of behaviors that constitute misconduct. We can also

identify resources dedicated to Institutional academic misconduct process examples. As highlighted in our analysis, university approaches to academic integrity also prioritize the management and verification of cases of dishonesty. Consequently we have identified some practices related to these phenomena, such as the Committee on Academic Misconduct of The Ohio State University. Figure 5 outlines the Five Easy Steps for Submitting Allegations of Academic Misconduct (The Ohio State University) that faculty can follow to report cases of misconduct.

As previously stated, the utilization of digital platforms, applications, and tools for the assessment of learning has significantly increased. In conclusion of this section, a brief reflection is offered on the digital resources employed for the verification of student-produced content. For the sake of brevity, a selection of examples is presented. A significant number of universities have long employed systems such as *Compilatio, Plagiarism Checker,* and *Turnitin* (e.g., Turnitin Originality, Turnitin's AI writing) for the detection of plagiarism or content generated with artificial intelligence tools. In considering digital resources, it is essential to take into account the diverse expectations and needs of both students and faculty (as well as any associated costs and functionalities of different systems). Given the potential risks associated with content generated by AI, it has become necessary to update regulations, guidelines, and other relevant documents with specific indications for these resources. Figure 6 presents an example developed by Southern Cross University regarding the consequences of using unauthorized systems.

The selection of these resources is far from straightforward as it involves considering many diverse factors. Numerous studies have investigated and compared different software solutions, particularly with the rise of AI tools (Foltýnek et al., 2020; Chaka, 2023; Cingillioglu, 2023). It requires choosing tools and resources that can seamlessly integrate with aspects of assessment, didactics, course design, while also aligning with university regulations and guidelines (if available and according to the levels we have assumed in our analysis). If it is true that students may engage in misconduct due to shortcomings in learning environments that can foster such behaviors, it is also true that all actions and strategies addressing issues like Cheating & Plagiarism have positive implications for student learning (Lang, 2013). The hypothesis is that intervening in instructional design, assessment, and even through the sharing and co-construction of tools and resources with students and instructors can impact the dissemination of a cultural real of academic integrity and the creation of shared institutional policies.

This is just one of the interests at stake, as the aim is also to influence assessment processes and student learning.

The Center for Teaching & Learning at the University of Berkeley suggests developing academic integrity through course design, identifying five potential aspects of a course designed to promote academic integrity and student learning (Center for Teaching & Learning, University of Berkeley, n.d.):

- foster students' intrinsic motivation;
- place emphasis on learning for mastery over performance;
- use frequent, low-stakes assessments;
- build student self-efficacy;
- prepare students for ethical considerations in the field/profession.

4. Conclusions

As highlighted, online assessment has accelerated its development and despite this growth and the emergence of new issues, the study of integrity and quality remains central. Efforts to promote academic integrity have become more prevalent in recent years. This involves encouraging a conscious understanding and active commitment to honesty in scholarly pursuits (Stephens et al., 2021). This initial analysis suggests that academic integrity is closely related to the need to make different teaching and assessment choices, especially in distance learning contexts. However, the challenges found in distance learning also apply to traditional courses, as the analyzed phenomena affect any assessment experience, not just online ones. Academic credibility in education is based on enduring principles of academic integrity, which remain constant despite changes in instructional methodologies, pedagogical theories, learning technologies, and delivery modalities (Amigud et al., 2017).

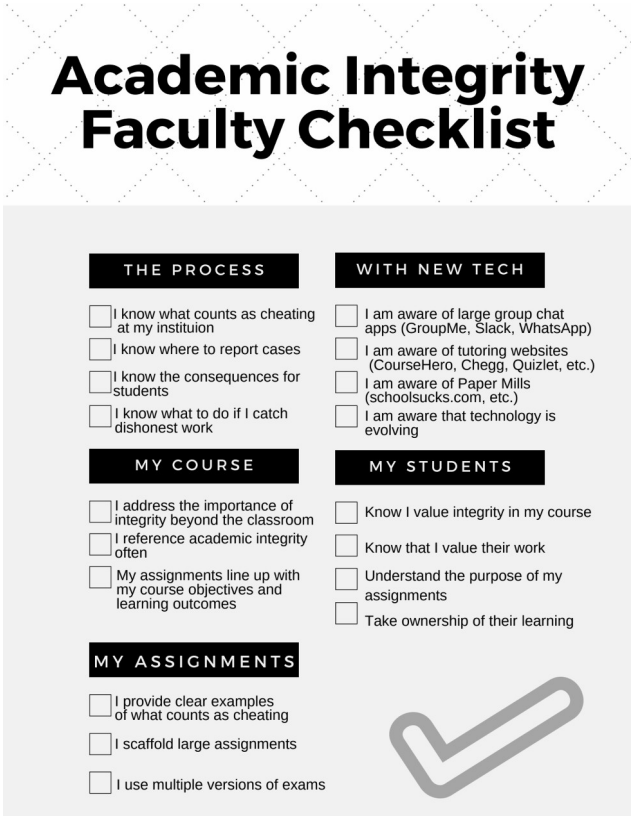

Figure 3 - Academic Integrity Faculty Checklist (ICAI).

Figure 4 - Checklists for Supervisors (ENAI, 2022).

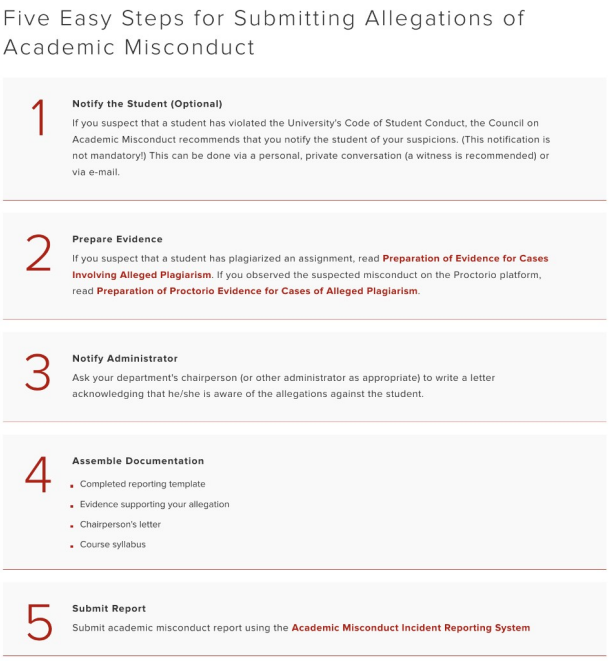

Figure 5 - Five Easy Steps for Submitting Allegations of Academic Misconduct - The Ohio State University (https://oaa.osu.edu/academic-integrity-and-misconduct/faculty-obligations).

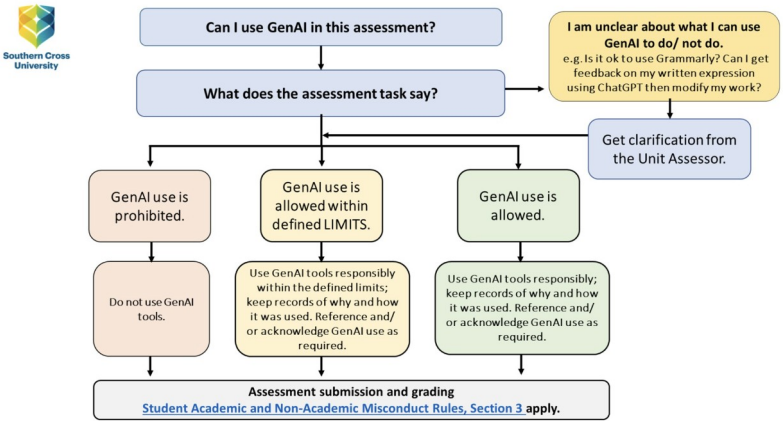

Figure 6 - Academic Integrity and GenAI Tools - Southern Cross University (https://www.scu.edu.au/current-students/learning-zone/academic-integrity-and-turnitin/).

The relationship between online assessment and academic integrity is predicted to become even more crucial, also due to the development and growth of Artificial Intelligence (AI) systems (Perkins, 2023) and online learning. The importance of these aspects cannot be delayed. The growing use of digital AI resources and tools (Zawacki-Richter et al., 2019; Chaka, 2023; Cingillioglu, 2023) has introduced new variables and challenges in the assessment process that cannot be addressed by supervisory tools alone. Therefore, it is necessary to develop diverse teaching and assessment strategies and methods. As a matter of academic literacy, training in these aspects will also have a (positive) impact on the development of students' skills. For future research, we can identify some useful points: issues of academic dishonesty are no longer just about online assessment; there is a need to positively rethink strategies to strengthen the culture of academic integrity (not only to sanction or intervene on summative assessment); digital tools and resources will have to integrate with regulations and guidelines and teaching and assessment choices (e.g. guidelines, checklists); developing a good culture of integrity also starts with confrontation with teachers and students through moments of co-design. Additionally, it is important to investigate the potential effects of Artificial Intelligence tools and their role in promoting integrity.

Authors' contributions

According to CRedit system, Katia Sannicandro (corresponding author): *Conceptualization*, *Methodology*, *Investigation*, *Visualization*, *Writing-Original Draft*, *Writing-Review & Editing*; Annamaria De Santis: *Resources*; Claudia Bellini: *Resources*; Tommaso Minerva: *Supervision*.

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From Video to Learning Prop: a top-down approach to improve the effectiveness of Multimedia Resources in Medical Education

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Abstract

In 2019 a multimedia project named Videolibrary was launched at the Department of Clinical and Biological Sciences of the University of Turin, Italy. The project aims to make video resources available for students attending the MD program in Medicine and Surgery. This article shows the development of e-contents for medical education starting from videos. Media contents, initially produced by an outside supplier, were later reworked by means of H5P, an open-source authoring tool which allows creators to produce reusable interactive contents. The result was the transformation of three 30-40 minute videos into three interactive learning props, hosted on the Moodle platform, that is the Learning Management System used at the University of Turin.

Keywords: Medical Education, Learning Prop, Multimedia, Video.

1. Introduction

Over the last decade, the increasing use of technology in medical education has drawn the attention of the research community (see, among others, Taslibeyaz et al., 2016; Ahmet et al., 2018; Srinivasa et al., 2020). Among educational media, videos are possibly the most widely used due to their easy accessibility and capabilities, hence becoming prominent for the learning transformation of all individuals.

While studying research trends in the literature on video usage, Taslibeyaz et al. (2016, p. 873) evidence that video resources promote effective learning and knowledge retention, thus having a positive impact on the acquisition of clinical skills. In addition, Ahmet et al. (2018, p. 1150), while analyzing a set of research works which explored the influence of videos in surgical education, conclude that video-based education can produce significant effects on surgical training. Moreover, Srinivasa et al. (2020, p. 689) report that online media are valuable educational tools also in postgraduate medical education. Finally, according to Discore (2010, p. 10), at present there are several websites, such as MedlinePlus and New England Journal of Medicine (NEJM), which publish reliable and quality videos. However, these platforms are less popular if compared to, for instance, YouTube, which constitutes the preferred choice, regardless of a certain variability in both the educational quality and validity of the videos published therein. This fact represents a critical issue for the use of media in education, especially as far as novice learners are concerned, as they might not immediately recognize information quality.

On a final note, even videos posted on trustworthy platforms seldom meet a specific learning objective. Hence, such lack of specificity represents a caveat when using video resources in education. As a possible solution to this problem, in-house design and production of videos exploiting internal resources should be relied upon.

2. Materials and Methods

In 2019 a multimedia project named Videolibrary was launched at the Department of Clinical and Biological Sciences of the University of Turin. The project's goal is to make certified quality video resources available to students who attend the MD program in Medicine and Surgery. Videolibrary is

hosted on the Moodle platform, the Learning Management System (LMS) used at the University of Turin. Videos were produced both by the university's Web and E-learning Staff and by an outside supplier which, after winning a tender, was appointed to release twelve media contents for the project. The videos, which originally included an Italian soundtrack, were dubbed into English at a later stage. For the sake of accessibility, every video was eventually subtitled in both languages.

By adopting a top-down approach, this article describes the transformation of the three videos related to urological topics into three learning props. Design, production and postproduction activities were carried out by the supplier in close contact with the urology professor, though without the supervision of the Web and E-learning Staff. The results were three 30-40 minute videos on the following topics: Access to the Upper Urinary Tract, Access to the Lower Urinary Tract and Minimally Invasive Surgery.

3. Results

In line with Multimedia Learning Theory (MLT), Mayer (2001) offers several recommendations concerning educational videos, especially on how to improve their effectiveness. In particular, he points out the importance of segmentation, namely the chunking of the information string, thus granting learners the possibility to engage with smaller pieces of information once a new topic is given. Segmenting can be achieved by creating short(er) videos, i.e. no longer than 6 minutes, or by including pauses within a video. Moreover, Bransford et al. (2000) report that non-interactive environments, such as linear videos, are much less efficient than interactive ones. Indeed, interactive videos allow learners to explore and revisit specific parts and make the learning process engaging and more effective.

Therefore, starting from these premises, videos were reworked by using H5P, an external plug-in integrated into Moodle, in order to produce three learning props. Among the resources available inside H5P, the 'Interactive Book' was chosen because it enables users to create props with different content types, such as interactive videos, image hotspots, questionnaires and multiple-choice quizzes.

Since the same type of editing procedure was performed for all three videos, only the one related to the 'Access to the Lower Urinary Tract' topic is described herein as a representative case. The first step involved segmenting the whole video into clips, later used to create an "Interactive Book" (Figure 1) divided into the following chapters:

1. Introduction;
2. Endoscopic Instruments;
3. Endoscopic Procedures;
4. Pathologic Findings;

4.1. Pathologic Findings: Test Your Knowledge;

5. Basic Endoscopic Procedures.

The clips were embedded both as non-interactive videos (chapter 1) and interactive videos (chapters 2, 3 and 5).

As for interactive videos, bookmarks (Figure 2), which allow learners to skip from a specific part of the clip to another, and single-choice questions for self-assessment with feedback (Figure 3) were inserted to enhance the learning experience.

As far as chapter 4 is concerned, an image hotspot (Figure 4) was implemented. The longer clip related to chapter 4 was further subdivided into seven shorter clips, one for each different pathologic finding. These seven clips were then embedded into a single bladder image as interactive hotspots, each of them placed in the pertinent pathology zone.

In this case, the single-choice questions for self-assessment were added separately (paragraph 4.1).

As reported above, H5P allows producers to create reusable interactive content packages that improve the learning process by making it more engaging and effective. Moreover, according to Nightingale et

al. (2019, p. 13), additional contents incorporated into videos can improve their accessibility and inclusiveness, particularly for people with Specific Learning Disorders (SLDs).

By following the top-down approach described, additional contents are not considered in the design phase. Their use was in fact limited, despite the large variety of H5P contents available. Therefore, to improve the learning process, particularly for students with SLDs, supplementary contents must be planned during the design phase. Unfortunately, as these learning props have been available on Moodle only since April 2023, no feedback from students is available yet.

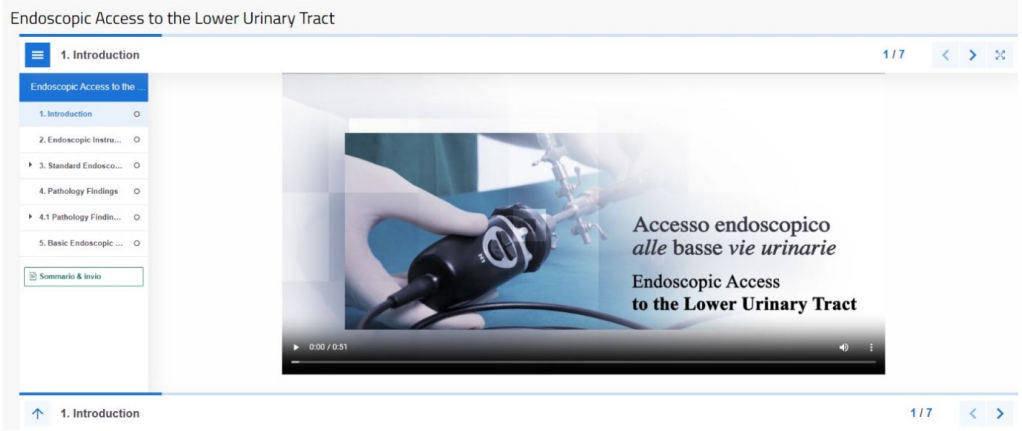

Figure 1 - Interactive Book on the Moodle Platform.

Figure 2 - Bookmarks on the interactive video.

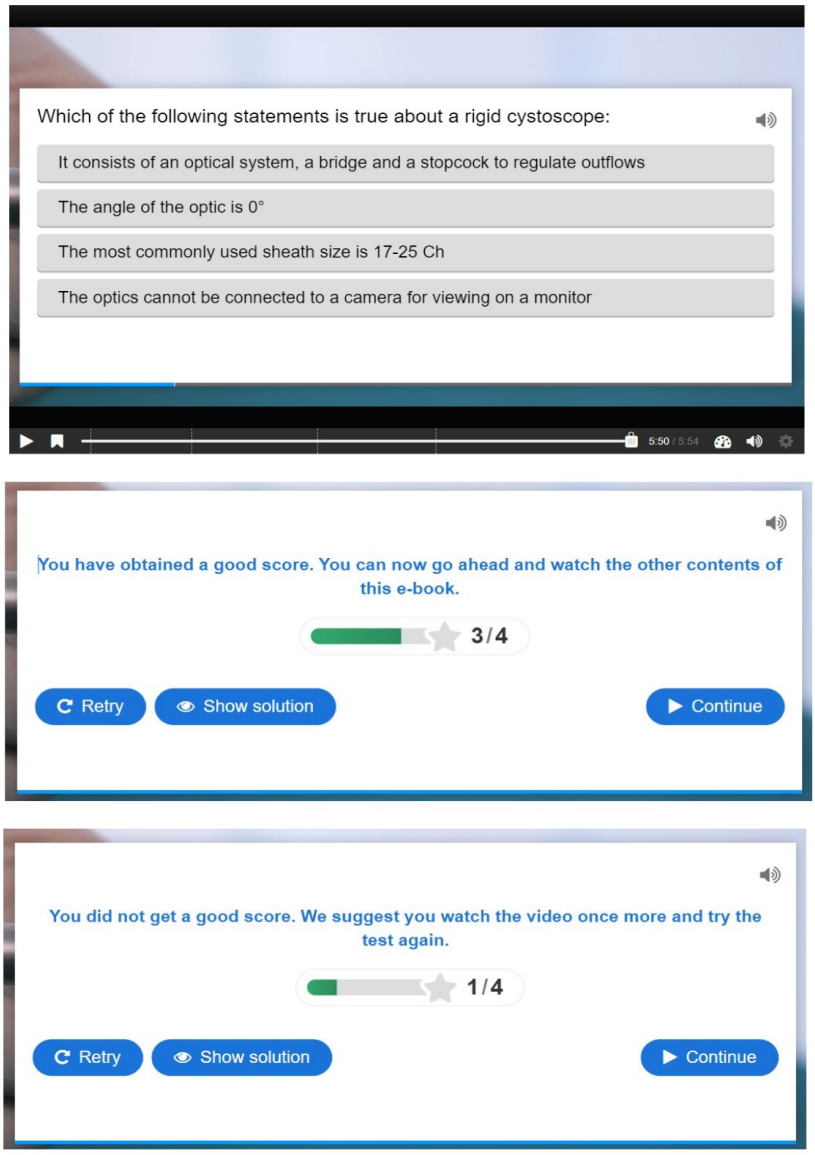

Figure 3 - Single-choice questions with feedback.

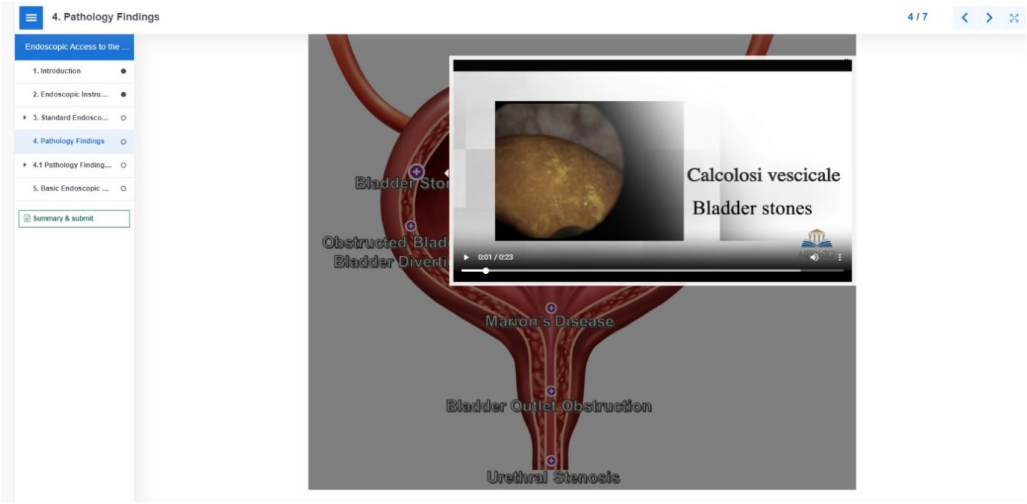

Figure 4 - Image hotspots.

4. Conclusions

The Videolibrary project is in constant development and, as a work in progress, the opposite approach, i.e. bottom-up, is also being tested. The final goal of this experimentation is to support both professors and the outside supplier in designing and producing new videos which, with the supervision of the Web and E-learning Staff, manage to follow the recommendations of Multimedia Learning Theory (MLT).

Moreover, an ad hoc employee bonus program was launched by the University of Turin in April 2023: the final goal of the program consists in defining a framework to support the stakeholders involved in video production for teaching and dissemination of contents in the medical area. Surveys, flowcharts, guidelines and a standardized protocol are being set up as part of an operational toolkit. Starting from the critical issues mentioned above, the program is also intended to make full use of both human and financial resources.

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ImpariAmo: how to engage a large population of non-digital workers

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Abstract

In 2019 CAMST started the ambitious project "ImpariAmo", aimed to supply the company's nearly 13,000 employees with a set of learning bites to improve their digital and social skills.

Three main directions were detected to act on: digital skills strictly related to the use of PC and smartphone, digital skills in everyday life and English language knowledge.

W.Training and CAMST worked in close cooperation to create a set of more than 70 learning bites that span different topics, from the use of Personal Electronic Identity (SPID) to the access to National Health portal – including a 7-episode situation comedy about Cybersecurity.

The article describes some of the instructional design techniques adopted to get the message through and the outcomes of the project in terms of participation and acceptance.

Keywords: Blue Collar Employees, Digital Skills, Non-Native Workers.

1. Introduction

CAMST Group, an important economic reality that since 75 years provides catering services to schools, companies and hospitals, with 88 million meals served in 2022. In the last years CAMST group added to its traditional core business also a division that deals with corporate facility management.

The CAMST Group activity is highly labor-intensive and the company employees about 13,000 persons. Most of them can be classified as blue collars: people that prepare food, wash dishes, clean industrial plants (Figure 1).

CAMST population age is aligned to Italian population, according to EUROSTAT Population and demography database that indicates an average of 48 years for the whole country.

CAMST population on the average is 49 years old, with a mode of 53 years (Figure 2).

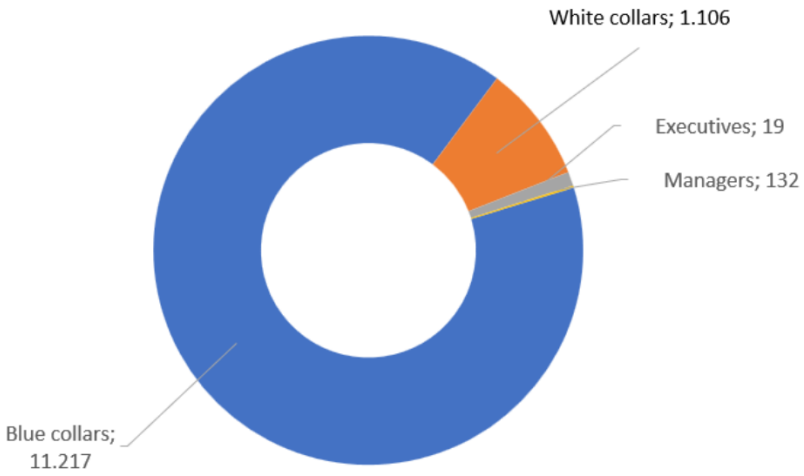

Figure 1 - Distribution of employees among the different categories.

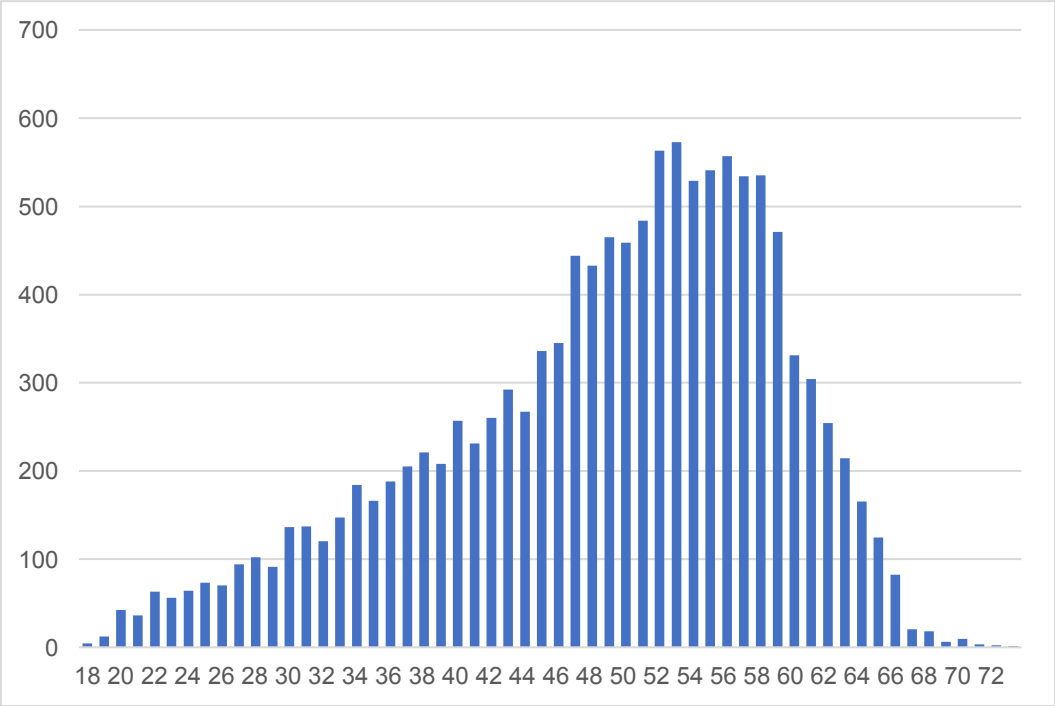

Figure 2 - Age distribution of CAMST Group employees.

Women are the majority of CAMST Group employees and count for 83% (10,398 people in August 2023) versus 2,130 men, a mere 17%.

However, even for blue collar workers, CAMST group operating environment is no longer just a catering environment.

All corporate communication is now channeled using digital media and this applies for professional and personal information alike. The monthly payroll, for instance, is delivered uniquely in electronic format.

More and more food processing equipment are software controlled and require some digital skills to be configured and used.

Many activities that were performed by phone or paper, such as menu selection or purchase of raw products, require now the use of computers and dedicated software.

The need to increase digital literacy on the whole employee population was badly needed but it could be done only on a voluntary basis because it belonged to the core job activity in a fraction only of cases.

2. Materials and methods

Since 2013 CAMST Group created an internal academy based on Moodle.

The platform underwent a major update and customization in 2017 to allow for higher standards of security and usability.

Data were collected from three major sources: the Moodle data tables, Success Factor HR management system and SAP employee database.

A custom set of SQL procedures automatically executed overnight align Moodle tables with SuccessFactor and SAP database.

The alignment involves both core Moodle data tables and custom created tables used for processing additional information.

Using a RAD (Rapid Application Development) tool, namely Scriptcase, a set of custom reports were created in order to manage the CAMST Group population according to the internal organization, based

on geographical areas and small business units, in some cases single canteens and in others aggregates of multiple canteens.

The learning bites were developed using a variety of e-Learning authoring environments. For SCORM creation the preferred tool was Lectora by Trivantis (now ELB Learning). Cartoons were created using Powtoon and Adobe After Effects.

Video editing was done using TechSmith Camtasia and Adobe Premiere.

3. Results

Three projects were launched from 2019 till today and are currently active.

"ImpariAmo" was the first one, aimed to supply bit of information about the use of IT technologies in different contexts, from school to self-improvement. The content was organized into five macro areas:

- digital skills;
- health and wellness;
- family;
- papers and bureaucracy;
- personal improvement.

Then came "La Scuola dei Mestieri" (the School of Trades) to let employee share experiences and virtually explore the wide range of CAMST Group activities.

The employees tell their stories and share experiences with a tone and with contents that are close to the culture and to the daily job of learners.

The project is aimed also to foster a stronger company culture, presenting the wide range of CAMST group realties, from large corporate canteen to small mountain school canteens.

And finally, the project "Best Practices in the Kitchen" was launched. The project is aimed to share the best procedures devised on the field to work better and more effectively.

The rationale of the project is to let more experienced workers to transfer their know-how to the younger, by sharing knowledge acquired on the job with a bottom-up approach.

The company goal is to identify solutions that let you work better and more effectively and that come from the field experience.

The content that was created for "ImpariAmo" adopted an Instructional Design Approach easy and appealing, based on:

- ample use of cartoons and animations;
- short videos;
- use of Internet documents, articles and videos that are integrated into a learning path;
- take away - short PDFs with the key concepts;
- self-evaluation quizzes;
- surveys to collect feedback for each activity.

In the effort to deliver these concepts in the more appealing way, a sit com on Cybersecurity in seven episodes was created.

The sit-com, that was called "Lost in the net", was scripted with the collaboration of security experts and featured professional actors. The series was highly appreciated and is available in the English version also, fully dubbed.

The modules have all the same structure (Figure 3) to minimize the interface learning curve:

- a short video with music and/or voiceover delivers a story, a dialog or an animation to communicate the key concepts.
- a quick guide in HTML summarizes the important ideas to be taken away. The guide is available both in HTML format to be easily read on smartphone and as PDF file, to be saved and consulted afterward.

- then a short self-evaluation quiz allows the learners to evaluate their knowledge.
- the last activity is a forum to collect criticism and suggestions and let learners share comments.

Since the first implementation of LMS platform there was a dramatic increase in number of training hours delivered, although the number of unique learners didn't increase.

This is because most of the first courses deployed were mandatory, namely Safety and Health and internal procedures, that expire after 5 years.

The two peaks shown in 2016 and 2018 are linked to new courses deployed to be compliant with State and internal regulations.

The increase since 2020 is partially due to the COVID-19 pandemic that forced to move online all the training, but also to the parallel deployment of less boring a more entertaining kind of courses.

It is therefore significant the increase in the ratio between training hours deployed and number of unique learners that goes from 3.5 in 2016 (mandatory courses) up to 6.2 in 2022 (voluntary courses in addition to mandatory), that indicates a higher adoption of e-Learning for training (Figure 4).

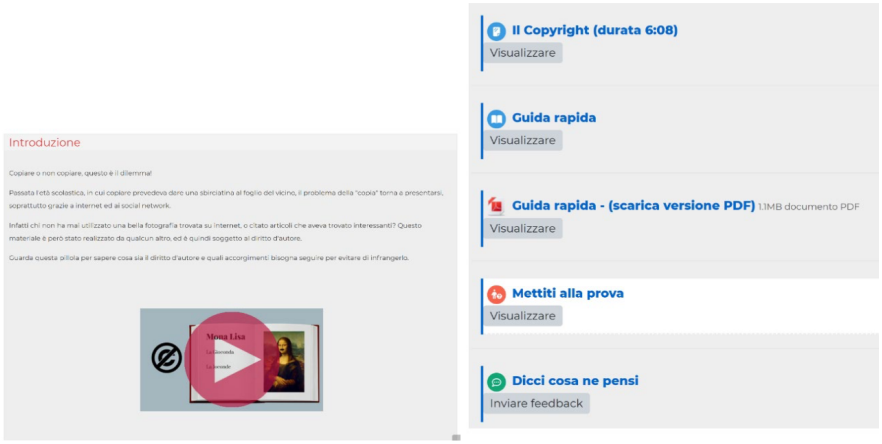

Figure 3 - An example of learning module's structure.

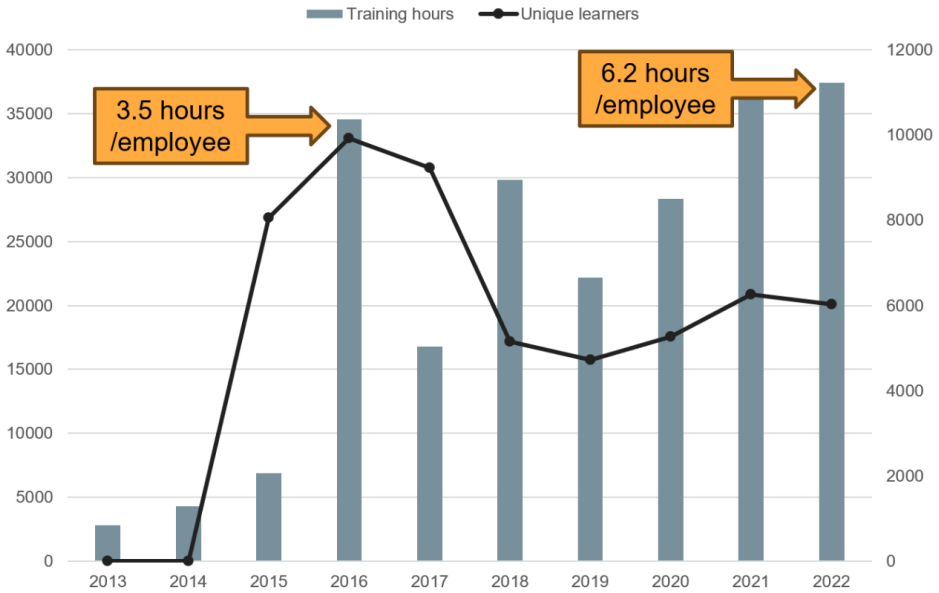

Figure 4 - Trends in training hours delivered and number of unique learners.

One of the biggest challenges in the "ImpariAmo" project was obviously to get the employees involved.

Different methods were used:

- open day to widespread knowledge about the project;
- articles published on the corporate magazine;
- top-down communication involving managers at local level;
- prize contest to foster participation.
- leverage on emulation and competition to present the best practices and cooking tricks.

The prize contest gave scores based on activity performed. Points were assigned for viewing content and forum participation. Each quarter there were two winners and at the end of the year it was computer a global ranking to reward the year's top learners. It must be stressed that prizes were just symbolic.

4. Conclusions

The "ImpariAmo" project alone involved about 1200 persons, equivalent to about 9% of the target population. Although this percentage is not very high, it is highly significant that all roles were involved, not just white collars. It is also worth of notice that participants' adherence to the initiative was entirely voluntary, driven by the willingness of self-improvement.

Each module was rated by users. Rating was quite high, and many users left positive comments and suggestions using the forum activity at the end of each module.

"ImpariAmo" affected positively a segment of CAMST Group employees offering them the opportunity to improve their digital skills and become digital-wise citizens.

Acknowledgements

The authors wish to warmly thank Giorgio Baldini whose vision inspired and promoted the "ImpariAmo" project and Marco Tosatto who contributed significantly with his IT expertise to the project success.

Notes

Lectora, Powtoon After Effects, Camtasia, Premiere and Scriptcase are trademarks of the respective companies.

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· Section 3 ·
Games, social networks, and virtual/augmented reality

Games and video games as scenarios to support digital literacies: the first results from the international project YO-MEDIA (Youngsters' Media Literacy in Times of Crisis)

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Abstract

The younger generation is facing many changes and challenges related to political, military, and pandemic crises that have gained prominence in the media: in this perspective, Media Literacy and critical thinking are very crucial to handling information and false content. Youngsters, in fact, often scroll through news content on their mobile devices without giving too much thought, consuming news content exclusively through social media (Herdzina & Lauricella, 2020; Jolley et al., 2021). The contribution will focus on the first results of the project YO-MEDIA - Youngsters' Media Literacy in Times of Crises - funded by the European Media and Information Fund established by the European University Institute and the Calouste Gulbenkian Foundation. In particular, we will focus on the primary connections between the point of view of scholars and researchers – expressed in papers and scientific contributions from the literature analysis – and the perspective of teachers, educators, and journalists interviewed. Drawing on a selection of data from the 46 scientific papers produced by scholars, from 2019 to 2023 in games and video games in times of crisis, and the interview conducted with teachers, educators, and journalists with background on media studies, games, and crisis management (N.10 in Italy) the main questions are: in what way can game-playing foster youngsters' media literacy in times of crisis? From what perspective are video games considered thinking about crises such as war, climate, and health emergencies? Are there experiences that can be regarded as good practices?

Keywords: Media Literacy, Crisis, Video Games, Games, Emergency.

1. Introduction

The younger generation is facing many changes and challenges related to the political, military, and pandemic crises that have gained prominence in the media: in this perspective, Media Literacy and critical thinking are very crucial to handling information and false content. The reason for choosing this target owes to the observation that youngsters often scroll news content on their mobile devices without giving too much thought, consuming news content exclusively through social media without a journalistic filter (Herdzina & Lauricella, 2020). This period is crucial for developing critical thinking, which allows youngsters to develop the ability to think for themselves, make decisions, and evaluate consequences. Considering these premises, the project YO-MEDIA - Youngsters' Media Literacy in Times of Crisis (funded by the European Media and Information Fund established by the European University Institute and the Calouste Gulbenkian Foundation) is working on this topic through the design and development of a hybrid game on misinformation/disinformation, information literacy, and crisis communication. YO-MEDIA is divided into three phases: map the literature on video games in times of crisis; develop and validate a hybrid game and a MOOC for media awareness; assessment of the feasibility of the strategies adopted. The research team uses mixed methods to combine quantitative and qualitative methods, approaches, or research concepts in a single study, improving the validity and reliability of the results and enriching the understanding of the phenomena studied (Cameron & Sankaran, 2015).

The contribution will focus on the first results from the literature analysis, drawing on a selection of data from the 46 scientific papers produced by scholars from 2019 to 2023 in games and video games in times of crisis, and the interview conducted with teachers, educators, journalists with background on media studies, games, and crisis management (N. 10 in Italy). In particular, the main questions are:

in what way can game-playing foster youngsters' media literacy in times of crisis? From what perspective are video games considered in crises such as war, climate, and health emergencies? Are there experiences that can be regarded as good practices?

These questions must be reconsidered from the perspective of Information Literacy, one of the components of Digital Education, or of Onlife Citizenship, which, as elsewhere analyzed (Pasta & Rivoltella, 2022) has made an important shift from an initial idea linked to computer technology and statistics to a vision of literacy as a fundamental prerequisite for proactive participation in the infosphere.

In the social web, Information Literacy is confronted with the relevance of new canons of authorship and *auctoritas* (Pasta, 2018; Rivoltella, 2015). In the book culture, the authority was guaranteed by recognized centralized powers, albeit orientable and bearers of interests (publishing companies, universities, newspapers, and magazines), while in the social web, the authority is recognized by peers and, by the algorithmic logic. With the fragmentation of knowledge, the "post-truth" is affirmed, that is, the discursive regime characterized by the impact of simple emotions and personal convictions concerning facts (Maddalena & Gili, 2017). Fake news, misinformation, and attempts held by different powers to manipulate information existed well before the web, but – here is the novelty – they increase the force of their impact at the time of post-truth. When "alternative facts" replace real facts and feelings to determine reality (McIntyre, 2018), post-truth does not deny the truth, seen as a process of a community with the final agreement on some interpretations; on the contrary, it supports its multiplication and privatization. In this way truths become as many as the subjects who want to support them, direct experiences legitimize words, while emotions and previous personal convictions count more than facts. Precisely in the narration of the conflict between Russia and Ukraine (Raviolo & Pasta, 2022), we have witnessed what David Bolter (2019) called the Digital Plenitude, in which everything seems to disintermediate and place itself on the same level without distinction between true and probable, high and low, competent and not competent.

After the pandemic, video games have begun to be even more crucial in young people's media repertoires, not simply in terms of time spent online or in front of the screen but also in terms of socialization. Video games also support social debate and become objects of confrontation within the groups of affinity (Gee, 2003), topics, and places to share information (verified or not).

2. Materials and methods

To deal with these two questions we decided to tick the primary connections between the point of view of scholars and researchers – expressed in papers and scientific contributions from the literature analysis – and the perspective of teachers, educators, and journalists interviewed.

Regarding the literature analysis, we considered works on the use of games (board games and video games) during conflicts such as the war in Ukraine, health emergencies such as the COVID-19 pandemic, and emergencies like earthquakes or other natural disasters.

The definition of the criteria of inclusion/exclusion comprises the following elements:

- keywords for inclusion: board games in a time of crisis, board games and trauma, board games in times of war, gaming, and COVID-19, using board games with natural disaster, video games in a time of crisis, video games and trauma, video games in times of war, using video games with natural disaster, games and video games in emergency psychology;
- date of publication: from 2019 to 2023 (starting with the first cluster in Wuhan);
- language: articles in English, Spanish, and Italian;
- contribution: essays, articles, and proceedings published in indexed journals and working papers in open access;
- database: Google Scholar, Academia, Researchgate;
- exclusion criteria: games and video games to teach grammar, math, and other subjects at school, war games (video games on war as a scenario), developing video games and technical skills, history of

video games, playful techniques in contexts of crisis – clowning, role-playing, dramatization – to remain focused on board games and video games.

The analysis included *scientific resources* and *systematic reviews* produced by scholars from 2019 to 2023. We refer to papers and articles published in this period, although in very few cases the contents refer to past events. The issue of war does not only refer to the conflict in Ukraine (the most recent, delivered in 2023, mentions this war). Last but not least, the literature landscape is not only European, especially referring to theoretical references and sources. Some resources are from Australia, the USA, and Japan (considering the important field of studies in terms of natural disasters such as earthquakes and tsunamis).

The corpus of the analysis comprises 46 resources, after dismissing contributions not corresponding to the set of criteria (for example papers on wargames, learning with video games, or resources in other languages).

Moving to the interviews they are structured in four main areas:

- the role of Media Literacy in times of crises, as a general framework;
- how to develop skills and work with adolescents on media topics, suggesting good practices from the field;
- teacher training in media literacy;
- video games in promoting young people's media literacy, exploring the main features of video games, and the role of game developers.

The Italian team conducted 10 interviews (see Table 1):

- 4 educators working with young people in different contexts (youth associations like *Spazio Giovani*, the Association *Gariwo* involved in the movement of the Garden of the Righteous, *Adelante* implied in community projects, and *Steadycam*, a group that recently developed a video games room to work on video games with secondary school students;
- 3 teachers, who have been involved in several projects to promote media literacy, developing different tools (games, cards etc.) in high schools and at university, with experience in projects and action research;
- 3 journalists from different news organizations in the field of video games or digital/e-sport issues.

Table 1 - Interviews.

Code	*Role*	*Link*
E1	Educator	https://en.gariwo.net/
E2	Educator	https://www.spaziogiovani.it/wp/
E3	Educator	http://www.progettosteadycam.it/
E4	Educator	https://adelanteonlus.it/
T1	Teacher	https://iti-marconi.edu.it/
T2	Teacher	https://www.reteparri.it/
T3	Teacher	https://www.iusve.it/
J1	Journalist	https://www.repubblica.it/tecnologia/
J2	Journalist	https://www.gruppoeditorialesanpaolo.it/periodici
J3	Journalist	https://www.corriere.it/

Each interviewee has varied experience in media literacy. Some opened the road to digital media as a topic for young people in their community or in school training, meeting students to talk on and work with video games, "on digital reputation or using *Minecraft* to design a garden for real, creating podcasts on fake news, using *Among us* or similar to reflect with young people in different topics" (E2); others

work in association devoted to the promotion of well being and the prevention of disease and addiction like Steadycam, studying "TV series and video games, because they are part of the media habits of young people and adolescents. At the moment we are using media as environments where we talk about some topics that our society does not face like death, self-esteem, and mental health" (E3); some have developed games to work on hate speech and social media violence, like Gariwo: "Media literacy, for example, related to online hatred, is another topic of our work, we developed the Chart of Responsibilities of social media, so we identified in social media one of the tools to carry out clearly, and unfortunately, the language of hate". Gariwo developed the game "*Oppressi e oppressori: tu da che parte stai*? (*Oppressed and oppressors: whose side are you on*?)" (E1). As for the journalists, one has been involved in esports (J3), one developed a weekly podcast of press review dedicated to young people to develop information literacy (J3), one works for the section devoted to technology (J2) and is deeply involved in the issue of information and information literacy.

3. Results

3.1 Results from the literature analysis

Considering 46 resources, 37 papers refer to video games, 4 to board games, and 8 to hybrid games. The main two scientific fields recognizable in the analysis are psychology and education, with a few papers from history and communication areas.

Besides 13 systematic reviews, articles and papers follow the classification in macro-areas of interest: *Games and COVID-19* (18 contributions total, 8 case studies, and 10 theoretical papers, 4 of which refer to the impact of video games during the pandemic); *Games and war* (12 contributions, 1 case study, and 11 theoretical papers, 4 of which on games and war under a historical perspective such as the Cold War, and First World War); *Games and natural disasters/catastrophes* (4 contributions - 2 case studies and 2 theoretical papers).

Table 2 - Distribution of the 46 resources (period and keywords).

Year	*N. publications per year*	*Keywords*
2019	3	Health; video games; avatar; climate change; pandemic; memory, Spanish war; COVID-19
2020	14	natural disaster; video games; serious game; COVID-19; simulation; agent-based modelling; war; digital games; social connectedness; mental health; PTSD; disaster risk management; systematic review; technology acceptance; community engagement; gamification; emergency planning; guerra; pacifism; chess; history; board games; diversity; game studies; health education; health games
2021	10	video games; internet gaming disorder; anxiety COVID-19; serious game; prevention; public health; health information; behaviour; multiplayer serious game; social distancing; African perspective; persuasive game; digital serious games, risk communication; tsunami; climate crisis; decision making; collaborative games; safety measures
2022	13	Video games; transmedia; stealth games; conscious games; history; colonialism; resistance; war; Metaverse game; COVID-19; memory; Public diplomacy; Narrative; Russian Federation; Cold War; protest games; decision making; game theory; defence science; warfare; tracking; First World War; stressful events; well being; effects
2023	6	COVID-19; video games; health awareness; Ukraine; children in war; story Generation; table-top role-playing games (TRPGs); role-playing games (LARPs); activism, war; serious games

As for the presentation of the main results, we adopted the same thematic criteria.

Games and COVID-19

On one hand, video games are connected to addiction: in times of social and physical isolation, due to the pandemic, people shifted their habits to an enclosed environment, using TV, the Internet, social media, and video games as a prior investment to spend time and live day by day. This affected the number of hours spent playing video games. Still, we also know that time is not the only element to be considered from the perspective of Media Literacy Education.

On the other hand, some resources underline the positive impact of video games in times of constriction (the connection is to the "stay at home" campaigns developed worldwide), where video games were the only way to manage stressful situations and to connect with people and friends ("together apart"). Studies have examined the positive impact video games and virtual social worlds have on mental well-being during the pandemic, suggesting their ability to fulfill basic psychological needs (Paul et al., 2022; Johannes et al., 2021; Yee et al., 2022).

As pointed out in the Editorial by Willy C. Kriz (2020),

> *the World Health Organization (WHO) have changed their attitude toward online gaming, from warning of its dangerous and addictive character to praising its positive impact on socializing and coping with stress. In 2019 the WHO called game addiction a sign of a mental disorder and warned people against developing game addiction. However, in 2020 the WHO appealed to people to stay home and play games. In a joint effort, the global games industry agreed to disseminate key messages from the WHO to support awareness and to slow the spread of COVID-19. More than 50 game and interactive entertainment industry leaders have launched #PlayApartTogether, an initiative that encourages their vast networks of users to follow the WHO's health guidelines.*

Other findings consider video games as psychological relief in stressful contexts satisfying key psychological needs (Canales, 2020). Or, to stay on the page, video games are connected to the possibility of escaping

> *from reality in a condition where the sense of time and space perceived by people has been altered by the COVID-19 pandemic, reshaping both their intimate and wider social interactions and eliciting a wide spectrum of disturbing emotions. Players escaped from this unsatisfying reality into video game worlds, searching for new normality that could compensate for the unpredictability and dangerousness of the pandemic life, as well as seeking uncertainty in the game environments to balance the flatness of the lockdown everydayness (Boldi et al., 2022, p. 1).*

Video games seem also an excellent environment to learn behaviors to prevent the dissemination of the virus and to protect people, for example with mobile gaming apps "to learn and create awareness among children about COVID-19. Using this app, they obtain scores/points by grabbing the right objects from their superhero-shaped player, which are fun, attractive, and psychologically helpful during this pandemic" (Satu et al., 2021, p. 321).

Games and war

Considering 8 contributions, apart from a single paper on playing in times of war (Gura & Roma, 2023), the main topics refer to the identification of the role played by video games (Cantano & Venegas Ramos, 2021) to reflect on the main challenges in war times, considering different scenarios, such as humanitarian crises and war conflicts in Africa, the Rohingya crisis, and presenting 10 specific video games titles are analyzed in depth.

The conflict in Ukraine entered the reflection of academics also as a case study, where "authors propose a game concept based on the framework of the automatic narrative generation game. [...] The game is based on an analog game in which participants advance a shared storyline mainly through

dialog. The proposed game facilitates story generation" (Ono & Ogata, 2023, p. 726). The game, released in October 2022 with a demo version currently available, includes three storylines set in Hostomel, Bucha, and Mariupol, respectively. All of the game's images are based on actual events, eyewitness testimonies, and photographs taken on the battlefield. This case study is very relevant and interesting, matching real-life experiences, images, and stories with identities, characters, and storylines on the video game screen.

Games and natural disasters/catastrophes

Moving to the third topic, there are a few articles we found particularly significant and many come from extra-European contexts, such as Japan (considering the number of natural disasters faced in the last decades, from earthquakes to tsunamis). But, are video games perspectives/tools considered in preventing or discussing the topic of natural disasters, climate change, and catastrophes? Considering climate disasters, the authors investigate the main connections between aesthetics, game mechanics, and politics through three modes: allowing players to interact with a model of climate change, generating feelings and emotions, and the combination of both (Kunzelman, 2020). So, video games create a sort of bridge between real-life contexts and imagination, helping people reflect on how we feel (or should feel) in terms of climate affection and making it possible to simulate and run experiences.

Another exciting topic refers to the predominance of "growth-oriented, techno-futurist narratives" in climate change video games, "arguing that these video games are privileged expressions of premediation. Premediation cultivates a multiplicity of future scenarios, while at the same time delimiting them to suit presentist concerns, evoking a sense of inevitability and predictability strengthened by repetition" (op de Beke, 2021, p. 184).

Systematic reviews

Considering the systematic reviews in the analysis, the partition is based on the contents of the reviews. In terms of *health/pandemic issues*, an integrative review explores the literature on serious games in dental education, to construct a conceptual framework for their strengths in this pandemic (Sipiyaruk, 2021); a systematic review to describes "the literature on the effects of video games during the early stages of the COVID-19 crisis on stress, anxiety, depression, loneliness, and gaming disorder (GD), examining the study characteristics and outcomes. A systematic search of the literature was made following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines" (Pallavicini, Pepe & Mantovani, 2022, p. 1); a systematic review investigating "the literature base of empirical examinations of prosocial digital game interventions for children and explores the measures applied and their effectiveness" (Saleme et al., 2020, p. 1); a scoping review of the design and evaluation of serious educational games for health care providers, patients, and public users with a total of 161 studies included (Sharifzadeh et al., 2020).

Last but not least, a paper presented a very interesting overview of the existing game-based interventions for COVID-19 (more than 60 games).

> *From November 2021 through April 2022, searches of Scopus and Google Scholar were performed to identify scientific articles describing the development and/or testing of COVID-19-themed serious games and gamified interventions to improve people's well-being (hereafter referred to as games). Additionally, Google and YouTube were searched for non-scientific articles and videos including commercial games and those developed by private citizens. Due to their overwhelming number, digital game prototypes that were developed for game jams or competitions were not included in this study (Kermavnar & Desmet, 2022, p. 33).*

Considering that most of the identified games were developed to inform and educate, the authors categorized them by applying the comprehensive taxonomy for serious games, developed by De Lope and Medina-Medina in 2017.

Moving to *war and defense*, a review refers to the attempts to use game theory to model decision-making scenarios relevant to defense applications. Game theory has been proven as a very effective tool in modeling the decision-making processes of intelligent agents, entities, and players in diverse fields such as economics, biology, and computer science (Ho et al., 2022). Another interesting work highlights the use of contemporary video games to protest, raise awareness about injustices, cause inconvenience and disruption to those in power, invoke a sense of community and solidarity; act as a communicative and organizational platform; operate as a terrain of battle; broadening the horizon for hopeful futures. The framework is represented by video game activism from Ukraine, Iran, the United States, and Hong Kong (Davies, 2023).

The reviews in the field of natural disasters and climate crisis are represented by a review of evidence and effectiveness of digital serious games (SGs) for communication of action-oriented key messages (related to tsunami evacuation) to children (Hawthorn et al., 2021); a systematic literature review on available gamified applications for disaster emergency planning and their purpose of use (Kankanamge et al., 2020); a systematic review of the academic research during 2011-2018, investigating the affecting factors on the intention to use IT for mitigating disaster's impacts (Meechang at al., 2020).

Other general topics are connected to video games and decision making; serious game design methods, the learning potential of board games in various settings, subjects, and diverse learners.

In the last section (Conclusions) we will go back to the literature, with a summary of the main findings.

3.2 Results from the interviews

As presented, the interviews comprise four areas of interest. In this paper, we decided to focus on the fourth one: video games in promoting young people's media literacy, exploring the main features of video games, and the role of game developers.

The interviewees feel the importance of games in promoting young people's media literacy on two levels:

- games and video games as objects of analysis. Many educators worked on video games to disassemble them and see what's inside, for example building a character or an avatar, and studying what kind of mechanics made the video game as it is. So this is a way to deal with video games as a medium and a language (to code). Another example is working on the monetization mechanisms;
- games and video games as a tool to work on other topics (history, sociology, religion etc.).

What works well in video games refers to:

- narrative dimension: video games and games are a form of storytelling, they tell a story and this supports students' learning, motivation, and engagement;
- mechanism of identification with a story or a person/character;
- engagement and the possibility of being on the same page/level: "It overcomes all the obstacles of catching the attention of students and then it creates that mechanism of being similar, among players there is not necessarily the best student" (E1), so it is not linked to marks or to being the first student in the road to perfection and performance;
- games are then based on interaction;
- you can start fresh from where you failed and reason on it: "If you fail, you can start over or maybe from a certain point, you encourage a reflection on the cause and the effect of actions" (T2);
- short-term goals and the need to develop a strategy to succeed.

Generally, interviewees have adapted traditional games to media literacy. For example, the "Game of Life" by Duccio Demetrio, adapted to communication and media: "students created their pawns – specifically made according to their idea of communication tools, so one created his pawn linked to the image of the smartphone or a APP – and when the avatar, that is, the pawn, fell into a specific box, they had to share what that word or theme meant for them: fake news for example" (T3). Or "the narrative dice, where a blue die is for the actions done online or with digital media, and the yellow die

refers to an effort to be performed in the classroom. For example, with *video games* and *collage*, I search for images on video games to make an example of what I think of them" (T3).

Other useful examples come from recent studies on pre-bunking, considered the most scalable method to fight against *misinformation*. Two titles above all are *Bad News Game* where players take on the role of fake news-monger, exposing the tactics and techniques used to mislead people (https://www.getbadnews.com/books/english/), and *Go Viral!* on disinformation on COVID-19 (https://www.goviralgame.com/books/italian/). Instead of correcting the tons of fake news circulating in every corner of the Internet, pre-bunking represents a preventive approach focused on macro-categories of spreading fake news. In this framework, Google has recently launched a new campaign across Europe to release short videos showing the mechanisms behind disinformation. The videos appear as advertisements on Facebook, YouTube or TikTok. As explained by van der Linden (2023), pre-bunking could help reach a sort of herd immunity when it comes to false information, limiting its impact.

Schools, educators, and students should not work alone, which is why it is crucial to foster a new collaboration with game developers, supporting a positive interaction to deliver a complex product: especially dealing with social messages or social issues, they have to be very well integrated and blended with video games mechanisms, so that it would be very difficult to separate or isolate the components (social messages and playing): "if I put a social content in a video game, it must be well integrated into it, otherwise I have a *foreign body* experienced as an advertisement, and in the video game all advertisements bother, [...] therefore the social content must be strictly functional to the story" (E3). As another educator stated, "don't lose sight of the fact that we are playing" (E2) so the playful/fun dimension of the game has to work well. So letting game developers play with students of different ages could be useful, especially thinking about education: "I would take developers with me to work with my students to have a different look. So developers do not *work for us*, but *with us*" (T3) and they should work on curiosity (J3).

In addition, game developers should work with experts in different fields, as for the video game *Attentat 1942* developed by a group of people at the University of Prague (at the Faculty of History) or *Bury Me My Love*, on migration from Syria "basically made like a WhatsApp chat between the girlfriend who is leaving and her boyfriend who has to stay at home" (E2). Last but not least, game developers should "reveal some background, remove some veils" (E4) and be part of the feedback on playing: "it might be interesting to get developers to support not only players' strategies but also how they are in the game, like *does it make me feel good*? *Does it make me feel bad*? *What makes me feel good*? *What did I try*?" (E4).

Generally speaking, while including video games in education, we need to make a shift in the very structure of the process: it is crucial to reason on *how* rather than on *what to say* to young people. Video games then can be a fruitful occasion to provoke questions, encouraging students to draw conclusions and to start from experience: "often one of the big problems is that questions are difficult to get, especially because they are not posed effectively, they sound like a prohibition, like judgments. Here, I believe we need to start from the experience or from proposing an experience" (E2). Considering the level of experience of students nowadays (and the approach they mainly have to video games, such as programming, and creating video games as it happens with *Roblox*), making and creating – rather than listening – is the best way to build media literacy and to strengthen digital competencies.

4. Conclusions

From the analysis of experiences, case studies, and interviews, video games, and games:

- are an engaging tool and they encourage active participation of the audience;
- allow to have a better understanding of important issues (such as crisis preparedness, monitoring, and control) simplifying complex systems;
- can help to anticipate potential consequences in given parameters (for example in emerging risk identification);

- offer a world where we can simulate solutions to problems we need to solve in real life;
- can answer the need for new tools to reach large audiences from different countries, contexts, ages, and experiences and to understand the perception of information, behavioral conformance to instructions, and model the effects of individual motivation and decisions on the success of measures being put in place;
- can support efficient decision-making, which is very relevant during a response to large-scale crises;
- should also be examined taking into account the positive impact on mental well-being, fulfilling basic psychological needs, and not just as an addiction, dispelling the negative stigmas surrounding video games, while coping with stressful circumstances;
- can be a medium to protest, causing disruption, raising awareness about contemporary problems and injustices, and invoking a sense of community and solidarity.

The most relevant connections resulting from the cross-referencing of literature analysis and the interviews can be summed up in three ideas, with an impact on the game design and on the MOOC (these actions refer both to the second phase of the project).

The first idea refers to the new role attributed to gaming and video games, in particular, after the experiences lived during the pandemic in terms of personal well-being and social connection, highlighting the importance of video games to get connected in times of physical distancing and commenting on the positive aspects of gaming in such a condition of social isolation. Referring to the game design, should be collaborative and played together, going beyond the idea of personal benefit and engaging in terms of shared "harmony". The focus here is on social impact and community building (McGonigal, 2023). Referring to the MOOC the idea is to foster the logic of pre-bunking and the action of debriefing, in the framework of playful learning.

The second recalls the importance of games in promoting young people's media literacy as objects of analysis (many educators worked on video games to disassemble them and see what's inside) and games and video games as a tool to work on other topics (history, sociology, religion etc.). The analysis of the data seems to reveal a renewed need for collaboration between young people, teachers, educators, experts, and game developers: especially dealing with social messages or social issues, they have to be very well integrated, and blended with video game mechanisms, so that it would be challenging to separate or isolate the components (social messages and playing). On the side of game design, it means feeding this collaboration, creating the conditions for students, game developers, and education/school/journalism to blossom. On the side of the MOOC, the promotion of media literacy can be based on working with teachers and educators on the definition of generative questions (Ghasempour et al., 2013) and the use of tools like notes, diaries, and reports from players. This can also pass by the unveiling of the analytics and reflecting on them with students.

The third idea is connected to the main features of games and video games to promote a more critical and active engagement with a narrative approach, as they are a form of storytelling and this supports young people's learning, and motivation; a mechanism of identification with a story or a person/character; an interaction combined with the possibility to fail; a need to develop a strategy useful also "outside the game" to learn how to deal with emergencies and decision making. The game design needs to pay attention to all of these elements, stressing the joyful side and balancing the learning effects required by schools and education. In the MOOC, this means working with teachers and educators on the importance of storytelling to connect the stories played in the game and students' real lives (Rose, 2024).

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Authors' contributions

The authors share the conceptualization of the contribution and the "Introduction". Alessandra Carenzio, responsible for the review and editing, wrote the following sections "Materials and Methods" and "Results from the literature analysis". Stefano Pasta wrote the section "Results from the interviews". Simona Ferrari wrote the section "Conclusions".

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A mapping of instructional scenarios for game-based learning

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Abstract

Gaming is ever more relevant in our society and noted for its potential in promoting engagement, motivation, and meaningful learning. However, games are still seldom employed in school and higher education. This paper presents a first comprehensive mapping of the different finalities that video games and boardgames can be used for in game-based learning (GBL). To this aim, we discuss and extend the concept of game scenario, reducing semantic confusion in the field of GBL in the process. Fifteen game scenarios are described based on current pedagogical, learning, and media education theories. This work highlights the different and overlapping roles that games, considered as a medium, can play in teaching and learning educational settings and provides the first step towards the development of an integrated instructional design model for GBL.

Keywords: Game-Based Learning; Instructional Design; Media Education; Constructivism.

1. Introduction

We live in a society of gamers: gaming, both analog and digital, is ever more popular for older and younger generations alike. A recent survey by IIDEA (2023) reports that there are more than 14 Millions of videogamers in Italy, of whom more than 80% are older than 18, contributing to a national market worth €2.2 billion. Traditional games, including boardgames, are a growing market worth around 19 billion dollars globally (BusinessWire, 2023). Given the prominence of games in our society, as well as their pedagogical valence, argued by authors such as John Dewey (1894), Lev Vygotsky (1967), Jerome Bruner (1990) and Seymour Papert (1993), and supported by growing empirical evidence (Abdul Jabbar & Felicia, 2015; Bayeck, 2020; Plass et al., 2020), games have raised interest for their educational potential, not only to engage and motivate students, but also to promote the acquisition of relevant knowledge, skills, and attitudes. However, actual use of games in Italian schools and higher education settings is still very limited (Allsop & Jessel, 2015; Loperfido et al., 2019; Persico et al., 2019) and directed toward a function of pure entertainment or exercise (Nicholson, 2011) rather than as a full learning environment. The reasons for this discrepancy are, at least in part, due to resistance by teachers to include games in their teaching and learning practice. Persico et al. (2019) report that teachers' competence in the design of game-based learning (GBL) activities is superficial and restricted to personal experience; teachers report not feeling adequately prepared to include games in the curriculum (Allsop et al., 2013; Takeuchi & Vaala, 2014), fearing the burden in terms of preparation time (Nieland et al., 2021) and having difficulties in finding games that are aligned with learning goals (Molin, 2017). In addition to these issues, there is a certain degree of confusion and semantic ambiguity in key GBL concepts, probably since is a multidisciplinary field that includes pedagogy, instructional design, cognitive sciences, computer sciences, social studies, and game design. For instance, the term GBL itself is sometimes used as a synonym for digital game-based learning (Plass et al., 2020), whereas the term also applies to the use of non-digital games, such as boardgames (Bayeck, 2020). Another term that is often used in GBL with different or partially overlapping meanings is that of "scenario" or "game scenario", which has been used as an umbrella term to refer to the contextualization of a game activity. In some cases, as in Savva & Bianchi-Berthouze (2012), the term is used as a synonym for "game environment". In others, like in Shelton & Wiley (2007), the term is used to define curated situations within a video game to engage students in problems or challenges. Sometimes, as in Pivec (2009), the terms refer to a role-play metagame. This article proposes a disambiguation of the term of scenario in GBL based on the comprehensive

definition provided by Thorsten Hanghøj (2011, 2013). Subsequently, the article expands on state of the art by providing a mapping and characterization of the different game scenarios that can be employed in GBL. This work provides the groundwork for further development of videogame- and boardgame- based instructional models, such as the GDBL ID model proposed by the authors (Andreoletti & Tinterri, 2023), with the aim of helping aligning curricular goals with game play.

2. Materials and Methods

The analysis has been conducted through bibliographic research on state-of-the-art literature on game-based learning and game-based pedagogy. The authors have conducted exploratory bibliographic research using keywords and Boolean searching on Scopus, Google Scholar, BASE, and ResearchGate. Furthermore, the authors used citation chasing and cited reference searching on AI-assisted tools such as Connected Papers and Semantic Scholar to extend the width of the research. Bibliography has been managed using Zotero software.

3. Results

Defining the game scenarios in GBL

"Scenario" is an Italian word that the Treccani dictionary defines as "the ensemble of the various elements […] that constitute the scenic environment: analogously, in cinematography, the environment in which the scenic action takes place". Thus, the concept defines a curated environment that frames and contextualizes an activity, in this case, a learning activity using digital or board games. The most in-depth definition of game scenarios in GBL has been offered by Hanghøj (2013). The author introduces this concept to address three interrelated challenges: "1) how games are perceived and adopted within a formal school context 2) how teachers facilitate games through different roles and 3) the relationship between teachers' pedagogical approaches and the pedagogical models of particular games" (Hanghøj, 2013, p. 1). In particular, he defines game scenarios "as contingency models that explicitly allow game participants to imagine, enact, and reflect upon the relationship between particular actions and their actual or possible consequences. In this way, game scenarios can be used to explore and experiment with the construction, deconstruction, and reconstruction of knowledge" (ivi, p. 3). Thus, the concept of game scenario serves the teacher in designing instructional activities, framing the desired game experience according to the context in which the activity takes place and to the learning goals of the activity. Katie Salen, game designer and founder of the Quest to Learn public school (Salen, 2017) employed the concept of scenarios to characterize a set of formative goals for whom games can be used as an environment (Salen et al., 2010). Salen does not define the term, but notes: "Rather than thinking about games and their play generally, however, both students and teachers at Q2L use games in many different ways to support different intentions and purposes" (Salen et al., 2010, p. 85). She identifies a set of eleven scenarios that represent the backbone of the revised and expanded table that we provide here (Table 1).

The first function of game scenarios concerns "the negotiation of aims – i.e. curricular aims versus the aims of the game scenario – which reflects a fundamental challenge when teachers position themselves in relation to their pedagogical approaches (ivi, p. 13)". Hanghøj notes that many authors in GBL theory tend to adopt a reductionist approach, often over-emphasizing how particular game designs, or game mechanics, may determine forms of learning (Pelletier, 2009) without taking into considerations "how the messy reality of teaching with games are actually carried out within a classroom context" (Hanghøj, 2013, p. 5). The nature of games as interactive, non-linear systems makes the experience of playing a game impossible to predict with the same degree of precision as, say, a learning activity based on the projection or a movie or attending a lecture. Games scenarios provide a framework to further define instructional actions to achieve the intended learning goal(s).

The second function of game scenarios is to guide the teacher in defining the roles that the teacher can play and the approaches that they can adopt within game scenarios. Research shows that, depending

on the learning goals and the context of the game, the role of the teacher may vary from leader to facilitator, from organizer and planner during the design phase to guide and tutor during gameplay (Kangas et al., 2017). The GDBL ID model expands on Hanghøj's and others researchers' work to define eleven roles that the teacher can play during a GBL unit (Andreoletti & Tinterri, 2023, p. 85). The third function concerns teachers' ability to reflect on their pedagogical approaches and teaching practices; reasoning in terms of game scenario allows teachers to make their pedagogical values and assumptions concerning their integration of games in their teaching practice explicit.

Table 1 - A mapping of game-based scenarios for learning
(scenarios adapted from Salen et al. are signaled with an asterisk).

Media education approach	*ID*	*Name of the Scenario: Games as*	*Description: Student play to*
Any	01	Self-expression	Have fun
Teaching with games	02	Systems of content*	Learn disciplinary content
	03	Manipulation of systems*	Explore and test non-linear systems
	04	Reflection prompts*	Start a reflection on a specific topic
	05	Self-reflection prompt*	Reflect on own's behaviors and habits
	06	Gateways of technologies*	Learn a specific technology
	07	Exploration of points of view*	Explore identities and perspectives
	08	Exercise*	Consolidate knowledge/skills
	09	Social opportunity	Meet, communicate, share an experience
	10	Assessment*	Assess specific learning goals
Teaching of games	11	Texts	Critically "read" and interpret games as artifacts that express values, beliefs, and ideologies.
Teaching through games	12	Code systems*	Learn how to write or code
	13	Documentary*	Document one's understanding and ideas
	14	Creation engines*	Create new media (games, mods, videos etc.) using the game tools
	15	Design challenges*	Design games as research/problem solving activity

Defining approaches and didactical aims for game scenarios

Hanghøj (2013) provides two frameworks for characterizing learning scenarios: the first concerns the educational functions of the scenarios, the second the didactical aims for using games. The first distinction is based on Gert Biesta definition of three main purposes of education: qualification, socialization, and subjectification (Biesta, 2009):

- *Qualification*. Provides learners the knowledge, skills and attitudes required to "do something", which can range from very specific to general tasks. Qualification scenarios are thus more oriented towards knowledge acquisition and its use to address challenges and problems.
- *Socialization*. Has to do with "the many ways in which, through education, we become members of and part of particular social, cultural, and political, orders" (Biesta, 2009, p. 7). Scenarios centered on socialization are based upon the assumption that the social interaction surrounding game encounters requires the ability to enact particular rules, roles, and frameworks within a given social context (Goffman, 1974).
- *Subjectification*. Biesta defines this function as "the opposite of socialization" (Biesta, 2009, p. 8). It is about "ways of being that hint at independence" (*ibid*.) from established social orders. Referring to the work of Bruner (Bruner, 1990), Hanghøj (2013, p. 8) defines game scenarios based on

subjectification as focused on "the player/student experience of projecting identities, and how this can be related to the individual's own beliefs and personal narratives".

The second distinction distinguishes three didactical aims for GBL (Table 2) based on media education theory (Rivoltella, 2019), noting that "the different pedagogical approaches teachers have toward games cannot be understood without relating them to their didactical aims" (Hanghøj, 2013, p. 16).

Table 2 - Didactical aims for GBL, from (Hanghøj, 2013).

Didactical aim	*Game as*
Teaching *about* games	Text/Cultural phenomenon
Teaching *with* games	Teaching method
Teaching *through* games	Design process and product

Mapping game scenarios for learning

Somewhat surprisingly, the author does not follow this definition and characterization of scenarios by providing concrete examples, aside from citing the use of specific games in past projects. This paper expands on this framework by mapping a comprehensive set of game scenarios, derived from relevant literature, to facilitate GBL instructional design. Starting from this initial mapping, we characterize each scenario with a description of its main educational purpose, the dimensions of knowledge that can be developed (Anderson & Krathwohl, 2001; Clark & Mayer, 2016) within the scenario and the pedagogical approaches that the scenario supports (Andreoletti & Tinterri, 2023; Hanghøj, 2013; Hanghøj & Brund, 2011), with examples for digital- and board- games, and a short description for each scenario.

Games as self-expression

Main educational purpose: Identity

Dimension(s) of knowledge: Factual, Procedural, Strategic, Metacognitive

Pedagogical approach(es): Playful

Example (boardgame): Playing a game of *Blackjack* for enjoyment.

Example (videogame): Playing a game of FIFA 23 for enjoyment.

The first goal of a game scenario should always be the fun of participating in a game experience. For many people, playing a digital or board game is a source of pleasure that is at least in part distinct from competition for victory (Wasserman & Weiss, 2020). Many authors (Huizinga, 1955; Koster, 2013; Suits, 2014; Vygotsky, 1967) agree that a source of such pleasure is the specific attitude with whom we approach a game: Bernard Suits called "lusory attitude" the playful disposition that we assume when playing: more inclined to take risks and make mistakes, knowing that it will bear no consequence when the game is over; from this perspective, every game activity is an opportunity to express one's personality through the choices we take in it. Self-expression can be the sole goal of a game-based activity; it is also a key part of every game scenario, including all the following.

Games as systems of content

Main educational purpose: Qualification Dimension(s) of knowledge: Factual

Pedagogical approach(es): Explorative, Drill and Skill, Pragmatic

Example (boardgame): Playing a game of *Cytosis* to learn the structure and components of the eucaryotic cell.

Example (videogame): Playing *Well Spent!* to learn properties and nutritional content of food.

Both video games (Abdul Jabbar & Felicia, 2015) and boardgames (Bayeck, 2020), have been shown to promote the acquisition of curricular knowledge and skills in different contexts and disciplines, ranging from mathematics, medical education, chemistry, economics, engineering, history etc. This

scenario consists in using the game experience to learn new factual knowledge, by exploring the game system and using such knowledge to solve the challenge presented by the game. For the game to engage the player in learning content, and the scenario to be effective, it is important that the knowledge acquired in the game is functional to gameplay (Nicholson, 2011).

Games as manipulation of systems

Main educational purpose: Qualification

Dimension(s) of knowledge: Procedural (Metacognitive)

Pedagogical approach(es): Explorative, Pragmatic

Example (boardgame): Playing a game of *Pandemic* to explore how the spreading of a viral infection changes according to the players' strategies.

Example (videogame): Playing a game of *Civilization VI* to explore how societies develop and expand.

Games are interactive experiences: this means that every action we take prompts a reaction from the game system, defined by the game rules. By playing a game, players get to explore and understand the relationship between the game elements and the system that the game simulates or represent (Parlett, 1999). When the game system is a useful representation of a real system, players develop an understanding of the functioning of the system itself. The game mechanism plays a crucial part, as it determines the kind of actions performed by the players (Illingworth & Wake, 2021).

Games as prompts for reflection

Main educational purpose: Qualification

Dimension(s) of knowledge: Metacognitive

Pedagogical approach(es): Explorative

Example (boardgame): Playing a game of *Unusual Suspects* to reflect on social and racial prejudices.

Example (videogame): Playing a game of *Bury Me, My Love* to reflect on migration.

As simulations, or representations of aspects of reality (Salen & Zimmerman, 2003) games are an excellent environment to reflect on a topic. Be it examined as a whole, or just a part of it, the game experience can be used as a starting point to critically reflect on a content, a problem, or a principle. Gameplay and game content can work as an allegory, that is, "a technique where characters, events, or elements within the game represent or symbolize ideas or concepts. An allegory can be used when an analogous representation of an event or experience is more effective than the actual event in terms of training" (Kapp, 2012). The prompt for reflection can also be derived from what the game does not include, concerning the system it represents. Either way, in this scenario "learning is set up in such a way that learners come to think consciously and reflectively about some of their cultural models regarding the world [...] and juxtapose them to new models that may conflict with or otherwise relate to them in various ways" (Gee, 2003, p. 211).

Games as prompts for self-reflection

Main educational purpose: Subjectification

Dimension(s) of knowledge: Metacognitive

Pedagogical approach(es): Explorative

Example (boardgame): Playing a game of *Ticket to Ride* to reflect on owns' tendencies to take risks or "playing it safe".

Example (videogame): Playing a game of *Stanley Parable* to reflect about freedom and choice, in games and life.

Reflection on game experience can also be focused on self-reflection, starting from the choices taken and strategies employed in the game to reflect on one's knowledge, behaviors, habits, and opinions. According to Gee's principles "learning is set up in such a way that learners come to think consciously and reflectively about their cultural models of learning and themselves as learners and juxtapose them to new models of learning" (*ibid*.).

Games as gateways of technologies

Main educational purpose: Qualification

Dimension(s) of knowledge: Factual, Procedural

Pedagogical approach(es): Explorative, Pragmatic

Example (boardgame) Playing a game of *How to fail your Research Degree* to learn how to perform bibliographic research.

Example (videogame): Playing a game of *Neurocracy 2049* to learn how Wikipedia works.

Games (especially video games) can be used to give students experience with technology, "whether it be in learning how to use a particular piece of software or platform (i.e., how to use a personal computer or a browser) or learning how to use a kind of technology (a mobile phone, wireless device)" (Salen et al., 2010).

Games as exploration of points of view

Main educational purpose: Socialization

Dimension(s) of knowledge: Metacognitive

Pedagogical approach(es): Explorative

Example (boardgame): Playing a game of *Shadows over Camelot* as loyal knight or traitor.

Example (videogame): Playing a game of *Before I forget* to experience the life of a person with Alzheimer's disease.

Games allow us to assume roles and goals that are very different from our everyday experience – be it a hero in a faraway land that must slay a dragon, a cat navigating a futuristic city, or a traitor at King Arthur's table. They also allow players to face the same challenge as other players, collaborating or competing with them but from different perspectives, starting conditions, and winning strategies. Through the exploration of different roles, players can experiment with different points of view and learn to observe, appreciate, and evaluate other's people feelings and behaviors.

Games as exercise

Main educational purpose: Qualification

Dimension(s) of knowledge: Factual, Conceptual, Procedural

Pedagogical approach(es): Skill and drill

Example (boardgame): Playing a game of *Timeline: British History* to reinforce knowledge of historical events.

Example (videogame): Playing a game of *Geoguessr* to exercise knowledge of world countries.

Games can be used to reinforce or consolidate knowledge and skills previously acquired outside the game, taking advantage from game's ability to contextualize (or re-contextualize) learning and engage learners towards learning content.

Games as social opportunity

Main educational purpose: Socialization

Dimension(s) of knowledge: Metacognitive

Pedagogical approach(es): Explorative

Example (boardgame): Playing a game of *Happy Salmon!* to break ice with strangers.

Example (video game): Playing a game of *Journey* to share an aesthetic experience with a stranger.

Many video games, and most boardgames are played with more than one player, which creates opportunities for sharing experiences, emotions (not always positive), and goals. Engaging in a game experience can be strengthened by the presence of others and the community of intents that is created with other players, through an implicit social agreement that Gregory Bateson (1955) calls metacommunication and which leads to the creation of an "affinity group" (Gee, 2003) bonded by shared endeavors, goals, and practices.

Games as assessment

Main educational purpose: Qualification

Dimension(s) of knowledge: All

Pedagogical approach(es): Explorative, Skill and drill

Example (boardgame): Playing a game of *Mastermind* to assess the player's deductive skills.

Example (video game): Playing a game of *The Witness* to assess the player's divergent thinking skills.

Games can be used as an environment to assess knowledge, skills, or competencies, at the beginning, during, or at the end of a learning process. In this context, some elements of games can be used as indicators of performance: for example, the game score, the objectives achieved or the time employed to solve a certain challenge (Ifenthaler et al., 2012).

Games as texts

Main educational purpose: Socialization

Dimension(s) of knowledge: All

Pedagogical approach(es): Explorative

Example (boardgame): Critically analyze the depiction of colonization in *Catan* (Sedelmeier & Baum, 2022).

Example (videogame): Analyze how evolutionary theory is represented in *Spore* (Bean et al., 2010).

The aim of this scenario is to have students critically "read" and interpret games as artifacts that express values, beliefs, and ideologies of the society that created them. When a game is used for an educational purpose, it becomes a medium, that is, a way to communicate and an instrument through which to read and interpret reality (Rivoltella, 2019). According to the theory of media education, games can be critically read according to four axes (Buckingham & Burn, 2007):

- language: the language of games is represented by game mechanics (or mechanisms, (Engelstein & Shalev, 2019). Game design is the branch of game science that studies mechanisms, that is, the system of rules that define the core gameplay loop (Abbott, 2020; Guardiola, 2016) of a game.
- representation: media are not objective presentation of reality, but rather representations of it, and board games are no exception. Modern publishing games cover many fields of human endeavor and can be placed on a continuum from abstract representations (such as Go) to simulative (Parlett, 1999, pp. 348). Studying how these games represent reality equals to analyzing what is considered real or authentic within the game; which aspects are included or excluded; how social groups, historical events, or aspects of the world are represented; and which consequences these representations produce on the public (Buckingham, 2019, p. 47).
- production: how are games produced? What are the different roles and responsibilities involved in the design, development, distribution of a game? What is the commercial plan for the game and its sustainment?
- public: what is the target of a game and how is it chosen? How do individuals and groups use the game? Which channels do they use to play? How do the public interpret those games? Which social factors are involved?

To our knowledge, while there is evidence in using video games as text for critical analysis in educational settings (Squire, 2006, 2008; Steinkuehler et al., 2012; Stufft & von Gillern, 2021), there is not yet an empirically validated template for the evaluation and use of boardgames as text in educational settings. However, work of game critics and semiologists (Booth, 2021; Brown et al., 2020; Parlett, 1999) provide compelling examples of how board games can be read critically in a media education perspective.

Games as systems of code

Main educational purpose: Qualification

Dimension(s) of knowledge: Factual, Conceptual, Procedural

Pedagogical approach(es): Explorative, Pragmatic, Skill and drill

Example (videogame): Playing *Code Combat* to learn how to code.

In this scenario, students use writing code as the primary gameplay mechanism, both as a mode to progress in the game and a mode of expression (Salen et al., 2010). "Because writing itself is produced as an artifact of the game play, this writing can be assessed to capture student understanding" (ivi, p. 89).

Games as documentary

Main educational purpose: Qualification

Dimension(s) of knowledge: Factual, Conceptual, Procedural

Pedagogical approach(es): Explorative, Pragmatic, Skill and drill

Example (boardgame): Using the components of *Era* to recreate the urban structure of a medieval city.

Example (videogame): Recreate a famous ancient battle using the *Rome: Total War* map editor.

In this scenario, games and their components are used as documentary evidence of student ideas and understanding. In the case of digital games, "students may be asked to play SimCity in such a way as to re-create certain social scenarios that they are interested in. Machinima (animations created using video game engine) or storyboarding with screenshots can be used to capture the details of the situation, which then can be used as the basis for additional discussion or reflection" (Salen et al., 2010, p. 90).

Games as engines for creation

Main educational purpose: Subjectification

Dimension(s) of knowledge: All

Pedagogical approach(es): Explorative

Example (boardgame): Players design a new card for *Dixit*.

Example (videogame): Players create a podcast to discuss the video game *Hellblade: Senua's sacrifice* and its depiction of mental illness.

In this scenario, students use games as a starting point to produce an artifact. This can be done using the tools provided by the game (many video games, such as *Starcraft*, *DOTA2*, and *The Sims* provide editors to create new maps, items, avatars, or mods) or external tools (such as recording videos, podcasts, writing texts, drawing art). According to Ejsing-Duun & Hanghøj (2019) we refer to the first as creation within game and the second as creation around game. In both cases, assessment for the artifacts produced comes "not from the game itself, but from the design domain to which the artifact is related and from the kinds of understandings the artifact was produced to express" (Salen et al., 2010, p. 86).

Games as design challenges

Main educational purpose: Subjectification

Dimension(s) of knowledge: All

Pedagogical approach(es): Explorative, Pragmatic

Example (boardgame): Players design a modified version of CO^2 to simulate on how environmental policies change the energy market (Castronova & Knowles, 2015).

Example (videogame): Players create a game on Nintendo Labo to increase sensitivity towards waste management.

In this scenario, students design or redesign games as a research activity to solve a complex challenge. To this aim, the student "must be knowledgeable about the system he or she is designing, using game design in this way requires students to think through how their players are learning and what they need to know about the subject of the game" (Salen et al., 2010, p. 90). This implies that, to address the challenge, the student/designer must a) research materials to be used, b) interpret such material and identify patterns, c) use these insight together with their existing knowledge of and experience with

game design, d) develop a prototype for their game, and e) test it with other players (Ejsing-Duun & Hanghøj, 2019). This scenario, whose pedagogical approach has been referred to as constructionism (Papert, 1993) presents significant challenges both to the learning designer and the student, but shows great premise to develop meaningful and deep learning (Kafai & Burke, 2015; Papavlasopoulou et al., 2019; Tinterri et al., 2023; Vos et al., 2011).

4. Conclusions

As of today, GBL is something of a paradox: on the one side, games are more popular than ever, and educational research reports its effectiveness as a teaching and learning strategies for different contexts, disciplines, and learning environments (Bayeck, 2020; Cantoia et al., 2023; Denner et al., 2019; Gashaj et al., 2021; Hainey et al., 2016; Hava & Cakir, 2017; Kafai & Burke, 2015; Mayer et al., 2014; Noda et al., 2019; Plass et al., 2015, 2020; Zheng et al., 2021); this is echoed by a general positive view of GBL by educational institutions and teachers (Allsop et al., 2013; Loperfido et al., 2019; Persico et al., 2019). On the other side, the methodology has insofar failed to achieve a significant adoption in Italian and European schools and higher education institutions. This article contributes to the field of GBL by providing, to our knowledge, the first comprehensive mapping of game scenarios for GBL. This has two intended goals: i) to reduce the semantic confusion in the field of GBL; ii) to facilitate the design and development of GBL activities, by defining the extent of educational purposes that video games and boardgames can be used for. This, however, is not and end goal but rather a first step in the development of a successful instructional design model for GBL. So far, existing frameworks have highlighted the need for alignment between instructional goals and the specific properties of games (Gee, 2003; Squire, 2006), such as the Smiley model (Weitze, 2016), the Q Design pack (Salen et al., 2010), and Nicola Whitton's model (Whitton, 2009). However, none of them have explicitly defined how this alignment is to be realized in a satisfactory manner. Other models, such as the Learning Mechanics-Game Mechanics (LM-GM model, Arnab et al., 2015) have tried a one-to-one mapping of game mechanism and learning objectives; the model, while promising (Abbott, 2020), requires an in-depth ability to analyze gameplay and understanding of game mechanics. Framing game scenarios is then a first step to help teachers and instructors facilitate the understanding of the complex, multi-dimensional potential of games for learning. Future research is required to operationalize game scenarios: from the definition of "acceptable evidences" for the achievement of the intended goals of a scenario to the definition of assessment and evaluation instruments to achieve constructive alignment (Biggs, 1996) between game and learning goals, to guiding the implementation of scenarios according to their specific properties. Further investigation and empirical evaluation are therefore required to test the usefulness of game scenarios as a framework to guide teachers and educators in GBL design. The literature in the field is rich in theoretical frameworks that provide too complex or with too high prerequisites to be useful; to avoid the risk of adding yet another fruitless conceptualization, the construct of game scenarios needs to be examined and critically evaluated in the context of GBL teacher training programs and in GBL implementation in real learning contexts. In conclusion, this paper provides, to our knowledge, the first comprehensive mapping of the different uses that video games and boardgames can have in GBL design, paving the way for an integrated instructional model of GBL.

Authors' contributions

Conceptualization, *methodology*, and *investigation*, Andrea Tinterri and Massimiliano Andreoletti; *writing-original draft* preparation, Andrea Tinterri; *writing-review and editing*, Andrea Tinterri and Massimiliano Andreoletti.

All authors have read and agreed to the published version of the manuscript.

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Determining behavioral intention to use Digital Game-based Learning in promoting 21st century Learning and Teaching amongst STEM pre-service educators

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Abstract

The demand in self-directed learning increases the likelihood of Digital Game-Based Learning (DGBL) in science, technology, engineering, and mathematics (STEM) education. The integration of STEM content into digital games is envisioned to promote 21st century critical skills. The engaging natures of digital games gives it the advantage over other digital technologies to aid STEM education post 21st century. International studies express DGBL successes in education and the diverse skills acquired through its use. However, the dearth in empirical evidence to validate digitalization hinders adoption, more so in developing countries. The study investigates PSE's behavior intention to use digital game-based learning. A model is proposed, underlined by the Technology Acceptance Model (TAM) and application of learning principles in DGBL. The model defines TAM's original constructs and introduces five external constructs. A quantitative survey design was adopted, and data was gathered from 255 PSE in an institution in south Africa. The fitness of the model was within an acceptable range, all measures indicated the model fits the data. A two-step assessment approach was conducted, first, the measurement model validated the instrument using Partial least squares structural equation modeling analysis. Secondly, structural model accounted for 59% explanatory strength PSEs' behavioral intentions. Learning opportunity, and social influence showed substantial correlation on behavioral intention. Pre-service educators show strong intention to use DGBL were opportunities for critical thinking, control, and experimentation are offered. These findings are essential in the contribution to research and the development of customized DGBL that addresses educational needs of diverse students and educators.

Keywords: Digital Game-based Learning, STEM Education, Pre-service Educators, Technology Acceptance Model, Digital Literacy.

1. Introduction

Information Technology integration skills are an important requirement in the learning and teaching of Science, Technology, Engineering, and Mathematics (STEM) in various ways. STEM education is envisioned to prepare young people with digital literacy skills and to work ethically in dynamic and demanding environments (Falloon et al., 2020). However, educators face many challenges in teaching STEM related subjects, and challenges facilitating 21st century skills. These challenges are enhanced in developing countries where educators are not competent in technological skills and engineering knowledge. Other challenges include access to infrastructure, resources, ICT skills, alignment to the curriculum standards, and school to employment ready (van Elderen & van der Stappen, 2019). For educators to develop these capabilities of facilitating STEM education and promote 21st century skills, cultural and environmental change should be advocated in the way STEM subjects are taught. Educators should be equipped with digital skills and to facilitate 21st century teaching and learning. These interventions require institutions and educators to move from the traditional classroom to a technologically enhanced environment of learning and teaching, involving student centered learning and innovative technologies (Oliver, 2018).

Technology enhanced learning and teaching in STEM is proven to offer benefits of easier access to information, giving students, educators, and institutions flexibility of time and place. This integration and digitalization of learning content is seen to promote a learner-centered teaching approach. Digitalization of learning content such as flipping the classroom, gamification, blackboard learn,

Moodle, YouTube and massive open online courses (MOOCs) have become popular and successful in STEM education (Aparicio et al., 2019). These developments are making way for self-directed learning technologies such as Digital Game-Based Learning (DGBL). This paradigm shift of digital games in education is revolutionizing the entire methods of conveying knowledge to learners. The fun and engaging nature of digital games gives it the advantage over other promising technologies that foster learning and teaching (Spann et al., 2019). Moreover, DGBL models integrate subject matter content and learning outcomes into a simulated game environment. These technologies have the potential to advance learning, assisting students and educators. Digital game-based learning can be advantageous in developing countries where educators are not competent in technological skills and face many challenges with interdisciplinary STEM education, as well as facilitating 21st century skills. As part of closing the digital literacy gap, capacitating developing countries like South Africa to improve digital literacy, increase performance in STEM related courses (Chibisa & Mutambara, 2022; Ghani et al., 2019; Titus & Ng'ambi, 2014). According to Blume (2020), the determining factors towards adoption of DGBL in education is largely influenced by students and educators behavior intentions.

The current study aims to investigate the factors determining pre-service educator's behavioral intentions to use DGBL in the context of STEM education, in South African. In realizing this aim, correlations are formulated with game-based learning characteristics proposed by (Zaibon & Shiratuddin, 2010) and the Technology Acceptance Model (TAM). TAM is adopted and extended with external constructs (learning theories, learning opportunities, perceived enjoyment, social influence) for evaluating behavioral intension to use DGBL. The model is based on the strength of two established constructs, perceived usefulness and perceived ease of use. Perceived usefulness refers to how using DGBL will improve task performance and perceived ease of use speaks of the degree to which a user finds that using the DGBL will be free of effort (Davis, 1989). Flexibility of TAM and its wide adoption across domains and disciplines gives it credibility in the study. Contextualized external constructs are proposed based on game-based learning characteristics, domain of the study and in consideration of the educational needs of diverse institutions, students, and educators alined with the requirement standards of Department of Higher Education and Training (DHET) in South Africa.

The success of DGBL in developing countries at large depends on students' and educators' behavioral intention to use DGBL given their diverse cultures. Inquiries into user behaviors are vital in understanding students choices to embrace a learning system like DGBL and the beliefs they hold about system adoption.

2. Literature review

2.1 Digital Game-based learning in education

When engaged actively in a game, a person's brain experiences the feeling of joy and being challenged spontaneously and the same experience is true in digital game-based learning (Serrano, 2019). Digital Game-Based Learning has been gaining popularity in recent years, with games being introduced as a learning environment in museums, libraries, after-school programs and in classrooms (Chen et al., 2020; Hébert et al., 2021). In the context of education, there are two approaches to game play: game-based learning and gamification. Gamification focuses on the concept of rewarding each task that is completed, whereas game-based learning leverages conflict and play to make academics more engaging and enjoyable (Khan et al., 2017; Sanchez, 2019). Taking learning to the next level, DGBL defines environments where game activities involve problem solving, cognitive processing, motivation and challenges the users providing a sense of achievement (Khan et al., 2017). Digital games in education support schools and educators towards creating a digital learning environment using devices such as computers, mobile phones and digital applications (Qian & Clark, 2016). Studies suggest great potential in digital games application in the 21st century learning and teaching. They are one of the few technical advancements capable of satisfying many of the 21st century's evolving learning demands and criteria (Bayeck, 2020; Dele-Ajayi et al., 2019; Lyons et al., 2019; Ng et al., 2020; Sanchez, 2019).

The fun engaging nature of DGBL has many successes reported in learning achievements and improved performance in Language studies and science, technology, engineering, and mathematics science, technology (STEM) in particular (Qian & Clark, 2016). Furthermore, information technology integrated learning approaches are more effective than traditional approaches in the aspects of learning from a cognitive perspective, retention, student participation and engagement (Blume, 2020). Making use of digital game elements aligned with established learning principles can enhance meaningful learning and engage players/students in adaptive self-directed learning.

The activities in digital game-based learning might range from simple task completion to the development of complicated problem-solving skills (Eseryel et al., 2014). Prensky (2003), suggested rules, objectives, results, feedback, challenge, and repetition as critical game elements necessary for effective learning in DGBL. Digital games differ from simulations in that a digital game is intrinsically motivating and involves competition. According to Vanduhe et al. (2020) at least five fundamental features are provided by DGBL: 1) Teamwork, contribution, and motivation; 2) task commitment and enjoyment; 3) problem-solving; 4) critical thinking; and 5) self-directed learning. Motivation, learning engagement, collaboration, cognitive engagement, and problem solving are game elements identified as critical in the context of DGBL becoming an effective learning and teaching tool.

2.2 Digital Game-based learning in the South African STEM Education context

Developing countries continue the developments into bridging digital literacy gabs in education and employment, done through various models of skill development (Herselman & Botha, 2013; UNICEF - Ghana, 2017). Promoting digital literacy is crucial to achieving one of the United Nations (UN) Sustainable Development Goals (SDGs), SDG 4 which is to provide inclusive and excellent education for everyone and encourage lifelong learning (Abrahams & Burke, 2022; Adukaite et al., 2017). Endorsed by the National and Future Digital Skills Strategy of South Africa, the Cabinet of the Republic of South Africa in August 2020 recognized that the world is experiencing a skill revolution (Abrahams & Burke, 2022). The overarching implementation document for the strategy set out to lead institutions and stakeholders on the implementation of digital and future skills program (2021-2025). The report recommends promotion of digital literacy skills and the adoption of innovative digital technologies to address the many levels of the digital literacy gap (Abrahams & Burke, 2022).

South African society at large show that access to computer devices and Internet is still limited, however the emergence and mass deployment of wireless technology has increased availability of affordable mobile phones, creating an internet advantage for mobile devices users (Greenop & Busa, 2008; Ndlovu & Mhlongo, 2020). Therefore, it is speculated that mobile gaming (online and offline) may increase in South Africa, especially amongst young adult, due to the increasing use of mobile technology and the affordability of large-scale wireless services. The advantages using mobile applications in education and their adoption has been researched in South Africa to a great extent, with promising results (Mutambara & Bayaga, 2021; Xala, 2018). Access to resources no longer a primary concern, developing countries are investing in digital skill development of young people, both men and women (Bayeck, 2020; Xala, 2018). Digital literacy is at the heart of the 21st-century skills development for the youth to live, study, and work, which is expanding beyond just functional technological abilities to include a variety of digital behaviors, traditions, and identities.

The study investigate DGBL in response to developing countries educational needs to address digital literacy problems and technology adoption in STEM education. Even the most advanced technology will not succeed if it does not kindle interest and a sense of usefulness for its intended users. There is scarcity of empirical research towards understanding students' and educators' behavioral intention to use DGBL in the south African education system (Alhebshi & Halabi, 2020; Archer & Newfield, 2014; Bayeck, 2020; Greenop & Busa, 2008; Sanchez, 2019).

2.3 Technology Acceptance Model

Technology Acceptance Model advocates that the acceptance of a technology is influenced by users' behavioral intentions. Behavioral intention is also determined by attitude, and user's attitudes are influenced by perceived usefulness and perceived ease of using the technology (Davis, 1989). The

model is adopted to extend determine PSEs' behavioral intention to use DGBL in learning and teaching of STEM, see Figure 1.

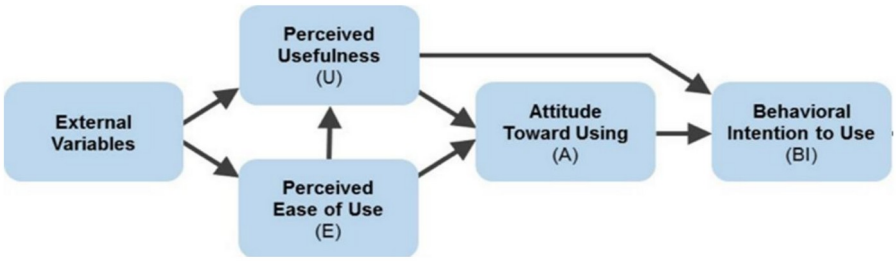

Figure 1 - Extended Technology Acceptance Model.

Comparative studies endorses TAM over other technology adoption theories, as it explains an average of 40-60% variance on technology acceptance and user behaviors (Venkatesh & Davis, 2000). In line with the 21st century skills development set and DGBL domain, the study extends TAM to define factors influencing DGBL. Pre-service educators' Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are extended to be defined by five external variables (Learning theory, learning opportunity, Cognitive engagement, perceived enjoyment, and social influence).

2.4 Theoretical framework and hypotheses

The extended technology acceptance model extTAM is mediated by external factors through perceived usefulness and perceived ease of use constructs defining behavioral intention to use DGBL (Figure 2).

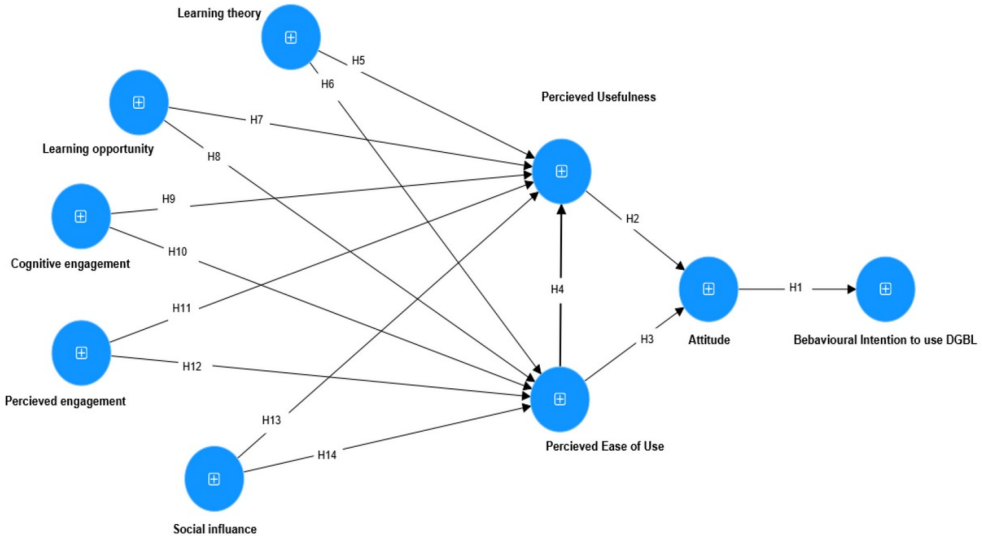

Figure 2 - The Proposed DGBL Technology Acceptance Model.

The proposed external constructs: Learning theories (LT) which defines pre-service educators' perceived learning and teaching approach in DGBL and how it differs from traditional approaches (Zaibon & Shiratuddin, 2010); Learning opportunity (LO) defines pre-service educators' believe that using DGBL can offer an opportunity to interact with experiential knowledge (Ibrahim et al., 2011); Cognitive engagement (CE) refers to pre-service educators' attention, attentiveness and eagerness to exert effort essential to grasp intricate ideas and master any skill (Fredricks et al., 2004); Perceived enjoyment (PE) suggests that if pre-service educators find DGBL enjoyable, then they are more likely

to find it useful in their daily learning activities (Abdullah et al., 2016); Social influence (SI) define the extent to which pre-service educators' perceives that others peers opinions and beliefs influences their intention to DGBL (Venkatesh et al., 2003).

The proposed external constructs are incorporated to extend TAM and fourteen hypotheses relationships formulated to verify the DGBL model.

3. Methods

3.1 Research Design

The study adopts a quantitative survey research design and a questionnaire was used in the data collection process. Descriptive statistics and partial least squares-structural equation modeling were used to explore the data and for the assessment of the above formulated hypotheses.

3.2 Participants

The survey was administered with the use of simple random sampling amongst STEM undergraduate students in the Faculty of Education at a south African university. In a population of 3,000 pre-service educators (PSEs), 353 is found to be a suitable sample size at 95% confident level. A sample of 400 PSEs participated in the study. The final sample size was two hundred and twenty-five (n = 255), at a rate of 64%, an acceptable sample size for the current study (Kline, 2015).

3.3 Instrument

A two section questionnaire was employed to collect data from the respondent on their perspective and intention to use DGBL. The first section gathered demographics of respondents and the second section consisted of a five-point Likert scale to collect data on the construct indicators (BI, AT, PU, PEOU, LT, LO, PE, CE, SI). The indicator items were adopted and adapted from different literature sources. The Likert scale was used to examine the extent of the respondents' agreement on the indicator statements that ranged from 1 as Strongly disagree to 5 as Strongly agree.

3.4 Data Analysis Technique

The Statistical Package for the Social Sciences (SPSS) software was used to compute descriptive statistics and screening for missing data (George & Mallery, 2019). Partial Least Squares Structural Equation Modeling (PLS-SEM) techniques were employed for the model and hypothesis testing with the help of SmartPLS-4 software. A two step approach was employed for the evaluation of the proposed model. The first assessment was performed for validity and reliability of the measurement model, and the second, for collinearity and path coefficient evaluation of the structural model.

4. Results

4.1 Descriptive statistics

The mean scores of the indicators were above the mid-point of 3.00, ranging from 3.18 to 3.82, indicating positive responses to the variables of the model (Table 1).

The data suggests PSEs have positive perspectives towards the use of DGBL in STEM education. A moderate spread of responses was reflected for the model via the standard deviation, which ranges between 0.85 and 1.08, suggesting a positive overview of construct indicators (Kline, 2015). The projected data indicates that pre-service educators mainly have positive perspectives about the use of DGBL in STEM education.

4.2 Measurement Model

The measurement model was used to address the model's dependability and validity by testing Convergent validity, Internal consistency reliability and Discriminant validity (Hair et al., 2019).

Discriminant validity was evaluated by Heterotrait-monotrait ratio (HTMT), to estimate the true correlation between two constructs would be if they were perfectly reliable (Hair et al., 2019). Discriminant validity problems occur when HTMT values are higher than 0.9. All HTMT values were lower than 0.9, indicating no discriminant validity issues observed (Figure 3).

Table 1 - Average score values for each scale.

Constructs		*Mean*	*Standard deviation (SD)*
Behavioral intention	BI	3.67	1.08
Perceived ease of use	PEOU	3.52	0.96
Perceived usefulness	PU	3.75	0.95
Learning opportunity	LO	3.83	0.85
Cognitive engagement	CE	3.68	0.99
Perceived enjoyment	PE	3.82	0.88
Social influence	SI	3.18	1.01
Learning theories	LT	3.75	0.92

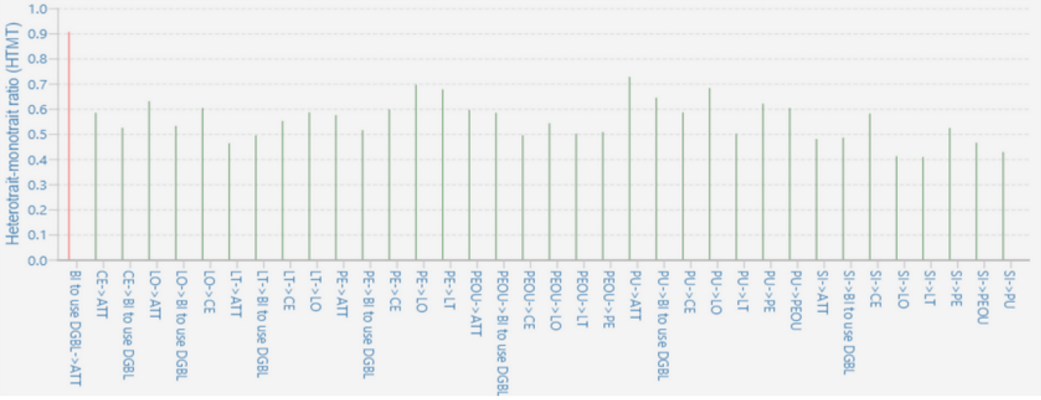

Figure 3 - Heterotrait-monotorait ration (HTMT).

Convergent validity was assessed through factor loading and average extracted variance (AVE). Depicted in Table 2, factor loadings for the 11 construct are greater than the threshold of 0.7, indicating all constructs were well represented by their indicator items (Hair et al., 2016). The AVE values range from 0.544 to 0.690 greater than the standard minimum 0.5, suggesting adequate convergent validity Internal reliability of the model was acceptable given the values of Cronbach's alpha (CA) and Composite reliability (CR) being greater than 0.7 respectively (Hair et al., 2019).

The measurement model's dependability and validity were successfully evaluated through Convergent validity, Internal consistency reliability and Discriminant validity. Results suggesting effective model strength for evaluating the structural model.

4.3 Structural Model

Bootstrapping procedure was performed to evaluate the structural model collinearity and path coefficient, with a sub-sample of 5,000 at 97% significance level. Collinearity within the model is reported as problematic when the VIF value is greater than three (Hair et al., 2019). Table 3 reports on VIF values, all the predictors' VIF values were below 3.000, suggesting there were no collinearity issues within the model. The Pearson product-moment correlation coefficient was used to examine variable correlation in the hypothesized relationships (Hair et al., 2016). Depicted in Table 3, are the t values declared significant if greater than 1.96, and a correlation of 0.05 or higher ($r \geq 0.05$) for substantive correlations.

Nine hypotheses were support and five not supported, LO, CE and PE were strong predictors of PU (H7: β = 0.32, p = 0.000; H9: β = 0.162, p = 0.005; H11: β = 0.200, p = 0.001). The f-square (f2) effect size was estimated by running the PLS-SEM algorithm twice, to measure the strongest relationship of a predictor construct on independent variable. Result also indicate LT and SI had no significant effect on PU (H5: β = 0.024, p = 0.310; H13: β = 0.121, p = 0.041).

Figure 4 illustrate the structural model, depicted to account for 59% of the variance of use in DGBL behavioral intention, exogenous variable explained 44% variance on PU, and 36% on PEOU. These findings are consistent with those of Bourgonjon et al. (2013) and Vanduhe et al. (2020), acceptance of DGBL among STEM in-service educators.

Table 2 - Measurement Model.

Construct	*Indicator Items*	*Convergent validity*		*Internal consistency reliability*	
		Factor loading	AVE	CA	CR
		>0.7	>0.5	>0.7	>0.7
Attitude	AT1 AT2 AT5	0.854 0.861 0.773			
Behavioral intention	BI2 BI3 BI4 BI6	0.785 0.827 0.835 0.784	0.644	0.862	0.900
Perceived usefulness	PU1 PU2 PU3 PU4	0.785 0.870 0.847 0.850	0.679	0.881	0.913
Perceived ease of use	PEOU2 PEOU3 PEOU5 PEOU6	0.778 0.740 0.806 0.775	0.597	0.831	0.881
Learning theories	LT1 LT2 LT3 LT4	0.785 0.868 0.807 0.833	0.667	0.875	0.909
Learning opportunity	LO1 LO2 LO3 LO5	0.758 0.791 0.809 0.768	0.591	0.827	0.878
Perceived enjoyment	PE2 PE3 PE4 PE5	0.847 0.898 0.762 0.808	0.690	0.815	0.877
Cognitive engagement	CE1 CE2 CE4 CE5	0.836 0.828 0.779 0.757	0.641	0.815	0.877
Social influence	SI1 SI2	0.856 0.887	0.760	0.685	0.863

5. Discussion

The study set-out to investigate STEM pre-service educators' intentions to use DGBL and proposed factors identified to influenced behavioral intention based on the technology acceptance model (TAM).

Table 3 - Total Effects Coefficients for the Structural Model.

	Path	*Path coefficient*	*t value*	*p values*	*VIF*	f^2	*Decision*
H1	ATT -> BI to use DGBL	0.598	10.668	0.000	1.632	0.537	Supported
H2	PU -> ATT	0.455	7.453	0.000	1.373	0.250	Supported
H3	PEOU -> ATT	0.389	3.309	0.000	1.373	0.071	Supported
H4	PU -> PEOU	0.287	3.381	0.001	1.697	0.079	Supported
H5	LT -> PU	0.024	0.336	0.310	2.133	0.002	Not supported
H6	LT -> PEOU	0.098	1.100	0.118	2.139	0.006	Not supported
H7	LO -> PU	0.327	4.483	0.000	1.802	0.094	Supported
H8	LO -> PEOU	0.185	2.164	0.031	1.971	0.007	Supported
H9	CE -> PU	0.162	2.783	0.005	1.651	0.046	Supported
H10	CE -> PEOU	0.127	1.763	0.078	1.727	0.004	Not supported
H11	PE -> PU	0.200	2.776	0.001	2.062	0.024	Supported
H12	PE -> PEOU	0.071	0.771	0.441	2.112	0.000	Not supported
H13	SI -> PU	0.022	0.387	0.022	1.338	0.013	Not supported
H14	SI -> PEOU	0.121	2.044	0.041	1.393	0.003	Supported

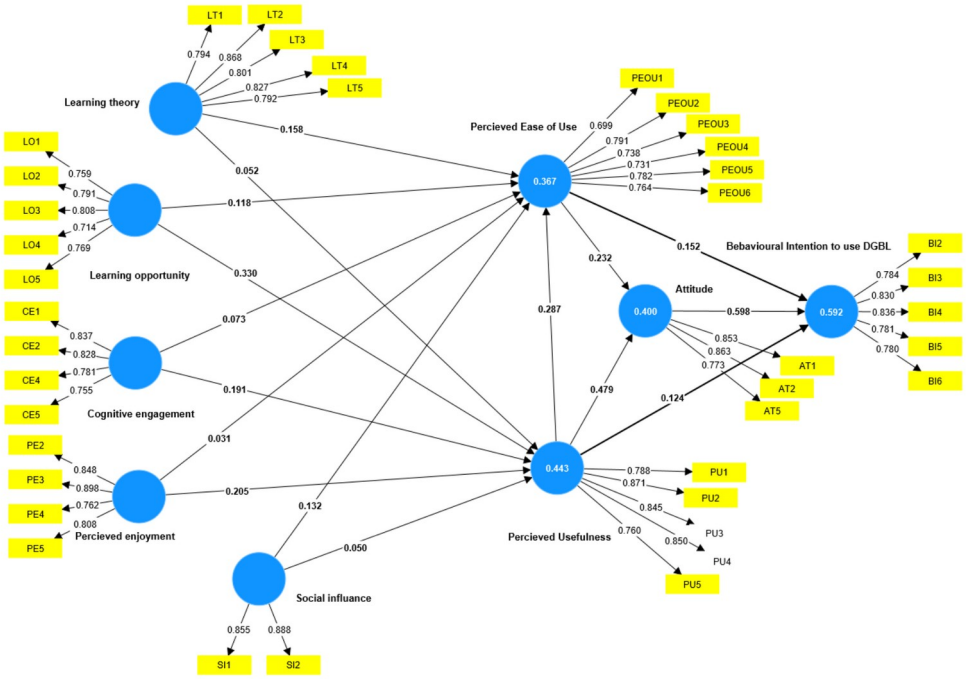

Figure 4 - Structural Model.

The original TAM constructs were extended with game-based factors; learning theory, learning opportunity, cognitive engagement, perceived enjoyment, and social influence. The model's total effect demonstrated that behavioral intention was positively influenced by all proposed factors. The original TAM constructs attitude, perceived usefulness and perceived ease of use were found to have positive and significant relationship to behavioral intention to use DGBL, all three hypotheses were supported (H1: $\beta = 0.59$, $p = 0.000$; H2: $\beta = 0.45$, $p = 0.000$; H3: $\beta = 0.20$, $p = 0.001$). The model accounts for 59% of the variance of use in DGBL behavioral intention. The exogenous variable explained 44% variance on PU, and 36% on PEOU. The models' path coefficient showed positive

correlation with behavioral intention to use DGBL. These outcomes are constant with literature (Chiu, 2017; Dele-Ajayi et al., 2019; Vanduhe et al., 2020). That is, STEM pre-service educators agree it is within their intention to use DGBL for learning and teaching.

Learning Opportunity (LO) was found to be a strong determining factor for STEM pre-service educators' behavioral intention to use DGBL. Pre-service educators believe that DGBL provides better learning opportunities in STEM related subjects is the strongest predictor of PU (H7: $\beta = 0.32$, $p = 0.000$) and PEOU (H8: $\beta = 0.18$, $p = 0.031$). The findings are consistent with those of Bourgonjon et al. (2013) and Vanduhe et al. (2020), suggesting a strong intent to use DGBL if its focused on digital skills, opportunities to experiment with knowledge, and control of the learning process in a fun environment. Social Influence (SI) results suggests STEM pre-service educators are influenced by their peers, educators, and family members towards using DGBL ($M = 3.18$, $SD = 1.01$) supporting hypotheses H13: ($\beta = 0.12$, $p = 0.022$) and rejecting H14: ($\beta = 0.02$, $p = 0.041$). Similar findings were reported (Camilleri & Camilleri, 2019), indicating that social influence is not a strong predictor of behavioral intention. The subject matter investigated in the study was STEM and related subjects. Therefore, the view is found that social influence plays a positive role generally to influence students towards DGBL, PEOU and intention. However, STEM pre-service educators where less likely to be influenced by their peers, parents, and educators towards perceiving DGBL usefulness in their learning needs. Cognitive Engagement (CE) was observed to be a determining factor for STEM pre-service educators' behavioral intention to use DGBL ($M = 3.67$, $SD = 0.99$), with positive and significant effect on PU (H9: $\beta = 0.16$, $p = 0.005$) supported and PEOU (H10: $\beta = 0.12$, $p = 0.078$) not supported. Suggesting pre-service educators' cognitive engagement were generally neutral. According to Blume (2020), favorable views are were contrariwise related to prior practice in formal school settings, current engagement in game playing affected academic skills and learning strategies positively. The current study found that game play may not affect pre-service educators' cognitive engagement. Perceived Enjoyment (PE) was found to be indirectly a determining factor for behavioral intention to use DGBL through PU (H11: $\beta = 0.02$, $p = 0.001$), however H12 was not support as PE showed no correlation with PEOU (H12: $\beta = 0.07$, $p = 0.441$). Both findings are consistent with literature noting that enjoyment is the key criteria in DGBL perceived usefulness, where students engage in learning activities in a fun and joyful manner. However, they did not relate the fun nature of games related to perceived ease of using DBGL. Learning theories (LT) results suggest no significant effect with PU (H5: $\beta = 0.04$, $p = 0.31$) and PEOU (H6: $\beta = 0.09$, $p = 0.11$). Qian and Clark (2016), noted that the learning theory construct might be key to understanding the effectiveness of DGBL as an innovative learning method. The study findings indicate that participants might have not understood the learning principles integrated in DGBL or pre-service educators found no correlation of learning theories with behavioral intention to use. The finding indicates that the external variables play a positive influence on the model to explain perceived ease of use and perceived usefulness. Perceived ease of use, perceived usefulness and attitude directly and positively influenced pre-service educators' behavioral intention to use DGBL.

5.1 Implications of the study

The findings contributes to the potential impact of learning opportunity, perceived enjoyment, social influence and learning engagement towards DGBL adoption in South Africa universities (Greenop & Busa, 2008; Titus & Ng'ambi, 2014). A good model fit of the proposed research model is depicted, the exogenous variables determined 59% influence towards behavioral intention to use DGBL. The study contributes to the potential impact of DGBL adoption, determining factors such as learning opportunity and perceived enjoyment, and PU as critical criteria in DGBL design and implementation. The study recommends well designed digital games based on experiential learning principles. The study was limited towards assessment and reporting on educational value of certain digital games, needed for future research.

6. Conclusions

The study set out to aid learning institutions in closing the digital gap identified in developing countries, by utilizing contextualized digital game-based learning technology. The objectives was to

investigate factors determining behavioral intention to use DGBL amongst STEM pre-service educators. The use of DGBL is envisioned to promote 21st century learning and teaching skills that are necessary in STEM education. The proposed models' predictability showed cognitive engagement, learning opportunity, perceived enjoyment, and perceived ease of use were found as good predictors the usefulness of DGBL in STEM education. That is, pre-service educators find DGBL a useful technology towards their learning needs in STEM education. Pre-service educators show positive intention to use DGBL due to the fun and entertaining nature of games and usability. Learning theories, learning engagement, social influence and games related self-efficacy had no meaningful impact perceived usefulness of DGBL. Outcomes demonstrated that STEM pre-service educators where less likely to be influenced by their peers, parents and educators towards perceiving DGBL usefulness in their learning needs. The argument with the correlation of learning theories and learning engagement constructs and the ease of using a technology might not be affected by its ability to provide good service. However, learning opportunity, social influence, and games related self-efficacy show positive impact on the ease of using DGBL. These outcome aid in understanding determining factors for behavioral intention to use and accept DGBL in STEM education. Another potential implication of the study is the design of game instructions to emphasize the usefulness factor (clear learning opportunities, clear instruction, entertainment and specific goals) while designing for ease of use (user interface is usually a primary concern). This result suggests that no matter how easy the tool is perceived, it will not be used unless it is found useful for specific learning purposes, performing and completing a task. The study was limited towards the effect of gender and age of pre-service educators behavioral intention to use DGBL.

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The electronic midwife: self-education through video games as a form of maieutics

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Abstract

May video games be used for moral literacy? I suggest they can, as a part of a maieutic process in which the player is compelled to elaborate and/or rewrite his own moral views in order to respond to specific game dynamics; in this case, the video game in itself "acts" as a facilitator, or a midwife, to put it socratically.

Does videogaming work this way in informal contexts? I believe it does: in fact, several commercial off the shelf video games out there throw their players right in the middle of fictional, virtual worlds calling them to confront with moral dilemmas and forcing them to engage in their solution.

May video games be used to encourage moral literacy in formal contexts? I believe they can, as a part of a wider self-education strategy that might respond to "civics'" inadequacy towards forming good citizens and morally developed adults.

Here I retell a controlled player-videogame relation as a potential maieutic process, urging the player to think or rethink his/her moral positions, and I foster its application to formal and informal learning contexts alike.

My final aim is to suggest a rethinking of the player-videogame relation in order to create the needed conditions for the definition of clear guidelines that would allow for the design and production of a maieutic video game, to be used as a powerful and ethical means for moral self-education.

Keywords: Videogames, Moral Literacy, Maieutcs, Civics, Self-Education.

1. Introduction

Digital natives were born and raised in a globally technological environment (Lenhart et al., 2015) which encompasses most of their relevant social and cultural experiences, from knowledge acquisition and social relation building to moral literacy (Tuana, 2007) and the acquisition of moral values. In the so-called onlife situation, informal learning contexts, such as virtual and digital environments (Hawkey, 2004; Selfton-Green, 2004), have gained paramount importance on account of the way they promote interest, motivation, collaboration and social interaction of individuals (Degner et al., 2022): that's why, in recent years, the academy has approached them with growing interest. Being able to transfer these benefits to formal learning contexts by truly applying digital and tech means would result in a big time learning revolution. Needless to say, this would imply an even wider and more invasive use of technology.

Risks and opportunities on that matter have been widely discussed and somehow assessed but, to date, no final answer has been reached: in fact, participants on this debate still seem to be manicheally split in two opposite sides, each one of which predictably digging in its heels.

On the one hand, to quote Umberto Eco's famous opposition between "apocalittici" and "integrati" (Eco, 1964), the hardcore critics, the millenarian-wannabes stressing on tech-development related risks; on the other hand, the dappled ranks of the "integrati", seeing engineers and programmers blindly developing hardware, software, sensors or whatever it takes to make technology easier and more useful, in one word more invasive ("because that's what we do…"), and corporate white collars hypocritically thriving on potentially risky technologies.

Commonsense should call us to one simple remark: both positions lack of reflection and/or impartiality, be it because of the subject's position within the productive system or due to an inveterate pessimistic view on progress.

In this case, I can't help but consider technology both as a risk *and* as an opportunity towards cognitive, emotional and moral development of the youth (Quimson, 2020). That's not just commonsense: I really believe that a correct use of technology might result in great benefits, even when it comes to possible tech-related risk prevention.

My project here is to speculate on the concept of "moral literacy" and its potential relation with new technologies, in what I deem to be a much-needed effort towards the creation of more responsible, active and self-aware individuals and citizens. In this respect, I will propose the use of video games as a means of self-education. I will then propose a rewriting of the gamer-videogame relation as a maieutic process. Due to the very nature of this question, a little background on the meaning of "moral literacy" and a comparison with the concept of "civic education" will be required.

2. Materials and Methods

In her fundamental article *Conceptualizing Moral Literacy* (Tuana, 2007), philosopher Nancy Tuana came to define "moral literacy" as a third literacy that, along with math and reading literacy (which were "highly valued by the American educational system") would help teacher and educators in their aim of giving kids "an education in those skills they need to lead a responsible and rewarding life". A classical statement, reminding of Hegel's idea of education to be intended as a way of creating "good citizens" - "When a father inquired about the best method of educating his son in ethical conduct" he himself had handwritten, as a remark to point 153, on his own copy of Grundlinien der *Philosophie des Rechts*, "a Pythagorean replied: 'Make him a citizen of a state with good laws' " (Hegel, 1820).

Elsewhere, in the aforementioned article, Tuana wrote about producing "productive and responsible citizens" (Tuana, 2007), creating a (not so) curious superimposition between leading a "rewarding life" and being a "productive citizen".

This is not the right place or time to pinpoint the deep meaning of Tuana's oversight, but let's keep this in mind, as this confusion might (and will) turn out to be important in the last section of this article.

Anyway, despite every possible preoccupation, Hegel's idea still strikes a chord: what's more beneficial than creating "good citizens"?

Well, Tuana's Moral literacy can be thought of as a means of creating good citizens: in fact, the locution is used to refer to "skills and knowledge specific to making ethical choices in life", whose development "can be and should be enriched through education" (Tuana, 2007).

This set of skills and knowledges, that should really be sought after and enriched, Tuana says, consists of three aspects: ethics sensitivity, ethical reasoning skills, and moral imagination.

Ethics sensitivity is defined as the ability to determine whether "a situation involves ethical issues" or not, to perceive "the moral intensity of the ethical situation", and to identify the "moral virtues or values underlying an ethical situation".

Ethical reasoning skills consist in understanding the different "ethical frameworks", being able to "identify and assess the validity of facts relevant to the ethical situation", "assessing any inferences from such facts" and being able to "identify and assess the values that an individual or group holds to be relevant to the ethical issue under consideration" (Tuana, 2007).

The third and last component of Moral Literacy is Moral imagination, a concept which Tuana borrows from Mark Johnson's book of the same title. This faculty is described as a blend of "affective and rational processes that contribute to the imagination" (Tuana, 2007), giving us an "ability to imaginatively discern various possibilities for acting in a given situation and to envision the potential help and harm that are likely to result from a given situation" (Johnson, 1993).

With her three-sided definition, Tuana seems to be tracking down a path that had been traced, back in the early 80s, by psychologist James Rest.

And I can't help but hear an echo of Rest's statement that moral ideals can be (and very often are) "compromised by self-interest" (Rest, 1982) in Tuana's remark that "moral agency requires a rich and affective commitment to being ethical"; in fact, "simply because one can identify that a situation involves an ethical issue and be able to employ ethical reasoning skills to provide an analysis of what would be a good or bad action in the context, does not mean that they experience the action as ethical or feel any personal investment in the situation or in trying to respond ethically" (Tuana, 2007).

I surely agree that, although being hard to teach, moral imagination is central in an individual's evolution into a fully formed "ethical agent".

Indeed, this "imagination", which allows us to pick an alternative relying on a full spectrum of possibilities, does not necessarily result in an ethical decision; and I can't help but see the optimistic enlightenment-informed point of view on that matter as counter-intuitive and empirically untenable: we now know that education, even "good education" does not necessarily create good, responsible individuals, not to mention good citizens. In fact, the news and our daily experience often confront us with well-educated people acting unethically, from corrupt politicians to cheating university students. So, here is a couple of questions: how can we try and turn moral skills and knowledges into moral action? Can we rely on new technologies to empower the century old project of "creating good citizens" to their own benefit, and to the benefit of society as a whole?

We have seen the general meaning of "moral literacy" and concluded that the locution can be used to refer to basic elements that jointly work as a *conditio sine qua non* for the pursuing of a progressive project of cultural and social renovation.

This important conceptual work, which was published in the Journal of Educational Administration, had emerged from a reflection on the current schooling situation in the US. Objecting that Tuana's point of view is somehow dependent from a strictly national perspective, both in its assumptions and its prospected outcomes (the author moves in a context in which literacy is seen as "the best way to sustain the American quality and way of life"), and enumerating its limitations far exceeds the scope of this article, so we'll just point this out. When dealing with general ethics, I think, there should be no space for national limitation, or limitations of any sort. Common wealth and rights are never common or right enough, as we, the citizens of modern western democracies experience on a daily basis.

Sure, the fact that the author's expected recipient is the US Department of Education, which, she hoped, would include moral literacy in its next report on how to strengthen education for the twenty-first century (Tuana, 2007) might be adduced as a partially mitigating factor.

This said, Tuana's concept might indeed be used as a heuristic model, to widen the scope of, and possibly strengthen, civic education, which is as close as you get to moral literacy in formal contexts. In fact, what is civic education? According to the Stanford Encyclopedia of Philosophy, the locution refers, in its broadest sense, to all the processes that affect people's beliefs, commitments, capabilities, and actions as members or prospective members of communities (Crittenden & Levine, 2018). In this respect, the so-called 2030 Agenda, could (and should) surely be used as a civic education roadmap for all UN member countries.

One might object, here, that, as Martha Nussbaum correctly pointed out in *Not for Profit: Why Democracy Needs the Humanities* economic growth seems to be the main focus for education, both on an individual and a collective level (Nussbaum, 2012), therefore the contents of the Agenda seem to be a little off, and hard to be integrated in regular teaching programs.

Still, there is another question that seems even more compelling: as we have seen, what we may roughly call "moral knowledge", doesn't necessarily evolve into moral action; unfortunately, the same goes for civic education, which doesn't automatically lead to civic action.

Now, as any other school subject, civic education can be taught in many different forms, from traditional classroom-based learning to gamified approaches, and all the way down to experiential learning; still, its inclusion in the school curriculum should not mislead us: civic education is not a collection of positive notions to be "imparted", and due to the very nature of the subject, there should be no room for traditional chalk and talk lessons in civics. Not unlike moral literacy, having to deal with values and ethics, civics should be rather thought of as a potentially indefinite set of values whose comprehension, internalization and dare I say "re-creation" on the part of the students comes not as a result of direct impartment, but emerges from experience, open reflection and discussion.

How can we handle the specific needs of this subject?

Well, in this case, technology might come in our help: in fact, studies suggest that digital media can be used as means of moral education (Katsarov et al., 2019; Khoo, 2012). Video games in particular, due to their specific immersive nature, which is both visual and kinesthetic, thus allowing for a tech-empowered "learning by doing" (Iavarone, Scuotto & Aruta, 2023) experience, can be used to encourage ethical reflection in players (Pohl, 2008) presenting an open path for an experiential acquisition of moral values (Zakhro, 2018).

But can we really use video games to promote and empower moral literacy?

And, if so, how should we treat that?

Let's start from the beginning.

Twenty years ago, upon publication of Prensky's classic book *Digital Game-Based Learning* (Prensky, 2003), computer-based training was already very common in private companies, but not so common in schools. Since then, video games have gone a long way. Not only have they been used for digital training, but also for digital education purposes.

In fact, we now know that they have the potential to engage and motivate students and offer custom learning experiences while promoting long-term memory and providing useful practical experiences (Deubel, 2006); they help students set and work towards achievement of goals, grant immediate feedback, allow for progress tracking, thus offering positive reinforcement etc. (Griffiths, 2002); they have a positive impact on hand-eye coordination, facilitate the acquisition of logical, problem-solving skills, school subjects' contents and notions (Peterson, 2010; Gee, 2005; Johnson, 2006).

We might say that, despite any preoccupation-risks and opportunities in this field are often tightly interlaced: we know that the use of social media, and technology in general, plays a prominent role in young people's development, but we also know that inappropriate contents or over-exposure might have a negative impact on health, moral orientation, thought and judgement (Ardi, 2018) – general benefits of digital game-based learning are widely recognized; still, I think, their particular relation with civic education and moral literacy has not been carefully investigated.

In fact, if we think about "classic" serious games, games whose final objective is the acquisition of a certain ability or a predetermined set of working or cultural abilities, often to be achieved through repetition, we are somehow falling back in the field of imparted notions. This is pretty much the case with maths-literacy or reading-literacy related video games. This kind of video games, based on repetition, do not promote philosophical reflection, therefore they would be useless to confront with moral issues and values.

So, what kind of game are we thinking about?

To effectively address this kind of problems, we should rely on another kind of game through which the player finds himself entangled in a dialogue of some kind.

Does this really need to be a "serious" moral game?

Not necessarily: in fact, though the idea of a "prosocial use" of video games has generated a noteworthy development in the game market (Christen & Katsarov, 2018), plenty of regular off the shelf video games had been soliciting in-game reflection way before this trend even emerged. It doesn't even necessarily have to follow a narrative structure. In fact, as Sicart comments, ethical gameplay, a caesura in the act of playing, happens whenever the player is not applying social or strategic thinking to engage with the game, choosing a specific kind of ethical thinking called "ludic phronesis" (Sicart, 2013).

3. Results

When we speak about gamer-videogame dialogue, we are referring to a truly philosophic relation. In fact, philosophy can be defined as a practice which interrogates and reconstructs the ideas and beliefs that underlie and/or follow from our epistemological, ontological, ethical, aesthetic judgments – and thereby our scientific and metaphysical systems, as well as the meanings and value we ascribe not just to our lives as wholes but also to our practical and morally significant act (Kennedy, 2004). Therefore,

a game which urges a player to rethink his/her own moral values must have established a philosophical relation with its player, namely a maieutic relation.

When we talk of maieutics we usually refer to either a dialogic method that can lead a subject to find and/or understand the truth, or a pedagogic approach that puts the learner at the center, treating him as an active subject in the construction of knowledge (Nussbaum, 2012), not just as a "receiver" or a container that needs to be filled up.

Well, the way I see it, this gamer-videogame relation we are talking about is maieutic from both points of view; in fact: (1) the video game acts as a facilitator, or a midwife, to put it socratically, urging players to think or rethink their moral positions, thus helping them to give birth to their own moral views; (2) the players are active subjects in the construction of their own moral knowledge.

Establishing this connection, we have finally stepped into the field of digital-driven experiential moral self-education.

What's so interesting about it?

This maieutic relation apparently allows for the stimulation of all three aspects of moral literacy: the constant confrontation with ethically relevant situations can help develop ethics sensitivity and ethical reasoning skills by contrasting moral blindness – a sort of inability that prevents us from seeing or recognizing a moral issue, letting us steer clear from moral decision-making and adoption of a moral behavior (Rest, 1986).

When it comes to moral imagination, the effect of video games seems even more interesting: in fact, gaming allows the players (young players? Students?) to experience the consequences of their actions, and I guess that we'd rather have them try for themselves and be mistaken in a virtual world, than just let them grope in the dark, leaving them unprepared to face unexpected (and unexplored) moral dilemmas in the real world.

Would this possibility result in a long-term effect on player's real life moral behavior?

Hopefully.

All's well that ends well, so?

Not really.

In fact, in my retelling of gaming as a maieutic process, I have left out a particular element…

Socrates.

4. Conclusions

"The triumph of my art is in thoroughly examining whether the thought which the mind of the young man brings forth is a false idol or a noble and true birth," reads Plato's *Theaetetus*, establishing Socrates as a guarantee for the nobleness and the truth of the "young men's" acquisitions. This considered, self- education should not only be integrated and promoted in formal contexts as well as in informal contexts – we know that self-education is not exclusive to informal learning contexts; in fact it's been considered as a key element of formal learning processes too, allowing students to develop and strengthen metacognition and soft skills by moving at their own individual pace (Zakro, 2020) – but should also be anticipated and closed by open discussion, directed by the teacher acting both as a facilitator and a guarantor for the moral reflection elicited by the gameplay. In this respect, informal gameplay too, could and should be used as a starting point for further discussion and reflection.

Still, a series of compelling questions remains open. In fact, taking back on Stanford's Encyclopedia definition, civic education "may not be beneficial: sometimes people are civically educated in ways that disempower them or impart harmful values and goals" (Crittenden & Levine, 2018). As Nussbaum remarks, the student's freedom of mind is always in danger "if what is wanted is a group of technically trained obedient workers to carry out the plans of elites who are aiming at foreign investment and technological development" (Nussbaum, 2012). Finally, the same concern seems to sit in the background of Tuana's reflection: "Education of this sort", she writes, again, speaking of moral

literacy, "provides students the opportunity to develop the skills they need to be ethical professionals and responsible citizens of a just society" (Tuana, 2007).

Unfortunately, we have no guarantee of living in a permanently "just" society, and I guess that even if we want to assume we do currently live in a "just" society (which might be more or less the case for some of us, at least), it is our clear responsibility as teachers, educators and citizens, to keep a very close eye on social transformations, so to anticipate and foresee potential negative evolutions.

Should video games even be used for moral literacy, then?

Sure, but only if we are ready to confront, take responsibility and somehow supervise the reflection.

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Pilot study on the adoption by teachers of a video game for learning Italian grammar

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Abstract

Despite the strong interest of teachers in the use of the game, especially the digital one, however there are several critical issues attributable to the teaching role, which make its adoption in teaching complex: (1) teachers have only limited time to prepare & play a game-based learning game; (2) teachers feel uncertain about using games in class due to their limited knowledge of (digital) games; (3) teachers find it difficult to identify appropriate assessments; (4) teachers find it difficult to integrate and choose video games effectively & efficiently into their classroom; (5) students find it difficult to connect knowledge acquired in a game & learning in the real world.

However, multiple difficulties often make it difficult to learn the basics of the Italian language. The video game "Ross & the Sgrammanebbia" is the first grammar didactic video game that has a correspondence between the levels & the topics of the textbook & offers the teacher a valid help to organize a didactic path studied on the curricular skills.

In order to define the guidelines useful for an effective introduction of the game in the classroom, participatory qualitative-quantitative research was prepared on the methods that a small group of teachers put in place to design the training activity with the video game. The goal is: (1) training planning skills for the use of the game: definition of learning goals, assessment methods & identified teaching strategies; (2) the pedagogical activities put in place to facilitate the introduction of the game in the classroom.

Keywords: Lower Secondary School, Learning Italian Grammar, Videogame, Use of the Game by the Teacher.

1. Introduction

In recent years, interest in games within educational processes has grown exponentially, even though the integration of games into teaching is still an unexplored area of study and has received limited attention in the field of research. (Girard et al., 2013; Hanghøj & Brund, 2011; Meyer & Sørensen, 2011; Tzuo et al, 2012; Kangas et al., 2017). As the Danish researchers Hanghøj and Brund (2011, p. 125) underlined, although research on the educational use of games now has a history of over fifty years, the effects on learning have mainly been investigated or attempts have been made to "identify the intrinsic learning potential of particular game projects" (*ibid*.), focusing essentially on individual projects and classroom experiments in which the game was investigated in students, focusing the research mainly on teacher-student interaction (e.g., Tzuo et al., 2012) or on teacher facilitation during the game (Hanghøj & Brund, 2011).

This research focus has in fact neglected to investigate the pedagogical dimensions of the teacher, such as the design solutions or teaching strategies that the teacher adopts when teaching with games. These gaps would seem to highlight a lack of reflection on the pedagogy of play in educational processes and the many observations on the importance and potential of play in training activities were not followed by broader considerations on the teacher's activities, as well as on the teaching practices and processes before, during and after the game, on the ways in which to design the activities supported and enhanced by the game, on the roles that students and teachers assume within the learning activities (Kangas et al., 2017).

2. Theoretical premises

Sociocultural theories have provided the appropriate framework for introducing gaming into educational environments (e.g., Egenfeldt-Nielsen, 2007; Kangas, 2010b; Squire & Jan, 2007), as, taking into consideration the social contexts and cultural aspects of games, highlight contextual and pedagogical issues, emphasize that learning occurs in interaction and interpret it as a genuine interdependence between human action, socially organized activities and technologies (Ludvigsen et al., 2010): the game itself is not sufficient to create the learning environment within the classroom context, but a dynamic relationship between teaching and learning is always necessary and is linked to the gaming experience and planning competence of the teacher or trainer.

The increase in training activities that involve the use of games in its various manifestations has not led to either a massive adoption of the use of games within schools nor, above all, an increase in the competence of teachers in the use of games for learning. Teaching: Knowledge about a game includes identifying the technical features, pedagogical stance, and content embedded within a game (Foster et al., 2011).

Research has found that in-service teachers report feeling inadequately prepared to incorporate play into the curriculum (Allsop et al., 2013; Takeuchi & Vaala, 2014); in particular, factors that influence teachers' use of games broadly include their inability to:

- *game analysis*: the main purpose for developing knowledge of a particular game or set of games is to enable teachers to make decisions about whether to use them and how to implement games in each context (e.g., curricular objectives, target group, available resources) (Koh et al, 2011). In the absence of deep familiarity with the game, in addition to feeling a low perceived value of the educational opportunities offered by the game (Kenny & Gunter, 2011), teachers' ability to design and create games is undermined (Egenfeldt-Nielsen, 2004). Gaming experiences, direct (e.g., playing firsthand) and indirect (e.g., observing someone playing), can allow the teacher to evaluate its potential and limits (Aarseth, 2003; Foster et al., 2011). For effective inclusion of games in the classroom, researchers emphasize as a prerequisite that the teacher is competent in playing the game she will want to use (Baek, 2008; Hirumi, 2010; Ketelhut & Schifter, 2011). According to Hanghøj (2011; 2013), to implement meaningful teaching with games, the dynamic interaction between different forms of practical knowledge (specialist or curricular, pedagogical or "scholastic", every day or non-specialized and of the specific scenario of game), which differ depending on the games, teachers, and students. The formative use of game scenarios always requires dynamic "translations" (interactions) across the four knowledge practices (Andreoletti & Tinterri, 2023).
- *integration of games*: knowledge of the game alone does not automatically make the teacher competent in teaching with games, even when texts about the game are available or the teacher has years of experience teaching (Eastwood & Sadler, 2013; Magnussen, 2007). The goal of game integration is to combine knowledge of game characteristics with teachers' teaching and curricular experience (Ritzhaupt et al., 2010; Rice, 2007). This primarily involves the teacher adopting multiple pedagogical roles to facilitate students intentionally connecting their experiences within the game to those of the curriculum. When the teacher becomes capable of reconfiguring his position in response to the events of the game, the needs of the students in the classroom and the demands of the curriculum, then he will be able to encourage their reflection, provide feedback and quickly adapt the training interventions to favor their learning (Hanghøj & Brund, 2011).

In the international scientific literature, various factors have been identified that affect the introduction of games in training activities. Those attributable to the teacher are (Hanghøj, 2013):

1. poor/absent gaming culture (game literacy);
2. presence of prejudices on the role and meaning of gaming in society and culture;
3. difficulty in translating curricular learning objectives into recreational activities and/or games;
4. difficulty identifying and selecting the most appropriate game and integrating it effectively and efficiently within the training activity;
5. difficulty in identifying the appropriate assessment methods for learning goals and recreational objectives.

Alongside the teacher, students, school, family, and territory should be considered (Andreoletti & Tinterri, 2023), which for the purpose of this article will not be explored in depth.

2.1 The teacher

The research by Kangas et al. (2017) highlights how important the active role of the teacher is when integrating games intended for learning into teaching: depending on the learning objectives and the game context, the teacher's role varies from leader to facilitator, from organizer and planner of training activities, guide and tutor during gaming sessions. Teacher activities should be considered in a broad perspective, consisting not only of teacher activities before, during, and after the game, but also various contextual and related factors, including physical and social resources.

2.1.1 The teacher's activities

The qualitative analysis of the literature on the formative use of the game in the classroom (Kangas et al., 2017) classified the teacher's pedagogical activities within a five-phase process:

1. *planning*: represents the pre-interaction in teaching (Kansanen, 1999) and is implemented before the actual game session; it is at this moment that the teacher (Barab et al., 2012; Chee & Tan, 2012; Kangas, 2010) defines the purposes (why to use the game), the methods (how and when to use it) and the teaching (how knowledge is shared, created and validated among the students) of the game;
2. *orientation*: the teacher presents the game session with a reflection that provides basic information on the purposes of the game (Barab et al., 2007, 2010) and guides the students to familiarize themselves with the topics, introducing the game, the process of play and the learning goals that the game seeks to achieve (Chee & Tan, 2012);
3. *game*: the teacher takes on different roles: he is a tutor and active guide who supports and supports students in their learning during the activity with the game (Barab et al., 2010; Chee, Tan, 2012; Watson et al., 2011), is a director (Hanghøj & Brund, 2011) who tries to guide their attention on the content aspects they should learn by playing (Barab et al., 2010; Wang & Hung, 2010; Watson et al., 2011), is a facilitator and organizer who promotes the development of students' identity and their epistemological beliefs related to the discipline (Chee & Tan, 2012). In some cases, the teacher interrupts the gameplay to discuss the issues and problems, defined by Watson et al. (2011) as "teachable moments", which students face in game situations (Arnab et al., 2013; Watson et al., 2011);
4. *elaboration*: post-gameplay activities aim to clarify many misinterpretations and, ultimately, lead students to a more correct interpretation of the problem (Barab et al., 2007); the analysis and reflection on the content of the game at the end of the gaming activity allows the connection between the experiences lived in the game (gameplay) with the curriculum and learning goals; post-game activities can include writing essays (Barab et al., 2012; Ifenthaler et al., 2012; Silseth, 2012), using concept maps (Johnson et al., 2009), thinking aloud (Ericsson & Simon, 1993), creating presentations or videos with significant parts of the game, holding a joint discussion on topics related to the game (Arnab et al., 2013);
5. *reflection*: understood as a moment of "teacher learning", it aims to promote and improve one's teaching practices (Wang & Hung, 2010).

3. Methods

3.1 Participants

Wanting to analyze the use of video games within classroom activities, we decided to identify a small number of classes in which we could directly observe how:

- on the one hand, the teacher proposed the game, connected it with the training objectives, organized and managed the classroom activity, possibly prepared supplementary activities and evaluated the training activity;

- on the other hand, the students were involved in the training activity integrated with the game, how they played the game, what their attitudes were towards a video game expressly aimed at learning about the game.

To define the sample, it was initially decided to adopt a non-probability sampling (Creswell, 2013) with reasoned choice (Ferrarotti, 2006), identifying an appropriately selected group of classes in the first year of lower secondary school, in which the Italian teachers had adopted the textbook combined with the video game. This choice was dictated by the following reasons:

- reduce possible technological problems caused by the use of the video game connected with an authentication process;
- have a disciplinary resource (book) fully aligned with the contents present in the video game.

The identification and involvement of teachers should have gone through the agents (those who offer textbooks to teachers) of the publishing house, as they have a direct relationship with the individual teachers. However, in December 2022, after more than two months of waiting, having understood that the solution adopted had not produced any significant results, we opted for a process of disseminating the project through other channels, searching for the subjects to be involved within of teachers' organizations. This second phase required another two months of searching for potential participants and initially allowed 14 teachers to be identified, which was subsequently reduced to 10.

The sample consists of:

- 10 female teachers, holders of Italian teaching in first grade secondary classes;
- 10 classes involved belonging to 6 different schools, 2 in the urban area of the city of Turin (Piedmont region) and 4 in the urban area of the city of Milan (Lombardy region);
- 2 classes belong to 1 private school in the city of Milan; the other 8 classes belong to 5 State Schools in the cities of Milan and Turin;
- 185 students involved (92 boys and 93 girls) aged between 11 and 12.

3.2 Methodology

Wanting to investigate the ways in which teachers:

- they appropriate the environment-resource-tool such as a video game;
- plan the training activity integrated with the game;
- implement it within their teaching activities;
- align the disciplinary contents of the curriculum with the objectives present in the game;
- manage educational activities integrated with games in the classroom;
- integrate the "in game" activity with further "around game" training actions;
- evaluate the activity as a whole;

we chose to adopt an integrated approach of qualitative-quantitative research, selecting the most suitable one based on the objectives that the research sets in the different phases of the project (Cresswell et al., 2011; Cresswell, 2014).

Phase 1 - Teacher's relationship with games and video games (second half of March 2023)

The first step, started after the identification of the teachers which took place between January and February 2023, concerned the analysis of the sample of teachers selected for the project and used a questionnaire with structured and semi-structured questions administered using the Google Form platform (CAWI technique). The questions present aimed to investigate the following aspects in relation to the game/video game:

- use of the game/video game by the teacher not for training purposes;
- effectiveness of the game/video game for achieving training goals;
- previous experience of use within the training activity;
- possible logistical, management, pedagogical and didactic critical issues that can be encountered in the use of games/video games in training activities.

Phase 2 - Planning of the teacher training activity (end of March 2023 - second ten days of April 2023)

The second step aimed to analyze the level of mastery in training planning by teachers using two separate tools:

1. compilation of a questionnaire with structured and semi-structured questions administered using the Google Form platform (CAWI technique);
2. return of the planning sheet of the training activity supported by the game where the aims of the training intervention, the training objectives (transversal and curricular), the game objectives, the evaluation tools and methods, the division into phases were described of the intervention.

Phase 3 - Observation of the training activity in the classroom (end of April 2023 - first ten days of May 2023)

The third step focused on the ways in which the teacher manages the training activity in the classroom, uses and mediates the video game with the students during the lesson, the pedagogical activities and the roles he implements, any further "around game" activities designed to integrate the training action, tools and evaluation methods. The classroom experiments were planned to have a single meeting in the classroom, with a variable duration based on availability and the design of the intervention hypothesized by the teachers. The observation took into account not only the time dedicated to the game, but also the overall lesson time:

- lesson time: minimum 42 minutes, maximum 88;
- time dedicated to the game: minimum 18 minutes, maximum 64.

The analysis of the times actually dedicated to the game compared to the time dedicated to the entire teaching activity, highlights how the game, on one extreme, can be reserved for a minimum portion of the overall activity of the lesson (18 minutes out of 85 overall, equal to 21% of the time) and, on the other extreme, occupy the entire lesson activity (42 minutes, equal to 100% of the time).

The activity that the teacher implements is complex and articulated, as it involves personal skills and attitudes, knowledge and application of diversified teaching strategies, and long experience gained "in the field". To analyze the "volatile" dimensions of teachers, such as speech, attitudes etc., which are difficult to map using an instrument such as the questionnaire, it was necessary to implement an ethnographic approach (Corbetta, 2003; Babbie, 2010) given by participant observation during the classroom lesson in which the following dimensions were analyzed:

1. description of the physical context: spaces, furnishings, resources, noise etc.;
2. description of the social context: group members, relationships and interaction between members, categories of interaction in relation to the use of the video game within the teaching activity;
3. interpretations of social subjects (teacher/students): for example, conversations, which bring out individual personal views on a given situation.

To do this, a special grid has been prepared with the criteria and indicators to be observed:

- physical setting and technological equipment of the classroom;
- pedagogical activity of the teacher;
- roles of the teacher in managing the game and the students;
- game scenarios.

Phase 4 - Analysis of the outcomes of the classroom training activity (first-second ten days of May 2023)

The fourth and final step, placed in the days immediately following the classroom observation, was structured with a qualitative-quantitative approach, based on a questionnaire and a semi-structured interview administered in two consecutive moments:

1. the questionnaire, administered to teachers using the Google Form platform (CAWI technique), had the objective of evaluating the training activity carried out and contained structured and semi-structured questions:
    - critical issues that emerged during the activity;

- achievement of set goals;
- definition of pedagogical activities and teacher roles;
- analysis of the game scenarios implemented;
- perception of the impact of the game on the class;
- evaluation of the effectiveness of the video game;
- identification of the elements to be modified at the teaching level and at the level of resources/tools;

2. following the administration of the questionnaire, a semi-structured interview lasting approximately 60 minutes was organized, starting from the analysis of all the elements collected (questionnaires, planning and observation):
   - analysis of the methods adopted by the individual teacher to introduce the video game into the training activity (teacher's relationship with the gaming activity and the video game in the teaching activity; organization of the class; technologies used; timing of the activity and game; inclusion of further "around game" activities; roles adopted by the teacher, critical issues in content management);
   - identification of the most suitable methods and tools to help the teacher in the appropriation and introduction of the game in the training activity (preparation of textual guides, technical and methodological videos/podcasts, targeted training activities etc.).

4. Results

Given the critical issues highlighted, the objective of the research was to:

- understand what the possible obstacles were to the introduction of a video game specifically designed for teaching and learning the elements of the grammar of the Italian language present in the Curriculum for the first class of lower secondary school;
- identify the most effective strategies to facilitate its appropriation by the teacher and its effective introduction within the classroom teaching activity.

This article aims to give an initial response to these critical issues by taking into consideration the following two aspects.

4.1 Lack of familiarity with the game (game literacy)

The sample of teachers present in the research is in line with what is indicated by the literature relating to Game Literacy (Kenny & Gunter, 2011): as only three of them (N = 10) use games in everyday life outside of their professional activity. The analysis of the titles indicated highlights "pastime" games and video games present on the personal smartphone of a "casual" genre. Four teachers indicate that they have had previous experience of introducing the game/video game into the classroom. The analysis of the types of games highlights a "low" and "simplified" use of the game, as the titles indicated can be traced back to behaviorist online solutions (Egenfeldt-Nielsen, 2007) or to knowledge evaluation tools "masked" with gamified mechanics (Kahoot!, Mentimeter etc.).

Research indicates that teachers, who use games little in their daily lives, find it difficult *to perceive the value of the educational opportunities offered by games and to take advantage of the potential expressed by games*. As indicated above, the causes of this poor/absent gaming experience are multiple and, mainly, attributable to ideological reasons on the role and meaning of gaming in society and culture (Hanghøj, 2013).

The consequences of little gaming practice are more evident when comparing what emerges from the planning produced by the teacher, from what was observed during the activity and from the evaluation given by the teacher to the activity carried out in class in relation to the possible scenarios that the video game "Ross and the Sgrammanebbia" can be used in teaching activities (Figure 1).

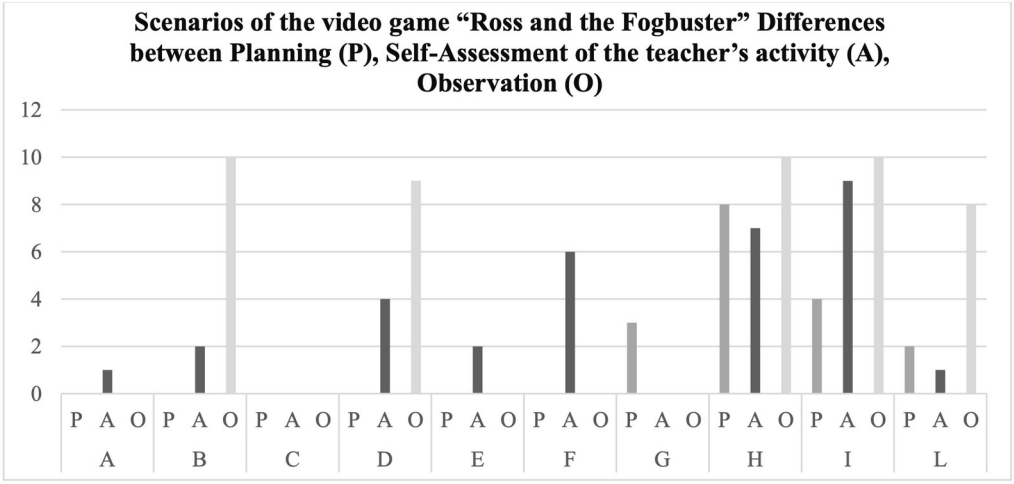

Figure 1 - Comparison of the video game scenarios between Planning made by the teacher (P), Self-Assessment by the teacher of the activity implemented (A), External observation on the activity implemented (O).
Key to symbols relating to the scenarios: (A) Self-expression, (B) Content systems, (C) Simulation and manipulation of systems, (D) Stimulus for reflection, (E) Introduction (gateway) of technologies, (F) Stimulus for self-reflection, (G) Examples of points of view, (H) Exercise space, (I) Socialization moment, (L) Evaluation tool.

Without consolidated personal experience of recreational activity and the use of games that cannot be traced back to behaviorist learning models (Gee, 2003; Egenfeldt-Nielsen, 2007; Andreoletti, 2023), with the sole experimentation of the game that will using the teacher makes it very difficult to identify all the possible scenarios that the game could take on during the teaching activity and will tend to bring the purposes of the game back into consolidated and socially shared practices (exercise, socialization). The analysis of the designs highlights how teachers indicate only 4 possible scenarios: exercise space (8), socialization moment (4), examples of points of view (3) and evaluation tool (2).

The self-assessment carried out at the end of the classroom activity also investigated the types of scenarios attributed to the video game and highlights how the teachers rethought the purposes that the game served during the lesson. The number of scenarios has increased, not only consolidating those previously identified in the planning [socialization moment (9), exercise space (7), evaluation tool (1)] but also identifying different purposes strictly connected with the disciplinary aspects [stimulus for self-reflection (6), reflection stimulus (4), content systems (2)].

It was, however, the observation moment in the classroom that highlighted how the teacher managed the game in the classroom by also attributing to it scenarios not previously identified in the planning or considered in the self-evaluation phase. The observation identified the use of scenarios more linked to disciplinary aspects [content systems (10), exercise space (10), reflection stimulus (9), evaluation tool (8)) and not only to motivational ones /social (moment of socialization (10)].

4.2 Difficulty in translating learning goals with the playful objectives present in the game

The reading highlights that the teacher's little practice with games both on a personal and professional level *does not facilitate the definition of disciplinary goals in relation to recreational objectives and vice versa, it makes it difficult to define the methods of evaluating educational goals and playful objectives and limits playful activity to the motivational dimension, to a mere exercise of the contents, to a moment of socialization*.

In relation to this aspect, it emerged those nine teachers (N = 10) attribute only transversal functions to the game: they mainly indicate motivational aspects for the effectiveness of the game in learning and the achievement of curricular training goals, without however providing any scientific foundation that justifies their beliefs. In line with this aspect, the three main purposes for introducing the game/video game into the classroom identified by the teachers are *motivational* (fostering interest in the topic), social (learning together with others) and *practical* (consolidating contents already learned through the repetition). This aspect is highlighted more when the teacher indicates the possible goals of the activity: it emerged that they would use the game/video game mainly to achieve transversal skills (8

teachers *Personal, social competence and ability to learn to learn*, 5 *Functional alphabetic competence* and 5 *Digital competence*), while the goals indicated in the National Indications for the "Italian language" curriculum are indicated by only five teachers.

From the questionnaire proposed before the activity, it can be seen that the major critical issues lie in specific phases of the activity design:

- solutions adopted to connect the disciplinary goals with the objectives of the game: 3 teachers explain the fact that they don't know how to do it, 2 teachers indicate the motivational and social aspects as a solution for the connection, 2 teachers propose indicate vague and generic methods and only 2 indicate methods that connect the narrative and content aspects of the game with the educational objectives. In the questionnaire proposed following the activity in which the game was presented, only one teacher highlighted this aspect as a critical issue.
- methods with which to evaluate the results of the video game action within the training activity: 3 teachers explain the fact that they do not know how to do it, 1 teacher indicates a generic solution without delving into the methods, 3 will use self-evaluation grids for the students and the teacher's observation of their attitude, 2 teachers indicate specific methods of evaluation (written assessment and creation of a product on the contents of the activity). This criticality is present to the teachers and is indicated by 50% of the sample in the questionnaire following the activity.

From the analysis of the plans produced by the teachers, carried out using an evaluation grid (scale from 0 = absent to 5 = well described) relating to the description and evaluation of the disciplinary goals, the play objectives, the products and the phases of the activity, we shows that (Figure 2):

1. generally, teachers were able to define and evaluate the "classical" aspects of teaching:
   - good/excellent (Q1 = 4) description of the training objectives;
   - good/excellent (Q1 = 4) description of disciplinary goals and objectives;
   - good/excellent (Q1 = 4) definition of the activity phases;
   - fair/good (Q1 = 3; Q3 = 4.5) definition of the methods for evaluating disciplinary goals and objectives;
2. champion highlighted difficulties when he had to define the aspects connected with the game:
   - low/excellent (Min = 2; Q1 = 2.75; Q3 = 5) description of the recreational objectives;
   - absent/fair (Q1 = 0; μe = 2; Q3 = 3) definition of the tools for evaluating the playful objectives;
3. the sample was very heterogeneous when they had to indicate the products of the training activity:
   - absent/good (Q1 = 0; μe = 3.5; Q3 = 4) in the indication of the products of the activity;
   - absent/excellent (Q1 = 0; μe = 4; Q3 = 5) in indicating the methods of evaluating the products of the activity.

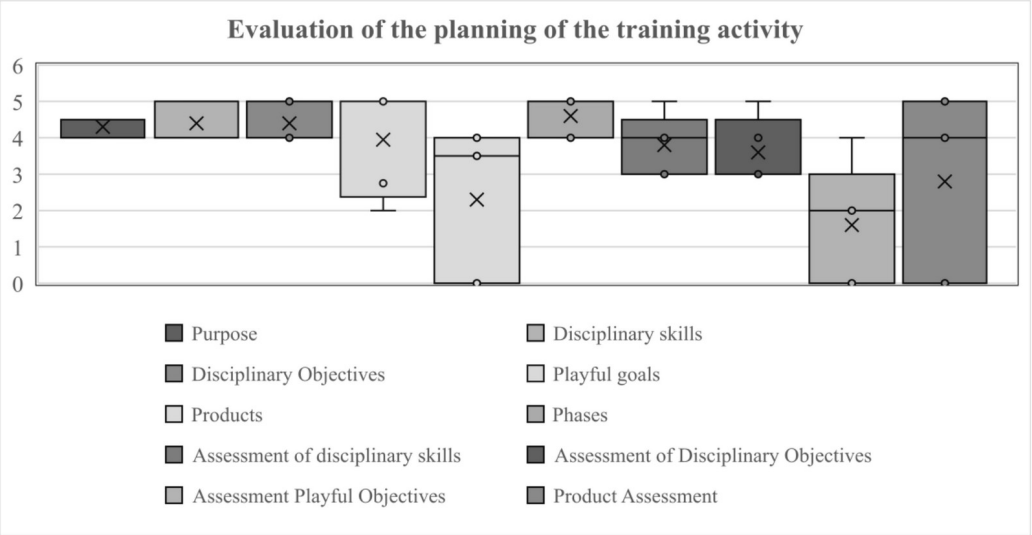

Figure 2 - Evaluation of the training activity design sheet.

The teachers themselves are aware of their shortcomings, as five teachers indicate as the main critical issues the *lack of competence in the use of games in general and four the lack of knowledge of games/video games suitable for teaching activities*. One of the possible reasons is indicated by 4 teachers as the lack of adequate technologies for the use of video games. From the analysis of the answers given, it is highlighted that no teacher indicated among the possible critical issues the *difficulty in introducing games/video games within the programming* and the *Difficulty in evaluating the gaming objectives*.

In the training activity evaluation questionnaire proposed to teachers in Phase 4, following the classroom activity, it is highlighted how the lack of familiarity with games in general makes it complex to be able to respond to the fundamental aspects of the intervention design formative [knowing how to evaluate learning (5), connect the formative objectives with the objectives present in the game (3)] and to define the pedagogical roles that he could have assumed to facilitate the learning process [identify the roles that, as a teacher, he would have able to implement before, during and after the activity with the game (3)] (Figure 3).

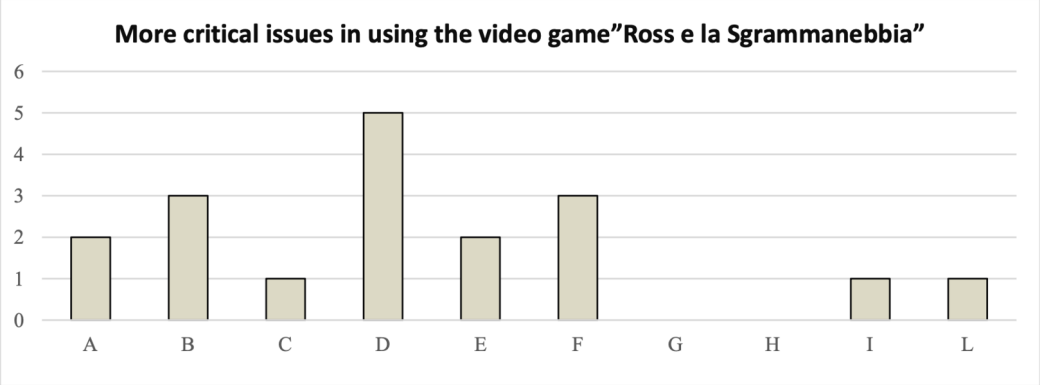

Figure 3 - Major critical issues highlighted by teachers in the questionnaire preceding the classroom activity. Key to symbols relating to the critical issues: (A) Navigating the game, (B) Planning the training activity as a whole, (C) Connecting the training objectives with the objectives present in the game, (D) Evaluating learning, (E) Hypothesizing the possible uses of the game in the classroom, (F) Identify the roles that, as a teacher, he could have implemented before, during and after the activity with the game, (G) Present the game to his students, (H) Manage the activity before using the game (days before the gaming session), (I) Manage the gaming activity (on the day the gaming activity took place, (L) Manage the activity after the game use of the game (days following the game session).

5. Conclusions

The use of games in Italian schools and educational contexts is still very limited (Allsop & Jessel, 2015; Loperfido et al., 2019) and directed towards a function of pure entertainment or exercise (Nicholson, 2011) rather than as real learning environment. The reasons for this discrepancy are, at least in part, due to skepticism regarding the effectiveness of video games in promoting learning. Many teachers seem to be stuck in a "transition phase", as the interest in a resource, which at least on paper is extremely effective, hardly translates into adequate learning episodes when moving around the classroom, due to the virtual lack of personal experience of the teacher's gaming culture, from the very limited, if not absent, training practice with games. Teachers report that they do not feel adequately prepared to include games in the curriculum (Allsop et al., 2013; Takeuchi & Vaala, 2014), as they find it difficult to identify games that are aligned with learning objectives (Molin, 2017) and due to indications on operating methods found online or obtained through training courses that are often unsuitable and qualitatively questionable.

Starting from these considerations, the teachers interviewed in the final phase of the research highlighted two main operational trajectories to facilitate the introduction of the game internally into teaching practices:

- *laboratory-based training activities* in which the teacher can:
  - *be accompanied in the planning of training courses* in which the mechanisms with which to translate and align disciplinary goals with the objectives of the game and vice versa are understood;
  - *effectively manipulate the games*, hypothesize training paths in which they can be introduced, discuss directly with other teachers on the experiences implemented;
- *game presentations*, also via the web, in which other teachers, game-based learning experts and researchers show the different possibilities with which the game can be introduced within the training activity.

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Digital games to promote transformative emotions and support moral development

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Abstract

Morality is a fundamental topic for education. Psycho-educational interventions employ digital technologies to promote moral competence and prosocial behavior. Interactive virtual environments and especially serious games and video games could feature various stimuli that make moral intuitions salient and allow players to immerse within compelling interactive narratives where they could perform moral choices, exercise social abilities such as empathy and reflect on the consequences of their actions. Furthermore, another interesting feature of virtual reality and video games is the possibility to elicit transformative emotions such as awe and elevation, that are proven to promote the motivation to behave prosocially. After the literature review, two commercial video games are briefly described and analyzed in terms of their potentialities for transformative emotions and the consequential promotion of morality. In the last part of the contribution, we list some guidelines for the development and utilization of gaming technologies to elicit transformative emotions and support moral competence and prosocial behavior.

Keywords: Morality, Videogames, Media, Transformative, Emotions.

1. Introduction

Morality is a fundamental topic for education. Developing a functional moral compass would prevent youngsters to engage in risky behaviors or commit immoral actions that could affect their future development (Milani et al., 2018; Kuther & Higgins-D'Alessandro, 2000). The research shows that moral development is influenced by individual differences (e.g., personality characteristics such as agreeableness or the dark triad; social abilities such as empathy) (Wu et al., 2020; Djeriouat & Tremoliere, 2014).

At the same time, besides personal morality, people (especially adolescents) could be driven to immoral behaviors by context, social relationships and group belonging (i.e., the Lucifer effect; social influence by peers) (Zimbardo, 2011). However, the research from the last decades has shown that just-informing or teaching moral values does not guarantee that morality develops in a desirable way (Suhor & Suhor, 1992). Media psychology has demonstrated that it is possible to promote moral development by showing examples of moral behavior through media such as books, movies, even immersive virtual reality (Cain, 2005; Frentzel-Beyme & Krämer, 2020; Shim, 2023; Vandenplas-Holper, 1990). However new media do not only provide examples of virtue or moral experience but also allow individuals to first-person experience moral dilemma situations in which they could make decisions and deal with consequences (Murphy & Zagal, 2011; Sofia & Klimenko, 2019).

This relates to interactive virtual environments and video games. Indeed, it is possible to prefigure gamified digital tools and serious games for the promotion of moral behavior and that could be used in educational contexts.

Gamification can be defined as the use of game design elements in non-gaming contexts, while serious games are specific games designed for learning certain skills or knowledge or even changing behavior (Johnson et al., 2016; Mulcahy et al., 2021). Through serious games and gamification processes it is possible to provide knowledge and information but also immerse subjects in situations in which they must make decisions through simulation mechanisms (Cheng & Wang, 2011). In this sense,

gamification mechanisms and serious games can be used for educational purposes (Wouters & van Oostendorp, 2017) encouraging moral development (Jin et al., 2017) or the implementation of empathy and prosocial behaviors (Ferreira et al., 2021; Schrier, 2019). There are serious games created specifically to promote the development of moral skills from interpreting morally salient situations to making decisions in such contexts (Lloyd & van de Poel, 2008; Schrier, 2019).

However, for games to become an effective tool for moral development and "moral laboratories" (Murphy & Zagal, 2011) that truly foster reflection on moral values and choices, the experience should be expanded over time (i.e., more instances gameplay) and connected to compelling narratives and characters. This is why some studies have highlighted that commercial video games can be more effective than serious games or games developed "ad-hoc" by professional educators. Commercial video games allow players to experience the consequences of moral choices can evoke emotions and support the development of relationships with characters (Schrier, 2015; Steinkeuhler & Simkins, 2008). For example, a review on video games for developing a socio-emotional skill such as emotion regulation showed that prolonged "in the wild" experience with commercial video games was more effective than limited instances of play with ad-hoc products (Villani et al., 2018). Consistently, research shows that more frequent video game players may be more responsive to video game-related stimuli used to improve moral competence (Sofia & Klimenko, 2019).

During the experience of playing a video game, individuals find themselves reflecting on the values or moral themes present in the game, feeling a sense of guilt even when they carry out immoral actions in virtual environments (Ahn, Grizzard & Lee, 2021).). Furthermore, experiences carried out in the virtual environment of video games can also have a strong impact on behavior in the real world, especially when experiences in the virtual world reflect choices of a voluntary nature and not imposed by the game context (Iten, 2018). Video games, in fact, stimulate prosocial or antisocial actions depending on the type of game. For example, Happ et al. (2013) discovered that playing a morally good character (Superman) in the video game Mortal Kombat vs. DC Universe led to an increase in subsequent prosocial behavior compared to playing a morally bad character (The Joker). Similarly, Gitter and colleagues (2013) found that the same violent action performed in a video game promoted prosocial or antisocial attitudes depending on the narrative framing and motivation provided. Moreover, the literature has shown that gamers tend to have systematic preferences regarding the choice of characters to play in video games on a moral level (i.e., where this is possible, towards "good" or "bad" characters) and these preferences associate with personality characteristics as well as social skills (empathy) (Triberti et al., 2015).

Several authors have demonstrated that to promote moral behavior through immersion in digital and gaming environments, it is important that specific stimuli that support the implementation of moral behaviors are present. For example, Le Maux & Necker (2023) showed the effect of honesty nudges in online games to reduce dishonesty while Tanner and colleagues (2022) have used feedback (prosocial nudges) and metacognitive suggestions help to improve moral sensitivity in video games. Moreover, Grasse and colleagues (2021) have verified that even playing a single short session of a video game that uses narrative role-playing and interactive choices can improve moral reasoning skills.

According to the model of intuitive morality and examples (MIME) the accessibility of moral intuitions is influenced using media (Tamborini, 2013; Tamborini et al., 2018). The MIME is partially based on the moral foundation's theory (MFT; Haidt & Joseph, 2007) that already maintained that moral intuitions are present in all human beings, but the strength and accessibility of any intuition varies among individuals depending on biological and environmental variables. According to Haidt, moral intuitions are *the result of an innate ability to access moral values considered substantially universal, such as fairness and loyalty* (Social Intuitionist Model, SIM) (Haidt & Joseph, 2004, 2008), while moral reasoning results from a post-hoc rationalization of these intuitions. In other words, one has a moral intuition while a criterium for evaluating right or wrong emerges in their awareness autonomously, not as the result of conscious reasoning.

Moral behavior in the game can be influenced both by innate factors and by stimuli present in the game, which would help making moral intuitions salient and improve their ability to guide here-and-now behavior and choices. Regarding the use of media and video games, subjects tend to behave in a manner consistent with the most deep-rooted and accessible moral intuitions (Joeckel et al., 2012; Tamborini, 2013). However, certain contents (stimuli that recall specific moral principles) present in

the game can make even less deep-rooted moral intuitions temporarily more accessible with an effect on in-game behavior. Moreover, if exposure to certain media content is repeated over time, it has been found that the related moral intuitions can be made chronically more accessible to players (Eden et al., 2014; Tamborini et al., 2018).

It is paramount to identify innovative resources to support moral development beyond the mere information/teaching of abstract moral values. As previously said, new technologies can be used to structure experiences that support moral development. One interesting resource comes from the study of transformative emotions. Transformative emotions are complex emotional states that motivate people to change their behavior (Chirico & Yaden, 2018). According to literature, two transformative emotions may be particularly interesting for morality promotion:

- *Awe* is a feeling of overwhelming wonder generated by the perception of "vast" stimuli that involves shifting one's range of interest from oneself to others. Therefore, the perception of vastness allows one to feel part of a "whole" (for example, society, community or humanity), overcoming egocentrism (Stellar et al., 2017) which translates into a greater empathic disposition towards others (Piff et al., 2015) to pursue the common good (Keltner & Piff, 2020; Gaggioli, Chirico & Triberti, 2016). Awe allows one to express wisdom and improve one's moral character (Kim et al., 2022). Previous studies have shown that the experience of awe affects prosocial behaviors and the ability to resolve emotional and social situations (Piff et al., 2015; Stellar et al., 2017) by taking greater consideration of other people's points of view. Furthermore, one could experience awe in front of strictly physical-perceptual stimuli, but also when considering abstract ideas and concepts (epistemic awe, e.g. great philosophical insight; spiritual contemplation) (Chirico & Gaggioli, 2021).
- *Elevation* is the moving sensation one feels when witnessing acts of notable moral virtue. When a person experiences elevation, he or she is likely to feel the desire to help others and perform prosocial actions (Silver & Haidt, 2008; Vianello, Galliani & Haidt, 2010). This experience is accompanied by specific physiological responses such as chest dilation and the "lump in the throat" and increase in oxytocin (Silvers & Haidt, 2008). In Schnall and Roper's (2012) experiment, participants who experienced elevation showed an increase in their helping behavior.

The elevation of transformative emotions and, to some extent, awe are interesting for moral development as the literature shows that they influence moral behavior (Oliver, Hartmann & Woolley, 2012). It is still unclear whether having frequent experiences of transformative emotions could improve moral reasoning or not. Typically, these experiences are relatively rare and often conveyed by the fruition of media (e.g., sad movies; art).

It would be interesting to design new technologies that are able to arouse these strong emotional experiences (Liedgren, Desmet & Gaggioli, 2023), while at the same time giving us the possibility of monitoring their effects within educational contexts. Kim and colleagues (2023) designed a study to induce transformative experiences of awe and flow through digital tools and found that such experiences increased participants' level of wise reasoning, epistemic humility, and willingness to effect moral change. Furthermore, the authors also found in a series of follow-up experiments that self-transcendence experiences not only help people make more moral choices in the moment (Li et al., 2019; Piff et al., 2015) but also increase their motivation to improve their moral character in the long term.

In this sense, besides using interactive virtual environments and video games to represent moral dilemmas, it would be possible to utilize virtual reality and video games also in terms of specific emotional induction.

2. Materials and Methods

At this point, it is important to explore whether video games could be able to promote transformative emotions in players and how. While performing a focused review of existing video games potentially able to promote transformative emotions would be a titanic effort, we believe it is useful to consider some specific products that could help the reader to understand the emotional potentialities inherent to the market.

In order to support the idea that interactive virtual environments and video games can be used to promote transformative emotions that would influence moral and prosocial behavior, we reference and analyze two commercial video games of interest. The selected games are briefly described anecdotally, highlighting the narrative features that support awe and elevation. Also, we use those two examples to emphasize how moral contents could be represented as mechanisms of gameplay (e.g., they are determined by players in-game choices and actions), or they are presented to the player as part of the narrative.

3. Results

For the purpose of these articles we have selected two commercially available video games, namely *BioShock* and *To the moon*.

BioShock (Irrational Games, 2k Games, 2007) is a recent classic in first-person shooter video games, a genre that relatively rarely touches on topics such as morality and empathy. During an adventure set in a utopian city that has fallen apart, the character sporadically find himself in the need of performing moral choices, in the form of saving some innocent persons versus "harvesting" them of energy to become stronger (altruistic versus egoistic choices). In the final scenes of the game, the choices made in these apparently secondary moral dilemmas strongly influence the end of the story: a moving cinematic scene awaits those players who behaved altruistically, implying that the final prize for beating the game is not mere survival or power, but having found a loving family that will last until the deathbed. Such finale rewards the players unexpectedly by highlighting the morality of their own actions, generating elevation and making moral values suddenly explicit as the final accomplishment of an adventure. *BioShock* has been already referenced in the literature as an example of video game that, by one meaningful prosocial decisions, teaches players how even a single action can have positive effects in real life (Iten et al., 2018; Cuddy, 2015).

Another interesting example is *To the moon* (Freebird Games, 2011). In this case, the transformative emotion-related content is not tied to the players' choices but just engrained within a complex and compelling narrative. The game is a point-and-click adventure and interactive story that revolves around a couple of scientists who work for an agency that uses sophisticated virtual reality and artificial memories to address clients' regrets and help them to live their unfulfilled wishes. Working for an eccentric old man whose desire is "to go to the moon" even if he does not recall why, the protagonists gradually discover his past by entering his personal memories. During this process a complex story of love, joy and suffering emerges. The game also touches on delicate topics such as grief and disability in a mature and positive way (da Silva, 2020).

In the game, it is very easy to dismiss some characters' behavior as the result of psychopathology or personality before a great plot twist reveals important meaning and intentions behind those characters' behavior. The game narrative leads players to question their own empathy and values, in a process that is likely to make moral intuitions salient. Through the epistemic awe and the elevation felt through the narrative, one may easily feel having learned something about the complexity and preciousness of human relationships, love and care, and acceptance of others' uniqueness.

Any passionate video game player knows that many other products can be referenced and briefly commented on in terms of morality-related contents and potential for transformative emotions. These are just a couple of examples to highlight the possibility for video games to promote transformative emotions, and to convey moral beauty through it. Future research may explore players' reaction to playing commercial video games in terms of reflection and salience of moral intuitions, and whether this could be associated with the subjective experience of transformative emotions.

4. Conclusions

In the present contribution, we have showed that interactive virtual environments and specifically video games could be used to promote moral behavior. First, as the most explored aspect in the

literature, they allow player to immerse within compelling narratives to first-person confront with moral dilemmas and the consequences of their own choices. Secondarily, when we consider video games as works of art and complex media, they could contain perceptual and epistemic stimuli that make moral intuitions salient and generate transformative emotions (awe and elevation), which contribute to promote prosocial behavior.

- In other words, we suggest using technologies (specifically digital games) to harness their transformational power (Riva & Gaggioli, 2019). This could be done both with commercial games in order to discover their possible utility for educational aims, and to identify guidelines for the design of new gaming technologies devoted to the generation of transformational experiences. Long-term methods such as experience sampling (Hektner, Schmidt & Csikszentmihalyi, 2007) may be useful resources to analyze video games' effects on moral development over time.
- It would be possible to employ immersive technologies to implement marvelous and breathtaking visuals (e.g., natural scenes or even unrealistic environments) that permit the user to feel awe: the literature has already demonstrated that immersive virtual reality is effective in the promotion of awe (Chirico et al., 2018; Kahn & Cargile, 2021). An interesting aim for future research is to explore whether these properties of immersive digital environments could be further improved through inclusion within the meaningful narratives of story-based video games;
- As far as elevation is concerned, video games could feature sophisticated narratives whose complex characters embody moral virtues. The immersive and interactive properties of video games could enhance the significance of morally-rich storytelling and improve its effects on viewers' intentions and behavior;
- Other aspects could be considered in terms of game design that could improve the effectiveness of such meaningful video game-mediated experiences (Schrier, 2019); the narrative content of video games and serious games developed ad-hoc could mirror personal interests and motivations of the target players, as well as their main contexts of moral agency (e.g., school for children); besides putting players within complex systems of relationships, the possibility to interpret different characters with their own points of view within the same game may possibly improve perspective taking and cognitive empathy abilities (Belman & Flanagan, 2010; Consalvo et al., 2016);

This creative use of new technologies may help developing digital soft skills (Iavarone & Aruta, 2022), namely abilities that would support an ethical usage of digital environments or a "digital moral literacy". Indeed, it is possible to achieve digital moral literacy by the implementation of educational interventions aimed at the involvement of participants in immersive virtual environments functional to the development of social skills. For the future, it is possible to envisage the contribution by media educators trained to use immersive, transformative digital environments for educational aims (Iavarone et al., 2023).

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Augmented Didactic: Augmented Reality for Learning and motivation through a multidisciplinary approach

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Abstract

In the field of teaching and learning innovation, augmented reality is a response that aligns with the new needs of the educational landscape. Augmented Reality (AR) in an educational context is defined by the potential it offers, as it allows students to experience augmented experiences, enabling a high level of interaction with the set of concepts they want to learn at that moment (Tomassoni, 2021). The potential of augmented reality encompasses the pillars that support the field of pedagogy, giving meaning to digital citizenship and outlining a framework for education seeking to develop it (Rivoltella, 2022). This work aims to promote and enhance the learning processes and motivation of university students, evaluating the role of augmented reality in understanding abstract concepts that become manipulable through it, in both humanities and technological faculties (Yildirn, 2018). Furthermore, the research supports a dual purpose: addressing the limitations of technologies due to excessive costs and making it accessible through smartphones, thus bridging the gap that could arise with the use of other less accessible devices, and supporting the concept of multidisciplinarity, which is crucial in the new landscape of teaching through collaboration with the engineering department, developing cross-cutting skills for the creation of innovative methodological approaches (Guglielmi, 2017). For a quantitative estimation of the effectiveness of the proposed method, this experimental quantitative research evaluates a control group exposed to traditional teaching and an experimental group exposed to teaching with the support of augmented reality.

Keywords: QR-Code, University, Abstract Concepts, Innovation, Smartphone.

1. Introduction

This contribution represents the continuation of a broader research strand called "Augmented Didactic", proposing a new educational methodology that incorporates the use of Augmented Reality to enhance learning processes (Lembo, 2023; Cipollone, 2023). The research hypothesis guiding the previous investigations focused on the impact of Augmented Reality on the learning processes of university students. The theoretical background supporting this research refers to the main constructivist and embodied cognition theories, which have long supported a flourishing scientific literature on learning processes (Gomez, 2013; Rivoltella, 2012). The versatility of this field has allowed research to be applied to various educational domains, all contributing to a multidisciplinary perspective that is now considered essential to understand the complexity of contemporary students.

The current educational landscape highlights the need to find new and up-to-date methods to cater to the learning styles of today's digital-native students. The digital nativity of students should guide the choices concerning teaching methodologies towards the forefront of digital innovation, aiming to align with the natural predispositions of these students (Morsanuto et al., 2023). As digital is the natural context in which students are born and grow up, schools, education, and pedagogy, at micro, meso, and macro systemic levels, should develop methods that resonate with the preferences of the new generation of students. In this context, e-Learning contributes significantly.

> *E-learning is a combination of methods, structures, and electronic tools orchestrated in networked systems that lead to the learning process or are designed to accomplish it (Dron, 2016).*

E-Learning platforms can excel in integrating digital influences into people's everyday lives. In the progressive outlook of online learning and technology-based teaching, the educational challenge lies in implementing what is inherently innovative and effective. E-Learning itself represents a step towards the necessity of responding to and keeping up with the digital evolution of this century. As such, research efforts should be directed towards further developing these platforms to make them practically useful in enhancing the quality of students' studies. This involves embracing the students' culturally ingrained inclinations and elevating motivation levels, which are crucial for meaningful learning experiences.

In the context of digital evolution, an opportunity also arises to narrow the gap resulting from students' socio-economic status. Considering that education is a right, it becomes essential to work towards making it accessible to all with equal opportunities. The contribution of this research aims to address this aspect as well, by democratizing Augmented Reality and presenting it not only as an exclusive offering for elite students, but as an educational opportunity available to all.

The potential of Augmented Reality lies in the ability to interact with objects and transform learning environments into digitally enriched spaces through manipulation and access to information that may not be immediately available. Students who have access to Augmented Reality via smartphones can scan images that allow them to ask questions and resolve doubts through exploration, creating an experience that expands the possibilities associated with interaction (Panciroli, 2018). Augmented Reality can be an excellent tool for educational support in terms of informational amplification, as it adds value both in terms of easy access to knowledge and by enabling learning through hands-on exploration of virtual objects (Annoscia, 2021).

Student-centered learning is enhanced by this technological innovation as it redefines centrality in terms of active learning and meaning-making derived from the experience provided by smartphones. Students become aware of their surrounding reality, transitioning from passive consumers to creators of innovative content (Quintero et al., 2019). The student use of Augmented Reality enhances their knowledge, languages, and reworking of what they have learned, fostering knowledge construction and creativity. Scientific evidence shows that one of the dimensions greatly favored by the contribution of Augmented Reality is interactivity. This dimension is identified as one of the most critical factors in promoting meaningful learning processes. In fact, objects presented through Augmented Reality are not subject to the static and immobile nature of more traditional teaching materials but can move and animate in response to the user's actions. The resulting significance of learning comes from improved memory capabilities, leading to a higher retention of knowledge acquired through Augmented Reality (Gargrish et al., 2021).

2. Materials and Methods

The research methodology chosen in the previous studies involved frontal lectures aimed at simplifying the understanding of concepts, founded as more challenging to grasp based on an analysis of students' academic results. Specifically, the lectures focused on the anatomical and functional composition of the brain, providing information about the neural correlates of emotions, language, movement, and memory. In this perspective, the lesson was designed on a dual level: one purely anatomical and structural, to understand the localization and recognition of the areas contributing to the activation of the mentioned constructs, and another level concerning their functions (Lembo, 2023; Cipollone, 2023).

The aim of the lessons was to provide students with the necessary information to enable them, within an overall view of the brain, to identify the relevant areas and describe their functionality, capturing connections and differentiations between them. These lessons were conceived with a theoretical background that leverages a type of learning defined as significant (Ausubel, 1978).

For this research, the effectiveness of Augmented Reality was investigated in a context where students used it autonomously. Instead of delivering frontal lectures, the approach was to abandon the direct mediation of the teacher as the didactic mediator through which students internalize knowledge, in favor of their personal experimentation. Augmented Reality models were loaded onto materials

accessible to the students, which they used for exam preparation. The contents in the materials, concerning the neural correlates supporting various cognitive functions, were augmented with manipulable virtual models, accessible through qr-codes scannable by smartphones (Figure 1). The QR code and markers are loaded onto the study materials available to the students. The students can scan the QR code using their smartphones, which activates the Augmented Reality feature. By framing the marker on the study materials, the associated virtual model of the frontal lobe, for example, will be displayed in Augmented Reality (Peluso & Lembo, 2023). Therefore, the students always had the opportunity to access the powerful features of Augmented Reality, giving a new perspective on using mobile phones and dispelling the demonization and prejudices that often surround them in the educational landscape.

Figure 1 - The QR code and markers are loaded onto the study materials available to the students.

If learning is considered a cognitive process, it must be assumed to be related to certain other functions such as memory, motivation, perception, and movement. This assumption supported the choice of features for the virtual objects in Augmented Reality provided to the participants. Let's primarily analyze the perceptual and movement-related processes correlated with learning: acquiring information involves a perceptual analysis of the content, and the body is a prerequisite for the improvement of cognitive functions.

To satisfy these assumptions, it was necessary to create three-dimensional models of the human brain, highlighting the cerebral areas underlying emotional, mnemonic, linguistic, and motor processes. The glTF format was chosen for the 3D models, as it optimizes rapid upload and download, thereby facilitating accessibility and use of augmented reality. This mitigates the risk of delivering lessons that could be perceived by students as cumbersome and slow, ultimately compromising the objective of enhancing motivation levels for learning, closely related to performance outcomes (Refat, 2020).

For the research purposes, HTML pages containing JavaScript code were created to activate the smartphone's camera and provide a real and direct view of the physical environment. Overlapping the 3D model onto the student's physical reality is closely related to increased engagement, as the student becomes the protagonist of a highly exciting learning experience, positively influencing the internalization of concepts that find an anchor in the surrounding reality (Tomassoni, 2021). The functionality of the HTML pages is realized through the framing of ArUco markers, anchoring the 3D model's reference system to a vertex that needs to be called (Figure 2).

Supporting the aforementioned assumptions, Augmented Reality is designed to be globally experiential by endowing the models with scalability and rotation functionalities through touchscreen gestures that leverage the coordination between action and perception, as well as the execution of gestural motor actions contributing to conceptual knowledge development from an embodied cognition perspective (Susa, 2010). This was made possible through the use of the Aframe framework, a library that allows students to manipulate the virtual object, consistently aligning with the research

objectives and leading to increased hippocampus activation, a structure known to be involved in memory processes (Gomez, 2016).

Figure 2 - For illustrative purposes, scanning the QR code on the left will activate the smartphone's camera, granting access to augmented reality. By framing the marker on the right, the associated virtual model of the frontal lobe will be displayed.

From this, it can be inferred that cognitive experiences must necessarily be correlated within a triangulation, where the other two vertices refer to the body on one side and the duality of emotion-motivation on the other. In this perspective, it becomes evident how the structuring of the lessons described above aims to anchor the motivational levels of students, which are closely related to the conditions of meaningful learning. Based on these conditions, the content to be learned must have a logical justification internal to the existing cognitive structures, the subject must already possess a network of knowledge related to that content, and they must be motivated to learn (Peluso Cassese & Lembo, 2023).

The conducted investigations moved towards understanding the significance of the impact of Augmented Reality integrated into the lessons and study materials provided to the students on their motivational levels, creating a positive influence on the learning processes. The construct of motivation can be defined as multicomponential, as it encompasses four categories that determine its entirety: "interest", "relevance", "expectancy", and "results" (Keller, 1979). These categories highlight the complexity of motivation, which is influenced by levels of curiosity and interest related to the conceptual content being learned. Additionally, the subject must perceive the relevance of the information in coherence with their objectives, learning styles, and past experiences. The motivational construct also involves the student's confidence and perceived satisfaction in relation to positive expectations for success and the consequent successes attributed to their abilities. Therefore, this construct is based on a complexity of sub-constructs that, in their interaction, contribute to determining the complexity of the entire motivational expression.

In the theoretical framework just described, Augmented Reality fits compatibly, anchoring itself to all the sub-components that define motivation. Manipulating virtual objects overlaid on the student's physical reality satisfies their levels of curiosity. This technology makes learning processes more effective during content presentations because it requires higher interaction and involvement from the students (Lembo et al., 2023; Cipollone et al., 2023). Augmented Reality allows overcoming the limitations imposed by current teaching materials such as slides, images, or video files, making the educational experience much more exciting and engaging (Tomassoni, 2021). The interaction through Augmented Reality with the concept to be internalized aligns with the new predispositions and attitudes of students, who are now operating in the digital sphere. Augmented Reality significantly enhances content presentation, demanding increased interaction and involvement from the students.

The sample consists of 197 students from the Bachelor's Degree in Educational Sciences and Master's Degree in Pedagogical Sciences of Niccolò Cusano University in Rome. The sample was divided randomly into two group: an experimental group (from both the Degrees) of 99 students and a control group of 98 students. The control group used the traditional materials used for the exam preparation, while the experimental group benefit from the use of the material with Augmented Reality.

This is a quantitative research where it was examined the potential of Augmented Reality for the improvement of students learning processes. For this reason, we analyzed the student exam grade of both the group, comparing them, in order to find out any differences. We decide to compare both oral

and written exam of two subjects: General Didactics and Neurodidactic for the Bachelor's Degree and Didactics and Neuroscience for the Master's Degree.

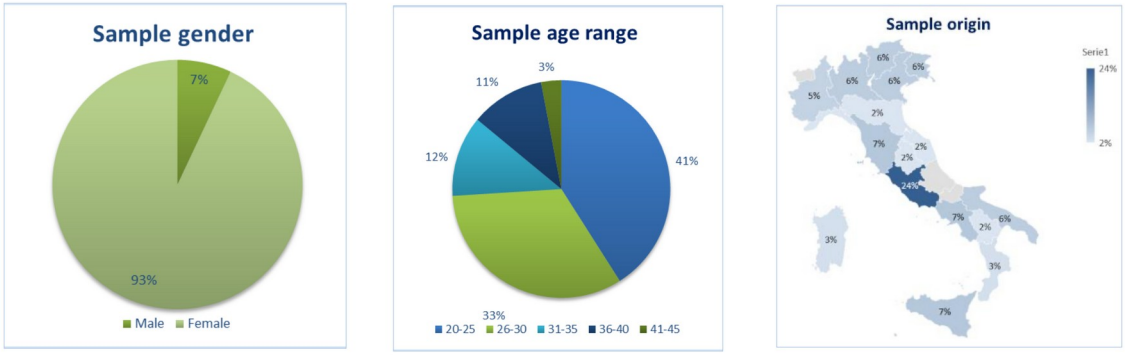
The we administered a motivation questionnaire, AMOS, in order to investigate the student learning motivation. This is a self-report questionnaire of 150 item, where it is possible to answer from 1 to 5, where 1 means "I don't agree" and 5 means "I agree". This questionnaire investigates five elements: elaboration, organization, cognitive sensitivity, strategies and self-evaluation.

At the end of the comparison, we use an independent sample t test and an effect size analysis in order to establish the validity of the methodology proposed, Augmented Didactic.

3. Results

The sample, made of 197 student from the Education and Pedagogical Sciences is composed of 93% females and 7% males (Figure 3). The age is quite heterogeneous, from 20 years to 45 years, with an average age of 28 years (Figure 4). The sample composed of students of the Niccolò Cusano University of Rome, has a heterogeneous origin from both the north, central and southern Italy (Figure 5).

Figure 6 shows a comparison between the two group in the Bachelor's Degree. Specifically, there is a difference in the average grades obtained in the exams between the two groups: the control group has an average grade of 21.68/30, while the experimental group has an average grade of 26.89/30 (in Italy, the maximum score that can be obtained in an exam is 30/30, and the minimum to pass the exam is 18/30).



Figures 3, 4, and 5 - Sample gender, age, origin.

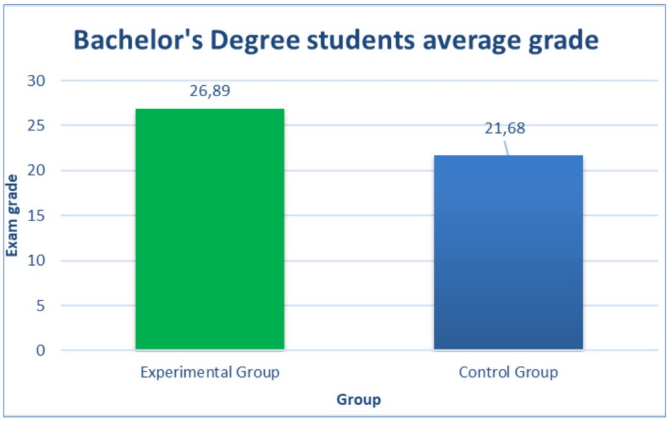


Figure 6 - Bachelor's Degree students average grade.

In Figure 7, we can see the same comparison made for the Master's Degree. Once again, there is a difference in the averages, where the control group has an average score of 23.45/30, while the experimental group has an average score of 26.63/30.

In Figure 8, the percentage improvement in exam grades for students in both Education Sciences and Pedagogical Sciences is reported. As observed, there is an important improvement, amounting to 17% in the first faculty and 11% in the second faculty, resulting in a total improvement of 14%, that corresponds to an increase of 4.2 points in the overall grade.

Then, we analyzed the level of learning motivation of the two experimental groups. Our research showed an improvement in the level of motivation to learn, showing a 4% boost. In Figure 9, you can see in detail the different areas, and you can see how the improvement has affected the processing component more.

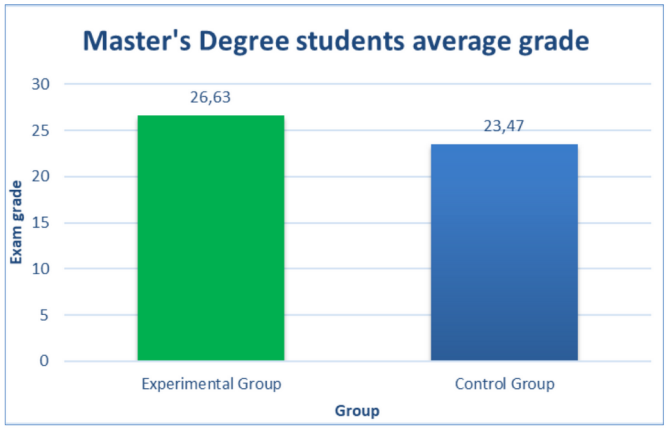


Figure 7 - Master's Degree students average grade.

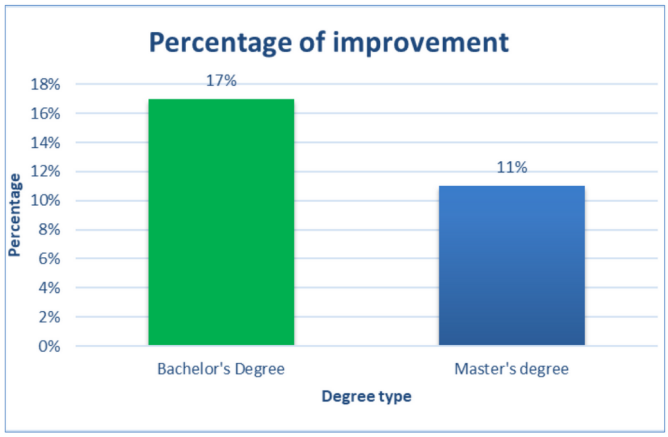


Figure 8 - Total percentage of improvement.

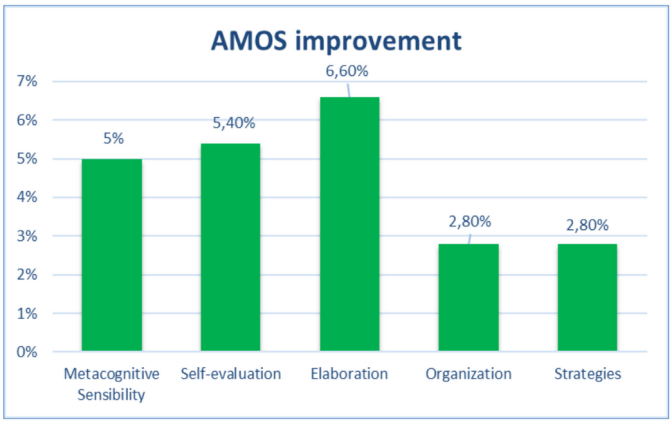


Figure 9 - AMOS scores.

Finally, we need to understand the actual validity of the experimentation presented. We therefore performed an independent sample t-test to check if our hypothesis is null, i.e. that the averages between the two experimental groups were equal, could be confirmed or rejected. The results show a difference in the averages between the two samples of 4.29 points and the p value, less than 0.001, tells us that this difference is statistically significant, which is why we can reject the null hypothesis and confirm the alternative one, i.e. there are statistically significant differences between the two samples. The fact that the difference is statistically significant, however, is not necessarily associated with the fact that the effect is large enough to have any practical interest. To get this information we used the analysis of the size of the effect, through the Cohen d. This index reveals the percentage of overlap between the two distributions, according to an effect that can be small, medium, large or very large. The Cohen d resulting from our research turned out to be greater than 1.17, so the size of the effect ranks as large, representing a 50/25% overlap between the two distributions.

Table 1 - Independent sample t-test.

Independent sample t-test						
Statistics	DoF	p value	Average difference	SE difference	Effect size	
8.23	195	< .001	4.29	0.521	Cohen's D	1.17
Note: H_a μ Augmented Didactics > μ Traditional Didactics						

The research hypothesis aimed to understand whether the application of Augmented Didactic can be useful for Educational and Pedagogical student learning processes. From the data emerged, it is evident that there is a benefit for students from the use of Augmented Didactic, which is why they show a significantly higher average grade in exams.

The improvement was observed in both the Bachelor and Master students. There is a slight difference in the level of improvement between the two faculties: Bachelor students in the control group displayed lower grades, while those in the experimental group showed a significant improvement. On the other hand, Master students exhibited a smaller improvement. This difference could be attributed to the fact that the topics covered using Augmented Reality in the experimental group are already part of the curriculum in the graduate program, leading to a more limited scope for additional learning.

The undergraduate students benefitted more from the introduction of Augmented Didactic as the AR elements provided them with a new and interactive way of engaging with the subject matter. Since these topics were not previously covered in their curriculum, the use of AR allowed them to grasp the material more effectively and resulted in a notable improvement in their exam grades. On the contrary, the graduate students already had exposure to the topics covered using AR, possibly during their undergraduate studies or as part of their current curriculum. As a result, the improvement in their exam grades was not as strong as they were already familiar with the subject matter.

We selected one of the most challenging subjects from the academic curriculum with the aim of making it easier to understand and study. The data clearly shows that the set objective was achieved, as the students reduced the failure rate in exams and demonstrated a better grasp of the subject matter.

Previous research conducted by Lembo et al. (2023) and Cipollone et al. (2023) had already highlighted the benefits of using Augmented Didactic during teacher-led explanations. However, in this study, the focus was to investigate whether the same benefits could be observed without the physical presence of the teacher, relying solely on the use of the new methodology during individual study.

The research aimed to address one of the main limitations of new technologies, such as Virtual and Augmented Reality, which is the high cost of the required equipment and the impracticality of their usage in traditional classroom settings. Augmented Didactic, on the other hand, provided a more accessible and convenient alternative, as it could be delivered through everyday devices like smartphones. This ease of access and user-friendliness proved to be crucial factors in the study's success.

Students quickly grasped how to utilize the Augmented Didactic approach, and as a result, they experienced notable improvements in both their acquisition of presented knowledge and their overall motivation to learn. The ability to engage with educational content using familiar devices allowed students to study autonomously and at their own pace, which positively impacted their learning outcomes.

The study's findings suggest that Augmented Didactic can be an effective and practical tool to enhance learning experiences without being solely dependent on the presence of a teacher. This accessibility and individualized approach offer new opportunities for students to engage with educational materials and cultivate a deeper understanding of the subject matter. The research contributes valuable insights to the field of education, showing how technology can be harnessed to create engaging and effective learning environments, even in self-directed study scenario.

The study revealed a general improvement of 4% in the motivation to learn among the students who participated in the Augmented Didactic approach. The most significant improvement was observed in the area of elaboration, which is associated with the in-depth elaboration of the concepts studied. This outcome aligns with the initial assumptions, indicating that students have experienced a higher level of appreciation and awareness regarding their processing and understanding of the subject matter.

The use of Augmented Didactic likely facilitated a more interactive and engaging learning experience, encouraging students to delve deeper into the topics they were studying. This heightened level of involvement and active exploration likely led to a better grasp of the material and increased interest in the subject matter. As students experienced the benefits of the augmented learning approach, they may have become more motivated to explore and understand the themes on a deeper level.

The improvement in motivation and the focus on processing demonstrate the positive impact of Augmented Didactic in fostering a more profound connection between students and the content they were studying. By providing an immersive and interactive learning experience, Augmented Didactic encouraged students to take a more active role in their education, which in turn enhanced their motivation to learn.

Overall, the study's findings support the effectiveness of Augmented Didactic in promoting deeper understanding, increased levels of processing, and improved motivation to learn. This suggests that incorporating augmented learning methods into educational practices can lead to significant benefits for students' overall learning experiences and academic performance

4. Conclusion

In light of what emerged, the research hypothesis can be defined as confirmed because the use of AR, during the preparation for the exams, has led to a statistically significant improvement in learning in the two selected faculties, as well as an enhancement of learning motivation.

The new methodology presented, Augmented Didactic, has once again proven to be effective, especially due to its accessibility and user-friendliness. Augmented Teaching is based on the need to embrace the digital nativity of today's students, and incorporating digital elements within education brings about a change in perspective. It shifts the focus from demonizing and holding prejudices about using phones during study to discovering a valuable resource that can be harnessed for learning.

By integrating Augmented Didactic into the educational process, students are exposed to a dynamic and interactive learning experience. It allows them to engage with the subject matter in new and exciting ways, fostering a deeper understanding and increased motivation to learn. The methodology recognizes the prevalent role of digital technology in students' lives and leverages it to enhance the learning process.

Furthermore, the ease of accessibility and practicality of Augmented Didactic opens up new opportunities for students to study autonomously. They can access educational content through their smartphones or other devices, allowing them to learn anytime and anywhere. This flexibility enables personalized learning experiences tailored to each student's pace and learning style.

Overall, the success of Augmented Didactic highlights the importance of embracing technology in education to adapt to the changing needs and preferences of today's digital-native students. By

harnessing the potential of digital tools and resources, educators can create a more engaging, effective, and inclusive learning environment.

In light of the promising results and benefits highlighted by Augmented Didactic, it is essential to continue investigations and studies to delineate this new methodology more precisely. We're planning to analyze other aspects, such as the insight into student performance, the evaluation of effectiveness on different age group and educational levels and the evaluation of the long-term effect.

By continuing to investigate these and other areas, it will be possible to consolidate and refine Augmented Didactic as an effective and sustainable teaching methodology, making a valuable contribution to the improvement of education and learning.

Authors' contributions

Luna Lembo wrote the Section 1; Luna Lembo and Pietro Oliva wrote the Section 2; Elèna Cipollone wrote the Sections 3 and 4.

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Augmented and Virtual reality: an innovative approach to learning "digital humanities"

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Abstract

Traditional methods of education become everyday increasingly digitized and driven by technology innovations. Among the most significant trends in EdTech, augmented reality rightfully takes a leading position. With AR, classroom education can be more interactive, as AR can enable teachers to show virtual examples of concepts and add gaming elements to provide textbook material support. This will enable students to learn faster and memorize information.

The study approaches a didactic disciplinary content (such as a history content) exploited in augmented or virtual reality with two groups of 15 years old Secondary School students, in order to monitor the influence of the different experience on learning. The first group took part in the augmented reality experience, based on a QR-race and the use of merge-cube app: the students worked in small group with their own devices, the race was held in the school gymnasium. The second group took part in the virtual reality experience, carried out using Class-VR visors with their interactive contents; this group worked in its classroom. An enjoyment survey was carried out short after the experiences, while a quali-quantitative test was carried out in a ten day and the result sub-sequentially evaluated. The observation lead to a preliminary conclusion: the augmented reality experience, based on a dynamic and social interaction, proved much more effective in providing a strong learning retention of the proposed contents, even if the virtual reality experience, individually run and widely static, was perceived as more appealing.

Aim and scope: evaluate the effects of an immersive virtual environment in a static, individual perspective versus the effects of an augmented reality environment in a dynamic, group-mediated experience, with relevance to didactic activities, in order to assess the cognitive footprint of virtual devices and contents compared with active AR-mediated, corporeal experiences.

Keywords: Augmented Reality, Virtual Reality, QR-Code, Experiential Learning, Game-based Learning.

1. Introduction

Traditional methods of education become everyday increasingly digitized and driven by technology innovations, while gamification and game based learning experiences are everyday more and more popular, at the point that games designed for entertainment are used in an educational setting, and Educators try to adopt features of game design to enhance learning. There is an abundance of overlap between playing a game and learning a concept (Gee, 2003). Even genres of games that adults frequently dismiss, like fast-paced action video games or match-three puzzle mobile games, are shown to have educational benefits. In the education world, rote skill-and-drill games are sometimes criticized on focusing on the wrong part of learning, but they often still employ characteristics such as rewards, goals, and narrative, which can produce demonstrative gains in learning (Dye et al., 2009). A way to model the elements of what motivates gamers implements action, a social component, setting achievement and getting awards, and focus on immersion and creativity (Yee, 2016).

When educators adopt features like the ones listed into a lesson, even if the result isn't quite a game, the lesson has been gamified and keeps learning objectives the same but makes the learning process more fun. Gamification is a tool that can build motivation and interest, and combined to technology can drive a successful path to learning.

Among the most significant trends in EdTech, augmented reality rightfully takes a leading position. With AR, classroom education can be more interactive (Johnson et al., 2000), as AR can enable teachers to show virtual examples of concepts and add gaming elements to provide textbook material support. This will enable students to learn faster and memorize information. (Bower et al., 2014) The outcome is a "mixed reality" (DiTore et al., 2020; Speicher et al., 2019) i.e. XR, a unique blend of digital and physical experiences, where users/students explore the interaction between humans, computers and digital technology (Rivoltella & Rossi, 2019).

The study approaches a didactic disciplinary content (such as a history content) exploited in augmented or virtual reality with two groups of 15 years old Secondary School students, in order to monitor the influence of the different experience on learning (Geroimenko, 2020) with regard to engaging, participation and enjoyment, in an engaging and fun learning by doing contest (Marougkas et al., 2023).

1.1 Framework for enhancing education through gamification and augmented reality

In the context of evolving educational methodologies, traditional approaches are undergoing a significant digital transformation. The integration of technology and education, becoming more and more common, implies the use of technology to enhance the student learning experience, in order to create learners who are actively engaged with learning objectives. Simultaneously, gamification and game-based learning experiences have gained wide popularity, designing an educational approach that seeks to motivate students by using video game design and game elements in learning environments.

This framework explores the intersection of digital education, gamification, and augmented reality to create a dynamic and engaging learning experience to maximize enjoyment and engagement by capturing the interest of learners and to inspire them to continue learning. A key feature of gamification and game based learning approach is found in recognize the commonalities between playing games and learning. Pivotal elements relating to video game taxonomies are rewards, goals, narratives, and immersive experiences (Bedwell et al., 2012). The very same elements are exploited in learning, making them valuable tools in education. It is also important to understand that even genres of games often dismissed, such as fast-paced action video games or casual mobile games, can have educational benefits. Rote skill-and-drill games, though criticized, still employ motivating characteristics that enhance learning. Moreover, identifying the key motivational factors in gaming, including action, social interaction, achievement, rewards, and immersion is a valuable resource in educational design. These factors can play an essential role to integrate gamification into education, focusing the educational framework on the underlying link between game design and learning outcomes (Repenning & Ioannidou, 2008; Van Staalduinen & De Freitas, 2011; Ahmadi, 2012).

The video-gaming world is a powerful tool but displays its unique features and problems even in its aesthetics, example can be given in the "uncanny valley phenomenon" (Todino et al., 2022), an effect that can be expounded as an unsettling or disquieting response experienced by specific individuals when they encounter entities that manifest human-like attributes but ultimately fail to attain a genuinely human resemblance. This occurrence is particularly conspicuous in the domain of humanoid robots and computer-generated characters, which, despite their heightened degree of realism, exhibit nuanced imperfections in their emulation of authentic human beings.

As a theoretical axis, we can consider "gamification in education" the whole process of integrating gamification elements, such as rewards, goals, narratives, and immersive experiences, into traditional educational lessons to enhance engagement and motivation, without altering the core learning objectives, recognizing that gamification is a powerful tool for building motivation and interest in students, increasing their enthusiasm for learning, finally, emphasizing the role of technology in enhancing gamification, such as using digital platforms, apps, and software to create a more interactive and immersive learning experience (Caponetto et al., 2014).

Moreover, a further theoretical axis concerns the acknowledgment of the prominent role of augmented reality in education and training technology (Squires, 2017). AR can make classroom education more interactive and engaging by enabling teachers to present virtual examples of concepts and integrate gaming elements. Exploring how AR can be leveraged to enhance traditional material by providing interactive, three-dimensional content that helps students understand and memorize information more effectively (Lee, 2012).

The third considered theoretical axis concerns the evaluation of the fusion of physical and digital experiences in education, resulting in a “mixed reality”, an immersive blend that allows students to explore the interactions between humans, computers, and digital technology, creating a dynamic learning environment. The example of shared environments such as the Metaverse and its effects on “avatars” and “digital twins” on body and sensations of net-surfers can be of strong instantiation (Di Tore et al., 2022; Sibilio et al., 2023).

In the evolving landscape of education, the integration of gamification and augmented reality holds the potential to revolutionize learning experiences. This framework provides a theoretical foundation for educators and instructional designers to effectively incorporate gamification and augmented reality into their teaching strategies, ultimately enhancing motivation, engagement, and learning outcomes for students. The seamless integration of technology, game elements, and mixed reality experiences can pave the way for a more dynamic and effective educational environment.

1.2 Aim and scope

This study aims at the evaluation of the effects of an immersive virtual environment in a static, individual perspective versus the effects of an augmented reality environment in a dynamic, group-mediated experience, with relevance to didactic activities, in order to assess the cognitive footprint of virtual devices and contents compared with active AR-mediated, corporeal experiences. The study aims at exploiting two kind of learning experiences, in which a different degree of social interaction between learners is involved, to analyze the main factors contributing in building an active and engaging learning environment. A group activity designed as a “treasure hunt” versus an individual activity involving augmented reality visors are compared trough learning goals and objectives.

2. Materials and Methods

The first group took part in the augmented reality experience, based on a QR-race and the use of merge-cube app. The students worked in small groups with their own web-enabled, camera provided devices (phones or tablets), the race was held in the school gymnasium. To create QR-codes www.qrstuff.com was selected because it allows to create codes in color, useful in color-coding by difficulty level or class period. The race was structured as an escape game, with qr linked to questions, images, or even sounds.

The second group took part in the virtual reality experience, carried out using Class-XR visors with their interactive contents; this group worked in its classroom. Class XR are didactic 3D viewers designed for augmented and virtual reality, provided with a joystick to surf contents and explore environments; disciplinary contents are provided in a vast database, selected and loaded in the virtual environment by the teachers.

An enjoyment survey was carried out short after the experiences, while a quali-quantitative test was carried out in a ten day and the result subsequently evaluated. The survey was run both to test how the AR-XR experience was perceived by students, and to evaluate the didactic outcome in terms of competence and knowledge achieved. The whole experience was carried out not just a gaming situation: students were aware of the evaluation at the end of the activities, and also of the parameters of the evaluation. The students took the test immediately after the experience, and had no further access to books or other materials.

The form of a survey has been selected in order to organize data between the two group of the study to obtain a clear and unbiased comparison of the experiences, allowing at the same time all partaking students to observe the learning experience in a metacognitive key.

3. Results

The enjoyment test was administered as a part of the content test, based on the history subject used to set the experience. Both AR and XR students enjoyed the experience, the augmented reality treasure

quest students (QR group in all the figures) registered a much more familiar situation and context, working in small random formed groups; the XR students perceived the novelty of the instrumentation and of the didactic setting (Figure 1), even if some of them declared an unsettling feeling after a while, resulting in the need of take of the visor in order to regain body balance (Figure 2).

In Figure 1 the XR students perceived the novelty of the instrumentation and of the didactic setting showing a high enjoyment, while the enjoyment of the QR group considered also the groups composition. Figure 2 explore the sense of comfort and enjoyment of the students in the experience; the VR group experimented an unsettling feeling after a while, resulting in the need of take of the visor in order to regain body balance. Figure 3 shows the results of the quali-quantitative test as a global score; a remarkable difference is found in the number of students capable of recalling the disciplinary contents, the augmented reality students being the most successful in retaining information and general context of the learning objects in the experience.

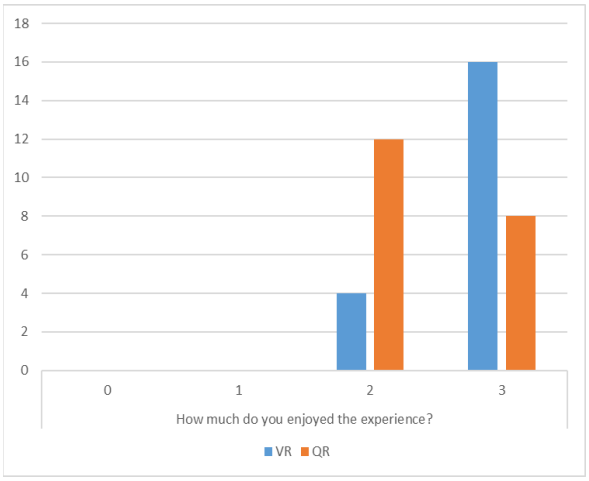

Figure 1 - Enjoyment in a 0-3 scale from “not at all” to “very much”.

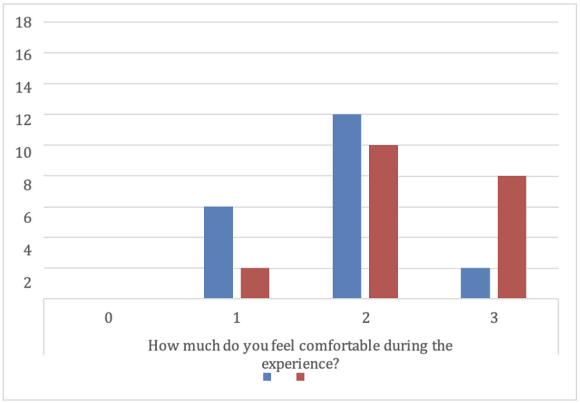

Figure 2 - Perceived comfort in a 0-3 scale from “not at all” to “very much”.

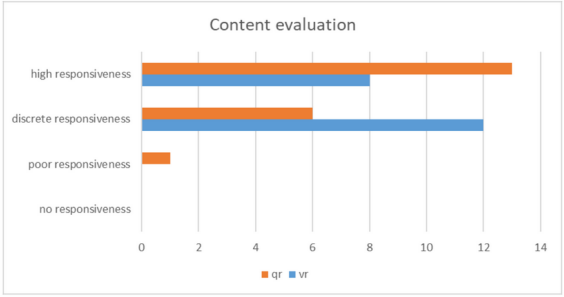

Figure 3 - Responsiveness to disciplinary contents, from “no responsiveness” to “high”.

4. Discussion

This study tries to offer some valuable insights into the use of immersive technology in education. It underscores the importance of considering both the advantages and challenges in harnessing these technologies for educational purposes, ultimately contributing to the ongoing improvement of teaching and learning practices. More in details, the study presents a unique and timely exploration of the cognitive impacts of immersive virtual environments, in the context of didactic activities.

The use of surveys and tests provides valuable insights into how students perceive and retain information in these settings.

However, the authors are aware of some weaknesses to consider. The small sample size raises questions about the generalizability of the findings. Additionally, the focus on short-term assessments limits our understanding of the long-term impacts of these technologies on learning outcomes. Future research could benefit from larger and more heterogeneous samples and longer-term follow-ups. Referring to the various issues that emerged in terms of SWOT analysis, emerging opportunities and risks are highlighted: the study showcases the potential for innovative educational approaches by integrating AR and XR technologies, this could open doors to more engaging and effective teaching methods; the use of web-enabled devices for AR experiences and educational 3D viewers for XR makes these technologies accessible and scalable for broader educational use, moreover, implementing immersive technologies may face technical challenges, such as device compatibility and maintenance. These challenges could hinder the widespread adoption of AR and XR in education, finally, integrating these technologies effectively into educational settings may require training for teachers, which can be a resource-intensive process.

The innovative research approach united with clear research objectives and the use of enjoyment surveys are, perhaps, the most evident strengths, finally the weaknesses related to small sample size and lack of long-term assessment have already emerged. which will be guaranteed in the continuation of this line of research.

5. Conclusions

Various theoretical aspects related to the evolution of education towards digitization and the increasingly prevalent use of game-based experiences, known as gamification, are examined in this study.

The researchers observe how the incorporation of elements typical of video games within the educational context, such as rewards, objectives, and narrative, can enhance the learning process. Furthermore, the study highlights how educational technology, particularly augmented reality (AR), is taking a prominent role in making education more interactive and engaging. This research focuses on the practical experimentation of these theories in an educational setting, involving two groups of students in AR and virtual reality (XR) experiences, aiming to assess their impact on student engagement, participation, and enjoyment in the learning process. The main goal is to evaluate the extent to which the use of virtual devices and content influences the understanding and retention of information compared to active experiences mediated by augmented reality. The observation led to a preliminary conclusion: the augmented reality experience, based on a dynamic and social interaction, proved much more effective in providing a strong learning retention of the proposed contents, even if the virtual reality experience, individually run and widely static, was perceived as more appealing. Further test will be carried on in order to assess the cognitive footprint of virtual devices and contents compared with active AR-mediated, corporeal experiences.

Authors' contributions

Nadia Carlomagno coauthored the study and provided scientific supervision, providing the design of the theoretical framework and discussing data. Vivien Valli coauthored the study designing the experimental setting, administering the survey and relating data.

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· Section 4 ·
Scenarios, experiences, and research reports

Prebunking as preventive ecology. The case of conspiracy thinking

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Abstract

This contribution intends to focus on the methodological aspects of an action-research project conceived and implemented in terms of an educational "remediation" of prebunking (van Der Linden, 2023). Conceived as an educational ecology intervention aimed at defusing, in the case of this experience, conspiracy thinking from within, prebunking can indeed be considered a complementary (and symmetrical) approach to debunking. In this perspective, the aim is to "vaccinate" the subjects involved in the training, providing them with the cognitive and methodological 'antibodies' to recognize and thus anesthetize the persuasive and seductive effect of misleading narratives, unfounded arguments and unreliable beliefs (Harjani et al., 2022). The application of this methodological approach specifically aimed at unmasking the logics and dynamics that innervate and make conspiracy narratives effective will therefore be accounted for here. And we will proceed by describing the phases that marked the action-research that was articulated around an activity (proposed to the trainees) of monitored co-design of persuasive and viral cases and scenarios. To experiment this approach in educational paths in the conviction that, with respect to retroactive debunking, it can also produce significant educational spin-offs in the perspective of an (educational) citizenship project.

Keywords: Prebunking, Conspiracy Thinking, Conspiracy Social Theory, Education, Preventive Ecology.

1. Introduction

This contribution intends to focus on one of the potential drivers of disinformation – conspiracy narratives – in order to show how the methodology of prebunking, if properly contextualized in an educational context, can in fact be a flexible and effective preventive tool. Prebunking interventions can help educators to counter the most widespread and dangerous strategies that often guarantee the virality and persuasiveness of a whole range of contents and digital materials that are in fact unreliable, however much they are considered "believable" by many.

In the following paragraphs we will therefore try to illustrate, albeit briefly, some of the typical characteristics of the so-called conspiracy mindset in order to make clearer the reasons that, from our point of view, could precisely allow us to identify prebunking as a desirable tool to counteract – also from the point of view of scalability – the polymorphous epiphanies of the unreliable that a "conspiracy mind" can simultaneously undergo and produce (Bruno & Moriggi, 2023, p. 102). Always bearing in mind – also in the light of what will be said below – that no one can, *a priori*, consider himself immune to the insidious fascination of such narratives. On the contrary, it would be precisely this kind of ostentatious confidence that should rather be understood as the likely symptom of an unconscious vulnerability (Brotherton, 2015).

2. Why do we believe in conspiracies?

According to Umberto Eco,

> *conspiracy psychology arises from the fact that the most obvious explanations of many troubling facts do not satisfy us, and often do not satisfy us because it hurts us to accept*

> *them [...]. The suspicious interpretation in a sense absolves us of our responsibility because it makes us think that behind what worries us lies a secret, and that the concealment of this secret constitutes a conspiracy against us.*

He added,

> *Believing in the conspiracy is a little like believing that one is cured by a miracle, except that in this case one is trying to explain not a threat but an inexplicable stroke of luck (Eco, 2007, pp. 127-128).*

Eco's reflections – and particularly this symmetry between conspiracy and miracle – recall (and develop) the social conspiracy theory that Sir Karl R. Popper had already illustrated in the now classic pages of *Conjectures and Refutations* (as well as in The Open Society and Its Enemies). According to the Austrian philosopher, conspiratorial logic, far more primitive than many forms of theism, finds its cultural matrix even in Homer.

> *The latter conceived the power of the gods in such a way that everything that happened on the plain in front of Troy constituted only a reflection of the multiple conspiracies plotted in Olympus (Popper, 1963, pp. 212-213).*

And, Popper continues,

> *the social theory of conspiracy is in effect a version of this theism, of the belief, that is, in deities whose whims or wills govern everything. It is a consequence of the disappearance of reference to God, and the consequent question, "Who is there in his place?". The latter is now occupied by various powerful men and groups – sinister pressure groups who can be blamed for organizing the Great Depression and all the ills from which we suffer (Popper 1963, pp. 212-213).*

Recent studies on conspiracy theories seem to corroborate (as well as complement) the insights of Popper and Eco, not to mention – along this same theoretical-interpretive line – that "crippled epistemology" described by Cass Sunstein and Adrian Vermeule (2009), which would prevent the conspiracy theorist from properly distinguishing causality from intentionality.

Indeed, according to Sander van der Linden, one of the most respected scholars of disinformation and a proponent of prebunking-based psychological methodology, conspiracies represent a "striking example of a fact-resistant worldview" (van der Linden, 2023, p. 49). That is, those who believe in a conspiracy are unlikely to be convinced otherwise on the basis of factual evidence alone -which, incidentally, would invalidate (a posteriori) approaches to countering disinformation based on debunking alone.

Van der Linden also identifies several characteristics that distinguish conspiracy thinking from factual thinking. The first and most important is that conspiracies are "monological belief systems" (van der Linden, 2022, p. 49), where different worldviews feed and support each other, even if sometimes in open contradiction with each other. This is the so-called "conjunction fallacy", known as Linda's problem, discovered by psychologists Daniel Kahneman and Amos Tversky (1982), whereby those who believe in a conspiracy are easily led to believe in other conspiracies not directly related to it. This fallacy allows the conspiracy mind to casually disregard factual evidence that, for example, sheds light on individual aspects of a narrative, rather than not giving due consideration to a timely analysis of data. In a conspiracy theory, the whole belief is more important than individual aspects.

Equally relevant, moreover, is the fact that conspiracy theories are not "theories" at all, but a clear example of "motivated reasoning" in action. Almost all of them start with the same premise, according to which there is a group of very powerful people working covertly to influence the fate of "ordinary" people (van der Linden, 2022, p. 50). Such a "theistic" premise (as Karl Popper again put it) leads to

an inevitable "attribution error" whereby those who believe in a conspiracy tend to attribute entirely random (or casually explicable) facts to the intentions of these negative entities plotting behind the scenes. A diagnosis that reiterates and corroborates Sunstein and Vermeule aforementioned "crippled epistemology".

In an attempt to trace the characteristics of conspiracy logics even more analytically, a group of researchers led by Australian psychologist Stephan Lewandosky has proposed the CONSPIR model, an acronym that condenses within itself the seven prerogatives that they claim characterize conspiracy thinking: contradiction, excessive suspicion, evil intent, something must have gone wrong, persecuted victims, immunity from evidence, and re-interpretation of randomness in a connected story (Lewandosky et al., 2015). It is on the basis of these rhetorical-narrative ingredients that conspirators would be able to circumvent – or even reject – conclusions that are uncomfortable or unacceptable to them (Lewandosky & Cook, 2020, p. 5).

By offering such simplistic versions to explain complex and not easily explained phenomena, conspiracy theories reveal the extreme persuasive effectiveness of narrative thinking – of which *Homo sapiens* is a "healthy carrier" not always aware (Ferretti, 2022). Moreover, as Johnathan Gottschall well explains, "conspiracy theories, in all their infinite variations, are not an effect of reason gone mad, but are powerful stories that cause a derailment of reason" (Gottschall, 2021, p. 95). And with these kinds of stories, counter-strategies based solely on debunking do not seem to have the same effectiveness. Indeed, on closer inspection, "almost all successful conspiracy stories could become Hollywood blockbusters, while most rebuttals would be public television documentaries at best" (Gottschall, 2021, p. 96).

Michael Butter, who has often insisted on the effectiveness of the rhetorical narrative strategies of "nothing is as it seems, nothing happens by chance, everything is connected" (2020), explained in an interview that:

> *Conspiracy theories draw boundless conspiracies and magnify intentionality beyond measure. Everything is planned and goes as the conspirator has planned, without anyone involved ever speaking up. Of course, this is never the case. [...] Moreover, in real conspiracies, something always goes wrong at some point. Those who killed Caesar wanted to save the republic, but in the end, they triggered a civil war from which Augustus emerged the victor and thus became the first emperor. [...] In conspiracy theories, on the other hand, there is no room for error. And this makes them practically unworkable, because reality can never be completely controlled (Bianchi, 2021).*

This disconnect between the designs of the conspirators and a reality that is never entirely predictable represents the same distinction on the basis of which Karl Popper identified the object and task of the social sciences.

> *I think that those who approach the social sciences by moving from a ready-made conspiracy theory are, by that very fact, precluding themselves from understanding what the task of those sciences is, since they assume that we can explain every social event by asking who intended it. [Whereas] it is the task of social theory to explain how the unintended consequences of our intentions and actions emerge (Popper, 1963, p. 215).*

3. Prebunking as action-research

Having thus defined the salient features of the conspiracy phenotype, it is now necessary to describe the methodology of prebunking as we have re-mediated it in order to make it as compatible as possible with an educational (in this case, school) context and its educational objectives. In this regard, a specific research-action was designed as part of "Open the Box" – a media and data literacy program active since 2020 involving thousands of Italian secondary school teachers and students.

The objectives of this research-action were the enhancement of some basic digital citizenship knowledge and skills, specifically targeting our educational intervention in a preventive action against conspiracy thinking.

More specifically, it involved working on improving and refining skills to identify the most common forms of misinformation typical of contemporary conspiracies; learning to recognize the narrative structure that shapes contemporary conspiracies; and learning how to interact effectively and constructively – and non-polarized – with those who actually believe in conspiracies.

In the action-research design phase, we relied on a precise prebunking framework (Harjani et al., 2022). This model was reshaped taking into account our intervention needs into a training-model proposal of four distinct operational phases: advance notice, prior refutation, explanation of manipulation techniques, and activation.

The first phase coincides, precisely, with a warning that activates the trainees' mental defenses against manipulative tactics (Harjani et al., 2022, p. 8), for example, by alerting them as follows: "Warning. While browsing social media you may come across a conspiracy theory that attributes phenomena affecting millions of citizens to a few people".

During our intervention, the warning was also proposed in an interrogative way, with the intention of highlighting the existence of the problem in an interactive and dialogic way, even perhaps starting from personal experiences: "Have you ever heard any friends or family members talking about vaccine-related conspiracies?".

In this phase, trainers simply raise the issue of conspiracy thinking, for example about vaccines, without countering, contradicting or providing any other data or evidence.

In the second phase, however, they proceed with a more precise pre-emptive rebuttal that provides the trainee with the methodological and operational tools to counter misleading information he or she may encounter in the future (Harjani et al., 2022, p. 7), such as, "Scientific research has shown that vaccines do not contain anything that transmits secret information". In this way, the participants' "immune defenses" are hardened even before proceeding with the actual administration of the "microdose" of conspiracy.

The third phase, on the other hand, coincides with the actual "inoculation". It involves the trainees in an immersive analysis of real cases of conspiracy functional to decipher the grammars and contents that constitute them (manipulated images, viral memes, synthetic media generated by artificial intelligence, manipulated data visualizations, false experts etc.). This immediate "exposure" makes it possible to share with the trainees (in the specific case of our training courses, these were teachers and secondary school students) techniques and tools for an anamnesis of manipulative strategies, useful at the same time to bring out the narrative and theoretical patterns underlying them.

It is in this same phase that the aforementioned CONSPIR model is introduced (Lewandosky & Cook, 2020, p. 6) and that the main conspiratorial strategies are discussed, starting with the narrative type strategies described by Michael Butter: nothing is as it seems, nothing happens by chance, everything is connected (Bianchi, 2021).

This is followed by a discussion of the main manipulation techniques typical of conspiracy thinking: impersonation, emotional manipulation, polarization, conspiratorial creation, ad hominem attacks, false dichotomy, and false balancing (Lewandosky et al., 2015).

In the final phase, then, we proceed with activation: the participants are asked to create a conspiracy theory simulation using the narrative strategies and manipulation techniques previously introduced. To initiate this activity, first of all, the trainees are shown (and provided with) a number of digital creation tools that allow them to create effective multimedia content – such as, for example, software for photo editing or for creating breaking news headlines, or for automatically animating images, or even for creating photo-realistic images using generative artificial intelligence software.

Next, the participants are divided into small groups and work independently first on writing a narrative "script", identifying a subject, a short plot, and a guided response to the three narrative strategies identified by Butter. At this stage, the trainees are also encouraged to construct a plot from (also) authentic news, in the awareness (hopefully acquired at this point) that truth can often be used in the

service of falsehood in order to create more effective rhetorical short-circuits (Bruno & Moriggi, 2023, pp. 102-103).

Having done this, the trainees continue their project with the creation of visual, textual and audio content that can be effective in order to spread their conspiracy theory on digital channels. During the experiments of this action-research, there have been conspiracies on video games that intrusively spy on young users, reworkings of famous historical cases (the kidnapping of Aldo Moro, the moon landing, the death of Lady Diana), but also the creation of totally fictional conspiracies (a more detailed analysis of such final products will be the subject of a forthcoming publication.) The activity concludes, then, with a public presentation of the "conspiracies" of all the small groups into which the trainees were divided.

4. Conclusions

The methodological approach of media literacy shared here has found its theoretical and operational poignancy by "re-mediating" prebunking in a way that makes it coherent and sustainable within an epistemological framework that values the evidence of modern evolutionary theory, particularly in relation to the concepts of inheritance and environment in particular.

More specifically, the evidence used to recontextualize prebunking in educational and training settings conforms to the now-established understanding that socio-cultural environments "are structured in response to specific adaptive challenges" (Tomasello, 2019, p. 7). If, on the one hand, this offers us the possibility of an archaeological (and genealogical) view of the contexts we have inherited (as a species and as individuals) in response to the specific challenges that nature and culture have posed to us (Dalmasso & Crespi, 2023); symmetrically, such an awareness can also be concretized in a design-educational logic to the extent that we will be able to devise appropriate adaptive challenges in view of the (educational and training) goals that we have set for ourselves.

In this specific case, prebunking – as we have proposed and described it above – comes to be configured as a methodological approach in which trainees are gradually (and consciously) exposed to challenges, in response to which they should be able (with increasing levels of competence and knowledge) to acquire practices of recognizing and neutralizing the kind of conspiracy narratives that prove particularly seductive and widespread.

It is precisely this conceptual landing that has thus allowed us to rethink the development of educational pathways that function to "dismantle" the logics of conspiratorial thinking in the terms of a methodological (and cultural) perspective that we could define here, on the basis of what has been shared so far, not only (as mentioned above) preventive but also ecological (Strate, 2017).

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University and high-level continuous and recurrent education: elements for a lifelong learning engine model

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Abstract

The aim of this paper is to identify the key elements of an innovative approach for the management of lifelong and recurrent education by Italian universities. A broader and more impactful approach is necessary to provide appropriate forms of educational support to the profound transformations in work and professions driven by digital innovation. The analysis focuses on the professional dimension of Web and digital communication professionals, characterized by a set of factors that are progressively extending to other professional sectors: technology, evolving from tool to an organic cultural component of an interdisciplinary approach; the project culture; instability, precariousness, and rapid obsolescence of knowledge; hybrid forms of on-the-job learning closely tied to the professional context and professional identity. An innovative model requires a stable and structured connection between the Master and the Third Mission, which are the institutional tools available to universities for this purpose. It also demands a Master's program design that connects research driving the disciplines with the evolution of the professional dimension and the most advanced forms of self-training and on-the-job learning. This approach also necessitates more streamlined organizational forms, resembling private-sector structures, and funding methods that, following the triple helix model, involve all real and potential stakeholders in lifelong education, innovation, and technology transfer.

Keywords: Lifelong Learning, Learning On The Job, Master, Third Mission, Digital Communication.

1. Introduction

In an era characterized by the pervasive and relentless impact of digital innovation, learning and knowledge dissemination have long been the focus of analysis by economists, sociologists, and scholars of organization, work and professions. Many researchers from these disciplines, albeit from different perspectives, not only emphasize the crucial importance of continuous education for economic and social development but also agree that it represents a fundamental and defining aspect of future education.

Stiglitz and Greenwald (2018) assert that one of the primary objectives of economic policy should be to create a "society of learning", of which the extent, ease and speed of knowledge transmission are crucial characteristics. In their strictly economic analysis, learning involves the entire society on different levels: "Learning takes place at all levels: individuals learn, but so do companies and governments. More broadly, a 'social learning' can be created, which involves a change in collective beliefs that, in turn, leads to different public actions through the political system". Among the topics they address, the authors focus particularly on the relationship between technology and education: "Technological change affects what we learn and how we learn (and what we should learn and how)" and the ability to learn: "The most important determinant of individuals' learning is their capacity and ability to learn [...] A well-designed educational system focuses on learning how to learn". In this perspective, the redefinition of "learning by doing" as "learning to learn by learning" is significant. The authors also emphasize the relevance of lifelong learning and the relationship between formal, non-formal, and informal education:

> *Modern education and labor market policies aim for lifelong learning that enhances individuals' ability to adapt to a perpetually changing market environment. This*

> *facilitates individuals' movement from one company to another, with substantial private and social benefits stemming from the resulting flexibility.*
>
> *Since a significant, if not the majority, portion of economically relevant learning occurs on the job, not in formal schooling, formal education and on-the-job training should be considered complementary, with the former aimed at enhancing the productivity of the latter (Stiglitz & Greenwald, 2018, pp. 65-68).*

Domenico De Masi (2018), outlining the main trends that will characterize the near future (2030) from a sociological perspective, writes:

> *Education will be understood as lifelong education and will occupy an increasingly substantial part of life. The greater production and transmission of knowledge will develop based on the "many to many" criterion, as already occurs with Wikipedia and Facebook (De Masi, 2018, p. 714).*
>
> *A 'new type of human' will emerge, which Shaft calls "homo studiosus" or "homo universalis", possessing a multifaceted education that allows them to change occupations depending on circumstances and, therefore, also within the social organization of work (De Masi, 2018, p. 726).*

The relevance of continuous education is closely linked to the concept of knowledge society and is further explored by scholars of organization and work in their analyses of the unique educational characteristics of its protagonists, the knowledge workers, "whose function is to produce knowledge through knowledge, increasing its utility value (by providing a service), economic value (creating income and wealth), and intrinsic value (which is diffusive, unappropriable, and not a commodity)" (Butera, 2008, p. XII). In a knowledge society, competitiveness significantly relies on qualified knowledge, communication networks, and the global dimension of processes. To maximize the opportunities, it is necessary to implement and integrate all innovative processes, with continuous education for workers and citizens being of paramount importance.

The common thread in these analyses is the role of technological innovation in driving profound and ongoing transformations in work. This becomes particularly evident when new generative AI-based systems foresee profound changes for intellectual and creative professions themselves. These systems are beginning to offer new ways of accessing documentation and functioning as intelligent assistants (copilots), capable of producing code, images, videos, text, voice, and music. An extensive and integrated use of these resources is already in advanced experimentation in the most forward-thinking corporate environments.

The strategic importance of continuous education requires that university institutions also adopt a more effective model that goes beyond what Stiglitz & Greenwald essentially propose, which is based on a clear separation between formal, non-formal, and informal education, with the former serving the latter. To discuss the elements of a new approach, we will draw inspiration from the characteristics of continuous education in the digital communication sector.

2. Professionals in digital communication: lifelong and on-the-job learning

Professions in digital communication, which have been significantly and rapidly impacted by digital innovation, serve as a particularly useful reference for discussing lifelong and on-the-job learning because they continue to experience professional dynamics that progressively extend to other work sectors. Web and digital communication companies produce services exposed to rapid obsolescence, handle models and tools that continually change, and have had to face, and continue to be exposed to, rapid paradigm shifts. In these companies, technology is not just a tool; it is a constitutive part of an environment that, through the interpretation of needs, trends, values, fashions, and styles – which guide expectations and product evaluation criteria – intertwines multiple cultures to produce services.

These companies are the result of and, at the same time, express the profound changes that have affected knowledge workers and digital creatives in recent decades, starting with the rise of the project culture. As Castells (2003) argues:

> *Although ownership and shareholding remain the legal and financial basis of a company, the true constitutive unit of today's economy is [...] the project, the operational core of every entrepreneurial initiative, a composite entity consisting of different company divisions, sometimes even individual individuals, that both provide and take away work, absorb money and generate profits. The project is the fundamental expression of current business and always has a network structure.*

The project is the lever that conditions the balance of this productive world and its intrinsic instability, but it also determines its propensity to interpret and capitalize on innovation and the pursuit of quality. It is the logic of the project, a granular monad in terms of quality, duration, jumble of skills, and profitability, linked to others by not always linear and intelligible threads, that brings forth strategic keywords for those working in this field: professional capital, reputation, self-education, self-promotion, networking, and relational skills.

The most typical knowledge workers work in these companies, that is,

> *those who are engaged in the processes of conceiving and producing novelties and emotions, in studying and anticipating people's needs and desires, in capturing their attention. To do all this, one must possess, actively use, and produce knowledge that, being aimed at generating novelty and meeting desires, is inherently dynamic and unstable. [...] Similar to desires, knowledge never reaches a state of stasis or equilibrium; it is not easily accumulable and never becomes an asset. In fact, some, or perhaps many, become obsolete. It would be best to forget them, as they become a burden. In any case, knowledge changes, there is no simple accumulation. [...] Novelty and change represent the normal characteristics of the knowledge society, where the continuous pursuit of novelty naturally leads to instability. It is impossible to predict where novelty may come from. Therefore, the best solution is an organization that does not favor any specific element but allows one to capture any relevant element capable of attracting attention wherever it may arise (Bagnara, 2008, p. 49).*

This interpretation links the evolution of competences both to an individual's ability to develop their knowledge and skills in the presence of continuous and unstable stimuli and to the way in which the work environment in which they operate is organized. For knowledge workers, the role of work in a company is fundamental since their figure

> *is not exclusively attributable to the possession of knowledge and skills but rather refers to values and styles, leadership, the ability to give meaning to work, and, more generally, how their individual characteristics contribute to performance. [...] International literature also confirms that knowledge workers are mainly characterized by a mix of skills linked to the situations, technologies used, the nature of the work processes, and the division of work model. These figures do not learn in the abstract but, rather, learn, act, and strengthen their competences within these professional and organizational contexts (Cesaria, 2008, pp. 115-116).*

In Web and digital communication companies, regardless of their size, learning by doing takes on forms reminiscent of apprenticeships and is combined with entirely contemporary forms, such as participation in peer-to-peer-based communities of practice. This hybrid corporate training, which relies more on coaching and mentoring than traditional educational actions, strengthens not only

> *and perhaps not even primarily [...] transferred knowledge and skills, but, rather [...] metacompetences, contextual competences, and the reinforcement of professional identity. It is these factors that make the difference between a traditional worker and a "knowledge worker" (Cesaria, 2008, p. 124).*

These competences also prove useful for managing non-linear and fragmented work paths and are associated with a strong sense of professional identity and pride in belonging to a specific professional group.

In the field of digital communication, factors are at play that progressively extend to other professional domains: technology evolving from tool to an organic cultural component of an interdisciplinary approach, project culture, instability, precariousness, and rapid obsolescence of knowledge. Furthermore, hybrid forms of on-the-job learning are closely tied to the professional context and professional identity.

3. Universities and continuous and recurrent education: Master and Third Mission

Universities have at their disposal, as tools for lifelong and recurrent education, the Master and the Third Mission. The connection between Master and continuous education is explicitly stated in the decree itself: "universities can activate, regulating them within their university teaching regulations, post- graduate courses and high-level continuous and recurrent education, following the completion of a bachelor's or master's degree, which lead to the issuance of first and second-level university master's degrees" (Decree 3/11/1999, no. 509, art. 3).

The purpose of high-level professional and continuous education is confirmed both by the supply and demand and the student's working status. The university's offer of Master's programs, which is extensive and diversified, mainly aims at specialization, updating, and re-qualification. Many courses prepare students for professions in the process of formation or change. In terms of demand, the primary reasons for enrolling in a Master are acquiring professional skills (88.3%), delving into cultural interests (69.1%), and direct job placement prospects (50.6%). The majority of students enrolled in Master's programs work full-time on a continuous (62.2%), part-time (12.4%), or occasional, sporadic, seasonal basis (11.8%) (AlmaLaurea, 2023, pp. 7-9). In both practice and premise, the Master in Italy is characterized as a tool for continuous and recurrent education. However, this role is separated from the other phases and subjects that characterize such a complex and long-lasting process, although it could serve as the linchpin of a more robust and effective path.

Within the institutional responsibilities of Italian universities, the Third Mission plays a significant role, encompassing a wide array of activities related to the transfer of scientific, technological, and cultural knowledge, as well as the productive transformation of knowledge. The Third Mission is based on the direct interaction between the university and civil society and the entrepreneurial fabric. Those linked to lifelong education and public engagement (conferences, lessons, public events, presentations) are explicitly included in the activities of the Third Mission. Similar to Master, the Third Mission necessitates a systematic interaction of universities with businesses, startups, funders, investors, and collaboration with intermediation structures and service providers such as incubators, science and technology parks, consortia, foundations, and technology transfer associations.

Despite the overlap in aims and interlocutors, Master and Third Mission almost always travel in parallel, crossing paths only episodically through the initiative of individual researchers.

4. Elements of a New Approach

The evolution of professions, driven by technological and organizational innovations, can only be addressed through continuous and recurrent education capable of connecting formal, non-formal, and informal learning pathways. This means increasing the robustness of formal courses with the different

forms of learning on the job, and enhancing innovative training and self-training models and tools that innovation itself brings out, such as communities of practice and, in general, collaborative peer-to-peer learning.

To contemplate a new approach, the fundamental reference point is the concept of professional dimension, which relates to the concrete practice of a profession, to the operational aspect that characterizes it. In the professional dimension, knowledge and skills, experience, intelligence, creativity, and personal qualities manifest themselves in the execution of specific work, regardless of its complexity – from defining a strategy to solving practical problems – in pursuing a goal, and in responding to a question. In the professional dimension, where personal culture and corporate culture meet, confront, and mutually modify each other, the suggestions of innovation become choices, organization, products, and work materializes in roles and specializations. This is a dynamic and dialectical concept, whereas the concept of professional profile carries within itself the idea of a declaratory (crystallized) set of skills and roles to be exercised.

The modes, timing, heterogeneity, and significance of the changes affecting the professional dimension, which are now occurring at a continuous pace, make the rapid evolution of professional profiles more evident. This highlights the need for a more articulated and flexible institutional model for continuous and recurrent education, which entails multiple interventions distributed over time. The Master, following an undergraduate or master degree, constructs a solid foundation for self-training through a scientific, theoretical, and methodological approach. Corporate culture and dynamics that impact the professional dimension contribute to the growth and strengthening of interdisciplinary, social, and behavioral skills. Collaborative learning compensates for disparities related to specialization and the product and materializes opportunities for the growth of professional knowledge and skills through cross-cutting and participatory collaboration. To bring together these components in a new approach to lifelong learning, it is necessary to initiate the process during the design of the Master's program and structurally connect Master's programs and the Third Mission.

5. Master's Program Design as the Core of a Lifelong Learning Project

The primary goal of a Master's program is to create the conditions – in terms of knowledge, skills, and abilities – for graduates to play an active role in the professional dimension of the relevant sector. This means much more than preparing graduates to interpret a professional profile; it presupposes a broad and dynamic vision of the professional area that goes beyond acknowledging the existing state – as presented by companies and job offerings – and is able to understand how that area is developing and relating to others. Forward-thinking companies are well aware of the state of the art and market scenarios they must navigate and how to address them; in other words, they know what they need today, while researchers work on what they will need in the future. A Master, therefore, has two essential reference points: the research that drives the disciplines and the professional dimension, by definition dynamic and dialectical. And it cannot do without either of the two.

Most professions, anchored in a reality driven by the interplay of technical opportunities and social action, evolve so rapidly that any fixation on current competence levels would be suicidal. As Paini points out:

> *Focusing exclusively on the present and neglecting the future is a significant interpretative bias that affects not only individuals but also institutions grappling with the challenge of digital transformation. Transformative processes are already underway, and we are already experiencing a significant series of impacts that constantly affect our life experiences. However, focusing our attention solely on the present is a serious approach error (Ferraris & Paini, 2018, p. 141).*

This awareness compels those managing a high-level vocational training program not to consider each stage reached as a definitive best practice. Instead, they should periodically attempt to read and interpret the most significant changes that can affect its general orientation, content, and teaching

methodologies. Increasingly, the design of a Master's program is continually evolving, both in terms of disciplines, the program itself, and teaching methodologies.

To illustrate what the link between disciplines and the professional dimension implies in terms of design, below are two graphs (Figures 1 and 2) related to the Master in Digital Communication Design at the University of Turin (MATEC). The first graph is from its first edition in 1996, while the second represents the current edition with proposed changes for the near future.

The graph is a "similar Comb-Shaped" because it does not fully represent the intersection between the breadth and depth of knowledge and skills concerning roles and professional specializations. The vertical segments below do not detail the knowledge and skills characterizing each specialization but only a set of specializations and roles aggregated by affinity, for which the Master's program builds the prerequisites. At the top, the horizontal segments show the core knowledge (hard skills) and the main cross-cutting competencies (soft skills) that the Master's program aims to nurture and strengthen. The Master's program broadens competencies and establishes the foundations for specialization or depth. The internship experience strengthens at least one of these specializations, but more importantly, it tests that breadth and those foundations in a real work context.

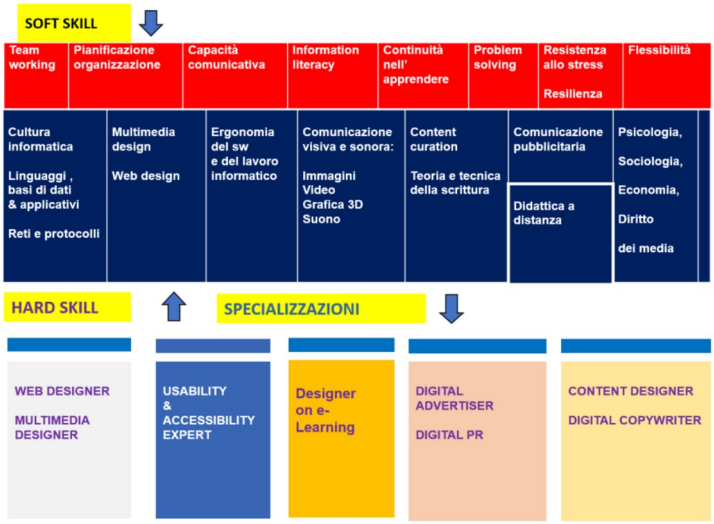

Figure 1 - Competences and Specializations 1996-97.

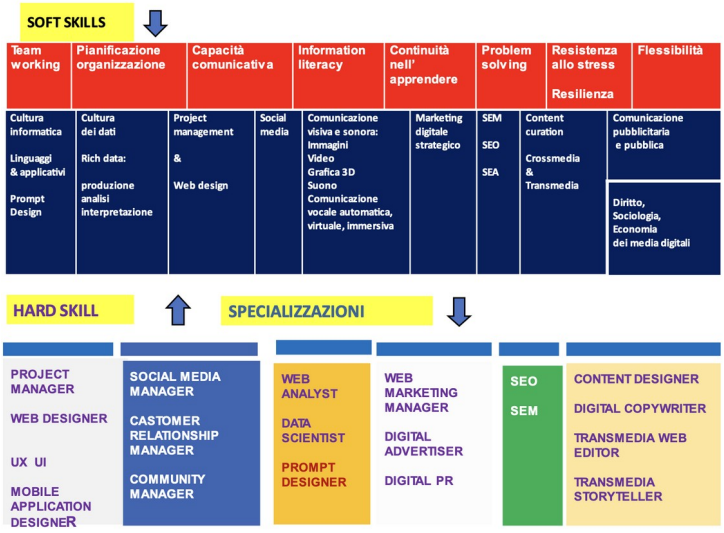

Figure 2 - Competences and Specializations 2024.

The comparison between the two graphs highlights the profound changes that have occurred in the professional field in the last quarter of a century. These changes have led to a significant redefinition

and multiplication of specializations in the professional sector of the Web and digital communication. At the same time, the Master's program has also changed profoundly to accompany, often prefiguring in advance, the evolution, expansion and reconfiguration of the necessary knowledge, skills and abilities.

It is in the robustness of the horizontal segments and their functionality in relation to the vertical ones that the capacity to play an active role in the professional dimension of digital communication is encapsulated. This is because the essential core of the cultural heritage, skills, and abilities required for those working in this field lies within these horizontal segments. The difference between professionals in digital communication and the diverse array of gurus, bricoleurs, hyper-specialists, and experts in nothingness – who populate the history of these professions and thrive on paradigm shifts – is founded on the suitability of the horizontal segments in relation to the vertical ones.

In addition to a dynamic approach aimed at anticipating the evolution of the professional dimension, it is necessary to adopt or reinforce teaching methods and tools that enhance the capacity for self-learning. Specifically, this includes both forms of hybrid teaching – that support personalization and cooperative, experiential and ubiquitous learning – and the use of Personal Learning Environments (PLE) that combine students' autonomous management of their curriculum and individually produced and collected resources with the availability of resources produced by teachers or identified by them on the web. It is essential to utilize techniques and metaphors derived from experiences that have emerged and solidified on the internet, within the realm of digital media and entertainment. Finally, it is necessary to adopt a project-based approach in teaching, starting by establishing the connection between student's initial situation – their skills, personal goals, and expectations – and the Master's program. This involves defining significant milestones and assessment tools for tracking the progressive acquisition of new knowledge and competences.

6. Conclusions

The necessary conditions for the Master to become the focal point or a substantial element of lifelong learning, rather than an occasional one, are its design oriented towards the link of disciplines and professional dimension and the stable and structured connection between the Master and the Third Mission. This connection would allow for the creation of stable and long-lasting pathways. These pathways could include, after completing the Master's program, periodic meetings for graduates and companies dedicated to in-depth exploration of research results, changes in scenarios or paradigms, webinars, update courses, summer schools, and the development of MOOCs on specific topics relevant to the profession.

Having a presence on professional social networks can facilitate not only maintaining a connection with alumni, providing a privileged channel for communication of initiatives, but also for identifying educational needs. This identification can lead to new Master or educational initiatives, specifically aimed at lifelong learning or public engagement.

The main obstacle to the practical implementation of such a model lies in the fact that it requires regulatory and organizational flexibility that, in general, universities do not possess. Managing activities of this nature can be entrusted to internal centers or consortium structures capable of dealing with complex paths that require flexibility, initiative, ongoing relationships, and minimal bureaucracy, while following private rules.

Regarding economic feasibility, the path is to reinvigorate a revised Triple Helix model, which has yielded in the past significant results. This approach would keep the connection alive among all the actual and potential actors involved in lifelong and recurrent education: universities, companies, public administration, professionals, professional and entrepreneurial associations, intermediaries, banking foundations, and innovation service structures such as incubators, scientific and technological parks, consortia, and technology transfer associations.

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Digital Education in Public Administration: results and challenges. The experience of the "Regione in Formazione" Project by Federica Web Learning

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Abstract

This work explores the value of MOOC courses in professional training. It discusses the reasons for the growing demand for online education and e-Learning methods in transmitting knowledge and skills for professional development. E-learning has become a permanent component of university education and professional training due to factors such as student preference for audiovisual content and asynchronous teaching tools, rapid technological advancements, and the need for continuous upskilling. The "Regione in Formazione" project, a partnership between the University of Naples Federico II and the Regional Government of Campania, is presented as a case study. The project delivered 18 MOOC courses to regional employees, resulting in high user satisfaction, completion rates of 80-90%, and a diverse enrollment in both hard and soft skills courses. The study also compares the analytics from the project participants with those from open-access MOOC users, highlighting the flexibility of MOOCs in catering to different learners' needs. Overall, the project's results confirm the effectiveness of MOOC-based training programs in addressing the requirements of professional training.

Keywords: Lifelong Learning, Learning On The Job, Master, Third Mission, Digital Communication.

1. Introduction

In this paper we intend to highlight the significance acquired by MOOCs (Massive Open Online Courses) in the educational sector, especially the effectiveness of e-Learning methodologies for high-profile professional education. Following widespread adoption of the remote learning methods imposed by the pandemic, the use of digital education for professional development and training has become a well-established trend and a best practice. The success of e-Learning methodologies can be attributed to a variety of diverse yet equally significant factors: the preference shown by students, especially younger ones, for learning through audiovisual educational content, preferably delivered asynchronously (Reda, 2020, p. 143; De Notaris & Passarelli, 2020, p. 81); the opportunity to experiment with new forms of interaction among learners and enhance the mechanisms for assessing the quality of the service and the usefulness of the study (Calise, 2020, p. 21); the increasing involvement of stakeholders other than state universities in the education market (Calise & Reda, 2021, p. 415), including online universities, other accredited public or private training organizations under the Ministry of Education, and entities providing consulting, coaching, and tutoring in various aspects of corporate organization and personnel training. In this regard, the case of Italian online universities is emblematic. In the academic year 2021-22, they recorded 223,937 enrolled students, marking a 410.9% increase compared to the academic year 2011-2012 when they had just over 43,000 enrolled students (ANVUR, 2023, p. 30); the inclusivity of e-Learning, enabling access to those who cannot attend physical education locations for economic, organizational, or health reasons; the inevitability of technological progress, leading to the widespread use of IT in the private sector and the digital infrastructure development in society as a whole, including public administration, which requires digitalization in line with economic and social inclusivity, accountability, and transparency (Musella, 2022, p. 21); the need for professionals and employees in every field, especially in the

digital sector, to continuously engage in processes of upskilling and reskilling (De Notaris & Melchionna, 2020, p. 106).

This becomes even more relevant in the context of work within public administrations, as one of the major challenges faced by the public sector is the need for its human resources to adapt to and continuously update their expertise in line with the rapid development of digital technologies (Acocella & Di Martino, 2022, p. 105).

It is worth noting that the urgency of upskilling and reskilling is perceived not only for technical skills but also for the development and improvement of soft skills. Globally, the public sector, along with employment services, infrastructure, and consumer goods production, has the highest demand for reskilling strategies related to soft skills (World Economic Forum, 2023, p. 48).

Given these premises, the discussion focuses on the case study provided by the "Regione in Formazione" project. This project was developed in partnership between Federica Web Learning and Regione Campania. The project aimed to create an online educational pathway for the continuous professional development (CPD) of public employees working for the Regione Campania. It involved designing, producing, and delivering 18 courses over a period of 14 months.

The project followed Directive 13/12/2001 - Training and Development of Public Administration Personnel (in the Official Gazette No. 26 of January 31, 2002), which provided guidelines for personnel training policies to improve the quality of training processes and encourage public administration leaders to invest in human and financial resources for training.

The "Regione in Formazione" project is the result of a partnership between Federica Web Learning and the Regione Campania through the project "Federica Weblearning. La fabbrica digitale" - POR FESR 2014-2020 II e III Fase Asse 2 Obiettivo Specifico 2.3 Azione 2.3.1. CUP: E69I17000130002. Specifically, Federica Web Learning has interacted with the UOD Organizational Positions - Staff Training - Labor Disputes - Customer Satisfaction Processes - Benchmarking. Thanks to funding from the European Regional Development Fund (ERDF), Federica Web Learning and the Regione Campania have embarked on an innovative and virtuous journey that has enabled the creation of a digital infrastructure explored by over 750,000 users in the Campania region and nationwide, providing them with access to over 500 MOOCs. The Regione Campania itself benefited from the presence of the Federica Web Learning Center in its territory, enabling ongoing upskilling and reskilling of its personnel and utilizing the extensive course catalog.

"Regione in Formazione" represented a pioneering experience in digital education within the public administration, benefiting from a dedicated platform and tailor-made services. The project also included an analysis activity that yielded valuable insights into learning preferences and learner satisfaction levels, with 3,400 public employees generating over 16,000 course registrations and earning more than 14,000 certificates.

2. Materials and Methods

The first step in the activities was the completion of a needs analysis and a consistent planning of learning activities, with the aim of ensuring the individual right to lifelong learning, in accordance with the institutional objectives of each administration. Additionally, there was a constant monitoring activity planned to assess participant engagement and satisfaction, with the goal of improving the service provided to citizens subsequently.

Feedback surveys conducted after each course revealed widespread satisfaction among users, with the majority of them rating the experience very positively. The proportion of enrollees in courses focused on technical skills compared to those dedicated to soft skills also demonstrated the versatility of MOOCs in conveying different forms of knowledge.

The courses offered are also available in open access format, allowing any interested user to access them through the federica.eu platform. This facilitated a comparison between the feedback from project participants and the feedback from users of open access courses, highlighting an additional point: the flexibility of MOOCs in adequately addressing diverse educational needs and different levels of engagement.

Overall, the results of the "Regione in Formazione" project confirm the effectiveness of MOOC-based learning programs in meeting educational, organizational, and professional training usage needs.

In the initial analysis and design phase, the Federica Web Learning team, in collaboration with its partners, proposed a selection of MOOCs from the Federica Pro Catalog to the Regione Campania. The Federica Pro Catalog is specifically targeted at professional users, and comprises courses that support upskilling and reskilling throughout their careers, allowing them to acquire updated and relevant workplace skills and competencies in the context of lifelong learning. Within this catalog, the Regione Campania UOD Office selected 18 MOOC courses to achieve the educational objectives of the period, divided into clusters.

Cluster Data Visualization

1. Business Intelligence con la Product Suite di Tableau
2. Data Visualization e manipolazione dei dati con Tableau
3. Introduzione alla Data Visualization con Tableau

Cluster Remote Management

4. Metodi e strumenti nel remote management
5. Lo smart working tra managerialità e leadership

Cluster Conti Pubblici

6. Investimenti pubblici e spese in conto capitale
7. La produzione e l'analisi dei dati per le politiche pubbliche

Cluster Lingua Inglese

8. English Beginner (A1.1)
9. English Elementary (A2.1)
10. English Lower Intermediate (B1.1)
11. English intermediate (B1.2)
12. English Upper Intermediate (B2.1)

Cluster Semplificazione Amministrativa

13. L'iniziativa economica privata e i poteri pubblici
14. L'attività amministrativa: principi regole e prassi

Cluster Soft Skills

15. Comunicazione efficace e gestione del conflitto
16. The Personality Game
17. Dimensione organizzativa e dinamiche psicosociali nei gruppi di lavoro
18. Smart Working: Sfide e Opportunità

The course delivery spanned over a period of 14 months, from April 2022 to May 2023. At the beginning of the project, a GANTT chart was developed with the aim of planning the delivery of courses to balance the production needs with the timing of course consumption by the target audience, thus facilitating the reconciliation between education and work. Specifically, the delivery of the first 9 courses was planned between April and September 2022, while the release of the additional 9 courses was scheduled between October and May 2023. The courses were made available to users for a one-month duration each, with the exception of certain special cases, both in terms of duration and

complexity of the topics, in which users were provided with a broader window for access. The target audience for this operation consisted of all employees of the Regione Campania, and the educational offering was divided into distinct clusters based on the needs of various personnel types:

- Managers;
- Non-managerial personnel;
- Employees (Managers + Non-managerial personnel);
- Specific operational units.

Considering that the target of the project consisted of approximately 4,300 personnel units, and the operation reached 3,403 users, approximately 80% of the target was effectively engaged.

To collect the data from the project, various analysis and measurement tools were used: inbound surveys (registration), follow-up surveys, open-ended question responses, and project Learning Analytics dashboards. Additionally, a significant amount of data was gathered through the development of a Single Sign-On (SSO) that allowed the retrieval of certain demographic and organizational information directly from the Regione's databases. Below is a brief overview of the most commonly used tools.

- SSO: the collected fields were name, surname, email, ID number, and category;
- Inbound survey: collected fields included name, surname, date of birth, university enrollment, as well as six optional fields: gender, nationality, educational level, employment status, sector, and how you learned about Federica. These additional fields were filled out by 2,010 users out of the 3,403 involved in the project;
- Follow-up survey: the survey was provided by the Regione and adapted for use within a Digital Education project. The survey is divided into 5 sections and is based on a rating scale from 0 to 6.

All the data collected were visualized through a dashboard created using Tableau software. This includes data acquired from the surveys, demographics, and learning analytics, which are data related to the usage of educational content extracted from the Learning Management System (LMS) during user engagement. The Tableau-built dashboard allowed for querying, cross-referencing, and filtering the data using various parameters. In short, it served as a tool of primary significance for conducting the analyses contained in this work.

The most significant data stored in the dashboards have been organized into tables included in the appendix to this document.

3. Results

As previously mentioned, the project involved collecting various data using SSO, inbound surveys, and follow-up surveys. Specifically, through SSO and inbound surveys, users' personal data were collected, while the follow-up surveys were instrumental in assessing feedback and information regarding user satisfaction with both the content and the experience offered by the MOOC tool and the Moodle platform.

Based on SSO and inbound surveys, the 3,403 unique users who participated in the project generated a total of 16,638 enrollments in the 18 courses offered. Users were grouped based on gender, age, educational qualifications, and professional category.

The data resulting from these categorizations have been compiled into Tables 1 to 6, providing general information about the overall project by classifying users according to specific criteria.

In particular:

- Table 1 classifies users based on the number of courses they followed;
- Table 2 classifies users based on their level of education;
- Table 3 classifies users based on their professional category;

- Tables 4 and 5 classify users based on age and gender;
- Table 6 classifies users based on course completion.

All data in these tables were derived from the voluntary submission of a form administered at the beginning of each course.

Table 1 - Classification of users based on the number of courses attended.

Courses attended	*Percentage of users*	*Number of users*
1-2	19.84%	675
3-4	22.27%	758
5+	57.89%	1,970
Sum		3,403

Table 2 - Classification of users based on their educational qualifications.

Level of education	*Percentage of users*	*Number of users*
Post-graduate	15.85%	390
Bachelor/Master	53.23%	1,310
High school Diploma	30.92%	761
Sum		2,461

Table 3 - Classification of users based on their professional category.

Professional Category	*Percentage of users*	*Number of users*
Manager	4.23%	136
Cat. D	43.63%	1,403
Cat. C	40.21%	1,293
Cat. B	11.69%	376
Cat. A	0.25%	8
Sum		3,216

Table 4 - Classification of users based on their age.

Age	*Percentage of users*	*Number of users*
25-29	1.47%	47
30-39	14.13%	453
40-49	29.17%	935
55+	55.23%	1,350
Sum		2,767

Table 5 - Classification of users based on their gender.

Gender	*Percentage of users*	*Number of users*
F	45.97%	1,157
M	54.03%	1,360
Sum		2,517

Table 6 - Classification of users based on course completion.

Completion	*Percentage of users*	*Number of users*
0 %	8.04%	1,338
0-49%	4.62%	769
50-99.9%	1.30%	217
100 %	86.03%	14,314
Sum		16,638

The information collected through the exit surveys is organized within Tables 7 to 10 and allows for a deeper analysis by exploring the feedback expressed by users based on specific questions at the end of the courses. These tables summarize the results obtained from the exit surveys conducted for a total of 14,049 course enrollments. At the end of each course, users were asked to express their level of satisfaction with various aspects of the course and the platform experience, assigning a score falling into three categories: 0-1 (needs improvement), 2-4 (good), 5-6 (excellent).

The questions in the surveys draw users' attention to certain aspects of the courses considered essential for determining their quality and effectiveness, namely:

- course objectives (Table 7), assessed for clarity, alignment with the user's work, usefulness for skill development, and achievement of those objectives;
- topics covered during the learning activities (Table 8), evaluated in terms of meeting expectations, alignment with program goals, duration of the learning activity, and the ability to provide expertise;
- teaching methodologies, instructors/consultants, and instructional materials (Table 9);
- overall assessment of the educational offering (Table 10).

Table 7 - Course goals.

Course goals items	*0-1*	*2-4*	*5-6*
1. At the beginning of the training, were the course objectives clear to you?	357 (2.54%)	4,511 (32.11%)	9,181 (65.35%)
2. Do you consider your participation in the training activity consistent with your job?	595 (4.24%)	4,335 (30.86%)	9,119 (64.91%)
3. Was your participation in the training activity helpful for the development of your skills?	493 (3.52%)	4,136 (29.44%)	9,420 (67.06%)
4. In your opinion, were the main objectives that the training activity aimed to achieve met?	301 (2.14%)	3,902 (27.77%)	9,846 (70.09%)

Table 8 - Topics covered.

Topics covered items	*0-1*	*2-4*	*5-6*
1. Did the topics covered during the training activity meet your expectations?	347 (2.47%)	4,365 (31.07%)	9,336 (66.46%)
2. Do you think the topics covered during the training activity were consistent with the program's objectives?	245 (1.74%)	3,651 (25.99%)	10,152 (72.27%)
3. How do you rate the duration of the training activity?	331 (2.36%)	5,191 (36.95%)	8,527 (60.69%)
4. Do you believe the training activity provided you with ideas, techniques, and methods applicable to your work?	691 (4.92%)	4,768 (33.93%)	8,590 (61.15%)
5. How do you evaluate the depth of the topics covered in the training?	254 (1.81%)	4,014 (28.56%)	9,781 (69.62%)

Table 9 - Teaching methods, lecturers, training materials.

Teaching methods, lecturers, training materials items	*0-1*	*2-4*	*5-6*
1. How do you rate the teaching methods used during the training activity?	310 (2.21%)	3,898 (27.75%)	9,841 (70.05%)
2. How do you rate the lecturers who participated in the training activity?	202 (1.44%)	3,214 (22.87%)	10,633 (75.69%)
3. How do you rate the training material provided during the training activity?	278 (1.98%)	4,139 (29.46%)	9,632 (68.56%)

Table 10 - General services and overall score.

General services and overall score items	*0-1*	*2-4*	*5-6*
1. How do you rate the functionality of the platform in relation to the program's objectives?	292 (2.08%)	3,694 (26.29%)	10,063 (71.63%)
2. How do you rate the support services (reception, simulator, helpdesk etc.)?	311 (2.21%)	4,316 (30.72%)	9,422 (67.07%)
3. How satisfied are you overall with the educational path?	406 (2.89%)	3,913 (27.85%)	9,730 (69.26%)

Tables 11 and 12, finally, result from the feedback provided by users through a questionnaire consisting of two open-ended questions administered for each enrollment in the project's courses.

To enhance the readability and interpretation of the answers provided, we chose to categorize and classify the responses into 9 self-explanatory tags, as can be seen below.

Table 11 - What would you change?

TAG - What would you change?	*Feedbacks*	*Percentage*
Nothing (the course was perfect)	999	41.42%
Course contents	343	14.22%
Course topics	335	13.89%
Organizational features and duration	261	10.82%
Increased interaction (onsite or online)	215	8.92%
More downloading materials	115	4.77%
Platform functionality	80	3.32%
Off-topic feedbacks	47	1.95%
Everything (the course was unsatisfactory)	17	0.70%

Table 12 - Any other comments?

TAG - Any other comments?	*Feedbacks*	*Percentages*
The course was perfect	556	63.91%
Course topics	82	9.43%
Course contents	69	7.93%
Off-topic feedbacks	52	5.98%
Organizational features and duration	35	4.02%
Increased interaction (onsite or online)	26	2.99%
More downloading materials	24	2.76%
Platform functionality	16	1.84%
The course was unsatisfactory	10	1.15%

4. Discussion

Examining the data presented in the Tables 1-10, it is possible to first learn some information about the target audience for the learning activities. The 3,403 users involved in the project collectively registered for a total of 16,638 enrollments in the 18 available courses. The response of the target audience in terms of engagement was positive, as evidenced by the fact that a high number of users chose to enroll in multiple courses: 758 users (22.27% of the total) registered for at least 3 different courses, and a substantial 1,970 users (57.89% of the total) enrolled in more than 5 courses (Table 1).

The project has equally engaged women and men (Table 5), who have diverse levels of education. Over 50% of the beneficiaries have attained a Master's degree, while just over 30% have completed their education with a diploma or a lower-level qualification (Table 2). The same diversity also characterizes the professional categories of the personnel involved, which are divided among Category B, Category C, Category D, and Executives (Table 3).

In contrast, the project's target audience appeared quite homogeneous in terms of age: nearly 30% of the surveyed users are at least 40 years old, and over 50% are 55 years or older (Table 4).

Furthermore, when examining the data related to course completion, it becomes evident that the course completion rate is very high: out of 14,314 enrollments, there is an 86% course completion rate (Table 6). The high course completion rate can be attributed to the opportunity to use the educational experience and certificates obtained to advance in one's professional career. In the specific case of public sector employees, it can also lead to career advancements when moving to a higher economic category.

As mentioned earlier, Tables 7 to 10 provide a more precise expression of learners' satisfaction. They were asked to rate certain characteristics of the educational program using specific questions related to the learning activities, particularly focusing on objectives (Table 7), topics covered during the learning activities (Table 8), teaching methodologies and instructors/consultants (Table 9), general services, and overall assessment (Table 10).

The average ratings provided for each of the questions in the different tables are high or very high, as more than two-thirds of the feedback falls at the top end of the rating scale, within the range of 5 to 6. This consistent positive trend is effectively summarized by Table 10: out of a total of 14,049 ratings, 12,208 scored between 4 and 6, and among these, 9,730 scored between 5 and 6. There is a high and widespread level of user satisfaction.

Tables 11 and 12 include feedback collected through optional response questions. For this reason, the number of responses obtained is less than the total number of course enrollments but is still significant, totaling 3,282 comments. Out of these, 2,412 are responses to the question "What would you change?" and 870 are answers to the question "Any other comments?".

The first question was aimed to grab the users' instant feedback to find out what they disliked most about the course attended and thereby which feature of the educational experience might undoubtedly be changed. The latter instead was addressed to get any other tip helpful in improving the service offered.

It was decided to classify users' feedback to both questions through the same tags, following a careful preliminary analysis and clustering of the received responses.

The 9 identified tags allowed for interpreting the suggestions and observations expressed by users in relation to the relevant context and namely:

- "course contents" deals with slides, video contents, assessment and any other item of the course;
- "course topics" reflects the claim for subjects or case study more targeted on the job position or the day-to-day tasks of the users;
- "organizational features and duration" encloses feedback that emphasize the need for a rebalancing between professional reskilling and work schedule, even reducing course duration and the timing of course delivery;
- "increased interaction (onsite or online)" highlights the opportunity to include on-site learning or webinars as well as to raise interaction between teachers and learners and among learners themselves;

- "more downloading materials" just points out the demand for learning material (slides, insights and so on) available for download;
- "platform functionality" is related to the user experience on the learning platform.

The tags "the course was perfect" and "the course was unsatisfactory" identify feedback reflecting a high level of satisfaction or dissatisfaction not more thoroughly examined. Finally, a specific tag has been selected (off-topic feedback) for labelling remarks who were hazy or not useful to improve the learning experience.

5. Conclusions

The "Regione in Formazione" operation is part of a development trend that began in 2021 with "Federica per la P.A." This initiative represents a new line of digital learning activities aimed at the world of Public Administration. It offers a rich portfolio of multimedia learning programs covering principles, data, processes, management, soft skills, and language courses. The project's aim is to address the need for continuous updating and the development of new skills to cope with regulatory, technological, and organizational changes in the Public Administration.

Starting from 2022 Federica Web Learning has been involved in other learning experiences for the benefit of the Public Administration. These experiences have resulted in the creation of tailored learning products targeting diverse user groups, each characterized by specific learning needs. Among the partners involved in these learning activities are organizations such as IFEL Campania, MAECI, and Fondazione Beni e Attività Culturali, among others.

In each experience of delivering MOOC products by Federica Web Learning directed towards the Public Administration, and particularly in the "Regione in Formazione" project, the extreme importance of tailor-made design in relation to the target audience becomes evident. The Federica Pro courses have been specifically designed and have been successful because they were meant to address the educational needs, methodologies, and formats most suitable for professional learning. They include features that go beyond traditional MOOC learning such as expert testimonies, best practices, real-world case studies applications of the concepts learned, as well as a user-friendly format and a hands-on approach.

Even within the specific context of the "Regione in Formazione" project, the courses that achieved the most success were those capable of imparting know-how that could be immediately applied in the daily professional lives of the target audience

The importance of these characteristics for the development of an effective product that can garner user satisfaction has become evident from the data collected during the "Regione in Formazione" project. The data collected before, during, and after the course attendance allow us to draw the following conclusions.

First and foremost, the learning program has proven to be effective regardless of the education level and the professional category of the personnel involved (Tables 2 and 3). This effectiveness is confirmed by another data point, which is the average age of the beneficiaries of the learning activity. It was surprising to observe that an educational program based entirely on online teaching methodologies was both accessible and engaging for a user base characterized by higher average age and a general tendency to be skeptical about work and learning done through digital tools.

Irrespective of gender, age, or professional category, almost all beneficiaries have found the attendance and completion of the offered courses to be beneficial. They have also noted the effectiveness of online education for the purposes of professional upskilling and reskilling (Table 6).

The most significant aspects of the learning program, such as course objectives, topics covered during the learning, teaching methodologies, instructors/consultants, and general services, have been rated as excellent in over 65% of the enrollments on average (Tables 7-10).

Tables 11 and 12 further confirm these findings: in response to the two questions posed to users, an average of 50% of the feedback received, essentially one out of every two feedback entries, expresses a completely positive evaluation of the overall experience offered by the learning programs in the

"Regione in Formazione" project. Among the remaining 50% of feedback entries, which provide valuable observations and suggestions, only an extremely low percentage, 0.70% in Table 11 and 1.15% in Table 12, evaluates the learning program as "unsatisfactory".

Certainly the most relevant data stem from suggestions and observations that will enable an upgrade of the educational experience. Looking at the Table 11, the major changes requested are related to course contents, course topics and organizational features. The Table 12, as well, includes remarks that mainly enhance the same points emerged from Table 11. There are thus specific challenges which push for a further rethinking of the design of digital education products for professional learning: it may happen increasing interaction moments and planning webinars to follow asynchronous learning where spaces for discussion and in-depth exploration of topics targeted to the specific working contexts can be created. The experience of "Regione in Formazione" indicates that MOOCs may be a tool for professional education, but in order to fully explore their potential it will be necessary to pay further attention to users' specific needs and to explore additional formats.

One final consideration. When comparing the results obtained from the "Regione in Formazione" project with those from MOOCs delivered in open-access format, both monitored through dashboards built on Tableau, we have found that in the two different modes of usage, the learners' satisfaction levels are aligned. In "partner" courses, as observed, on average, 65-70% of users give the courses a score between 5 and 6. In "open" courses, the percentage of users rating the courses with a score between 5 and 6 falls between 60% and 65%. Regardless of the target audience, the feedback remains consistent. In fact, irrespective of the varying course completion rates and the different motivations of the target audience, the feedback reflects a generalized and high satisfaction with the learning activity provided by Federica Web Learning, both in courses delivered as partner offerings and in those delivered in open-access format.

This data is of great significance in the writer's opinion because it demonstrates the high quality, flexibility, and adaptability of Federica Web Learning's digital MOOC education, making it an extremely effective learning tool for imparting professional skills.

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Inside Black Mirror: *Media, Society, Education.* A multidisciplinary work for the study of media and audiovisual education at school

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Abstract

In recent years, especially in response to the pandemic, a variety of Media Education and audiovisual literacy courses have multiplied in response to the increasingly mediated experience of being in the world and onlife presence of technologies (Floridi, 2017). The contribution intends to discuss a theoretical perspective and a proposal to work with schools and extra-school contexts on and with the TV series Black Mirror to (1) gain insight into the workings of the contemporary media context; (2) expose students to the social implications of living in a mediatized world (the relationship with devices, the fine line between media control and trust, cyber stupidity, the cohabitation of public and private); (3) learn basic skills to detect and understand the use of the audiovisual language. Black Mirror is a science fiction series organized into self-contained episodes that cross different genres each time, touching in each episode a specific thematic scenario that forwards the relationship between man and technology in a possible future. This TV series perfectly meets the objectives of a "New Media Education", allowing it to critically explore multiple characteristics of the contemporary media landscape and how its potential future impacts our lives. Therefore, the project comprises a collection of lesson plans to adopt in different school and educational contexts. The activities have been designed around images and texts from a selection of Black Mirror episodes and sequences, with ready-made scenarios and lesson plans to engage adolescents and younger people.

Keywords: TV Seriality, Media Education, Audiovisual Literacy, Education, Interdisciplinarity.

1. Introduction

In recent years, especially in response to the pandemic, a variety of Media Education and Audiovisual Literacy courses have multiplied in the attempt to respond to the increased *onlife* (Floridi, 2017) and mediated experience of being in the world.

Media Education is taking on unprecedented and fruitful changes, through the recognition of its "borderless nature" attributable to two orders of ideas. The first has to do with the spread of media beyond the usual places, becoming part of the connective tissue that binds us to each other. Shirky describes the sense of technology as a connective tissue, a perfectly integrated element, one of the spontaneous ways through which we communicate content and build our identities (Shirky, 2010).

If the objective of Media Education is to focus on the places inhabited by the media, it is clear that there is no longer a single place of election (the school or the family), but a continuous presence. This reasoning stems from the fact that, historically, Media Education has always coincided with the school context and aimed at a young audience (Buckingham, 2020; Carenzio, Rivoltella & Rondonotti, 2020; Masterman, 1990; Rivoltella, 2020).

The second idea is linked to the recognition of a change in purpose: from basic literacy to digital competence, from critical analysis to responsible content production, and from rules mastery to the ethics of communication (fake news, misinformation, disinformation). The sense of this shift – from alphabet to responsibility – is certainly a response to the changing role played by the media (not simply languages "to read") and gives credit to the commitment of Media Education in the vast community where people live and grow up. These premises necessarily meet the new environment

molded by the pandemic: people, regardless of age, found themselves alone, finding the media – especially the social web – the only way to connect, to distract, to spend time, and sometimes to forget the daily worries. After that "media binge", it has been very difficult to step back from the pervasiveness of media devices in everyday activities (from work to school, from fun to social interaction). The need for Media Education, and media literate people, is a clear implicit consequence of the implication of the pandemic in the field of education and citizenship.

Not only Media Education, as we discussed at the beginning, but also Audiovisual Literacy studies are gaining a new interest. Since cinema's inception, the images that moved on and behind the screens of the first cinematographers changed completely the way we relate to and represent reality. Audiovisual media have gradually become both a mirror (sometimes distorted) that reflects the attitudes, values, and norms shared by society and, simultaneously, a window towards distant worlds and perspectives. Some scholars have highlighted how cinema has become a "place of memory", a large collective diary, a space capable of welcoming in the short, medium, and long term, the sensitive or minimal oscillations of an economic and social, ideological, cultural, and anthropological nature. Conversely, today the widespread consumption of TV series seems to fulfill another function: it can be considered, and studied, as a barometer to measure social change, global sociocultural penchants, and the influence of global economic powers in shaping what and who is profitable to represent on screen. If we look at the statistics, and the offer of audiovisual products, we realize that it has been largely permeated by television seriality; in 2022 alone, 599 original scripted series were produced in the US between broadcast services, cable, and streaming (https://variety.com/2023/tv/news/peak-tv-tally-599-original-scripted-series-aired-2022-1235487593/) with a transversal viewership that brings together spectators of different ages and sociocultural background.

TV series also become the arenas where younger generations debate and negotiate new social imaginaries and identities. In other words, TV series reflect the reality we already live in and shape what we envision for the future. Thus, learning how to "read" moving images empowers us to understand what it means to be in the world during digital hyper-connectivity and how they can shape our society. The task of guiding students through the ever-growing complexity of the contemporary mediascape has increasingly fallen onto schools and teachers who often feel unprepared, and often at a disadvantage compared to their digital "native" students, to undertake this mission. Furthermore, in the last decade in Italy, there has been renewed attention from institutions to include cinema, and more generally audiovisual media, within the school curriculum, which has elicited many requests from teachers to be supported in the development of lesson plans that are mindful of the changing sociocultural context where their students are living.

We chose *Black Mirror* as a scenario to work on Media Education and Audiovisual Literacy: a well-known science fiction series organized into self-contained episodes (stand-alone episodes) that cross different genres each time, touching in each episode a specific thematic scenario that forwards the relationship between man and technology in a possible future.

Black Mirror's dystopian representation of this relationship acts as a probe to think critically about the kind of society that might unfold before us. This speculative/predictive capability speaks to us of a post-digital society (Norman, 2020) in which the boundary between humanity and technology has become strongly blurred, just as the distance that separates reality from fiction is also blurred. Viewers are pushed to ask themselves whether certain technologies presented in the series are not already being tested today or how far our societies are from the unfolding of a "*Black Mirror* scenario".

Against this backdrop, this complex TV series (Mittell, 2015) lends itself perfectly to meeting the objectives of a "New Media Education" (Rivoltella, 2020): it allows us to critically explore multiple characteristics of the contemporary media landscape and how its potential future impacts our lives. The ability of the series to narrate contemporary (and in some cases, future) themes, issues, and problems is certainly enhanced by the construction of suitable settings to support reflections in the various communities involved.

Starting from the viewing of a selection of sequences from the TV series *Black Mirror* the project wishes to achieve three main objectives: (1) gain insight into the workings of the contemporary media context; (2) expose students to the social implications of living in a mediatized world (the relationship with devices, the fine line between media control and trust, cyber stupidity, the cohabitation of public

and private spaces and practices); (3) learn skills to detect and understand the use of the audiovisual language.

2. Materials and Methods

Our intention is to respond to the need for a new education on, about, and with audiovisual products and the combined commitment to understand and live in the contemporary mediatized society, offering educators and secondary school teachers of any subject an innovative guideline that combines theoretical reflections and practical activities to develop lessons plans that integrate Audiovisual and Media Literacy Education in the classroom, in educational spaces, or third spaces (Potter & McDougall, 2019).

The project is structured into three primary phases. Firstly, it encompasses a series of systematic reflections on media and contemporary culture. These reflections delineate four core themes inspired by *Black Mirror* to address the requirements of teachers and educators. They aim to update their theoretical foundations and enhance the reservoir of resources at their disposal for engaging with students and young individuals.

These systematic reflections are based on the main literature on *Black Mirror* (Bennato, 2018; Brembilla, 2019; Cerase, 2018; Cirucci, 2020; Garofalo, 2017; Johnson, 2020; Parisi, 2014; Pescatore, 2018), digital media culture, and Media Education (Buckingham, 2019, 2020; Rivoltella, 2020) written in the last few years. The idea is to create the baseline of the architecture – the main theoretical framework – that will host the teachers, students, and educators. In pursuit of this objective, we fortified our literature review by drawing upon works within the domains of communication studies, television studies, media education, and the corpus of *Black Mirror* itself.

Secondly, it provides a group of activities and educational resources to bring *Black Mirror* into school and educational contexts (storyboards, screenplays, and activities). These are based on the method called Episodes of Situated Learning (Rivoltella, 2013, 2016, 2023). The idea is to provide a sort of catalog to connect *Black Mirror*, its topics, and Media Education in the classroom.

The ESL method (EAS in Italian) was introduced in 2013 through the efforts of Rivoltella and is structured into three distinct phases, as outlined in Table 1. These phases are underpinned by the principles of microlearning and instructional design, which include aligning the educational objectives of both learners and educators, examining alternative hypotheses, bolstering knowledge derived from practical application, and fostering metacognition facilitated by theoretical comprehension and meta-reflection (Laurillard, 2014).

Table 1 - Episodes of Situated Learning: phases, teacher's action, student's action.

Phase	*Teacher's action*	*Student's action*
Preparatory	Assigns tasks Builds and exposes a conceptual framework Provides a stimulus Gives a delivery	Listens, reads, understands, explores Performs assigned tasks (in advance and mainly at home, individually) Follows the teacher's stimulus (created with digital tools and environments)
Operatory	Defines the timing Organizes individual/group work	Produces and shares an artifact
Restructuring	Evaluates the artifacts Corrects the misconception Fixes concepts through a lesson "after the experience"	Critically analyzes artifacts Develops reflections on the main process activated Fixes concepts

Within the ESL framework, the first phase, "Anticipation", involves encouraging the development of individual ideas and reasoning within a guided yet open framework that integrates elements from the daily lives of children and young individuals, drawing stimuli from contemporary media. The second phase, "Production", entails the collaborative construction of meanings and skills in conjunction with

peers, situated within the context of the zone of proximal development as conceptualized by Vygotsky (1978). Here, peers and educators serve as catalysts, facilitating collective growth and the elaboration of novel thoughts. The third and final phase, "Reflection", is dedicated to the process of retrospection and is facilitated by debriefing sessions. This phase encompasses an examination of three interconnected dimensions: cognition, emotion, and procedures, as expounded by Rivoltella (2013). The third step, then, refers to the design of a model to deal with TV series to be used to deepen our approach to digital media and citizenship, beyond Brooker's creation. The result is also an intellectual laboratory within the academic system as it deliberately combines two perspectives, that of Media Studies and that of the Educational Sciences.

3. Results

The project's main result is a book – *Inside Black Mirror: Media, Society, Education* (Carenzio & Farinacci, 2023) – nourished by a collection of lesson plans that can be adopted in different school and educational contexts. This contribution will focus on the results of the first two, simply presenting the foundations of the third stage – in progress – temporally placed in the school year (2023-2024). The above-mentioned objectives are disseminated in the first two moments and will come to life in the third one, meeting students, teachers, and educators in their contexts and experiences. Results are organized into three sections: *Topics and theoretical challenges*, *A set of resources*, and *An integrated model*.

3.1 Topics and theoretical challenges

In 2011 the first season of the anthology series *Black Mirror* was released, a science fiction organized into self-contained episodes (stand-alone episodes) that intersect each time a different genre, touching a specific thematic scenario connected to the relationship between man and technology in an eventual future. Science fiction narratives, particularly dystopian ones, can record the still invisible impact of futuristic social systems and explore all possible "maps of hell" (Moylan, 2000, pp. 106-107) that could occur shortly. The British series, produced for Endemol Shine Group, was born from the idea of Charlie Brooker, author and award-winning producer who has permanently moved between television, radio, press, and online media. The first two seasons aired on the British broadcaster Channel 4 (the first series arrived in Italy in 2012 on Sky Cinema), and the third season of the series landed on Netflix (October 21, 2016). This is certainly not a secondary factor since it contributed to the construction of a popularity, beyond the initial forecasts.

Thanks to the ambiguity and indistinguishability between reality and science fiction, *Black Mirror* allows us to investigate some of the most significant issues of our times: being or appearing at the time of social media and the social web; sharing the private world for loneliness, pleasure, or inability to manage relationships; digital stupidity as described by Prensky (2010), almost ten years after the appearance of the popular idea of digital natives (Prensky, 2001a, 2001b); parental control through apps and software; wearable media as part of our daily experience. These are key issues that find a clear place in the construction of digital citizenship (or simply citizenship) in the debate on living in the media ecosystem today and in the prevention of risky behaviors, especially for adolescents and young people.

The result of *Black Mirror* is a mixed effect, combining familiarity with certain formats (game shows, talent shows, portable devices, social media, storage systems) and a sense of inadequacy and repulsion towards the ambiguous relationship with technology. Could it be us or is it already us? Who dominates who?

We have structured the presentation of the topics into four distinct sections: an introductory overview (the antechamber) followed by three main sections (rooms). In the antechamber, we provide a preliminary framework for the topics. Subsequently, in the first room, we undertake a comprehensive exploration of the specific topic within the narrative and textual context of *Black Mirror*'s episodes. The second room serves as a space for an in-depth examination of concepts, encompassing the contributions of various authors and theoretical frameworks. Lastly, the third room synthesizes the

educational inquiries and considerations about each topic. For this study, we have selected four focal topics: the dynamics of human-device interaction, the theme of control, the interplay between frontstage and backstage personas (in line with Goffman, 1969), and the concept of cyber stupidity (drawing from Prensky, 2010).

The images below show the four topics highlighted, the main scholars, the theoretical background, and the list of episodes used as references and scenarios.

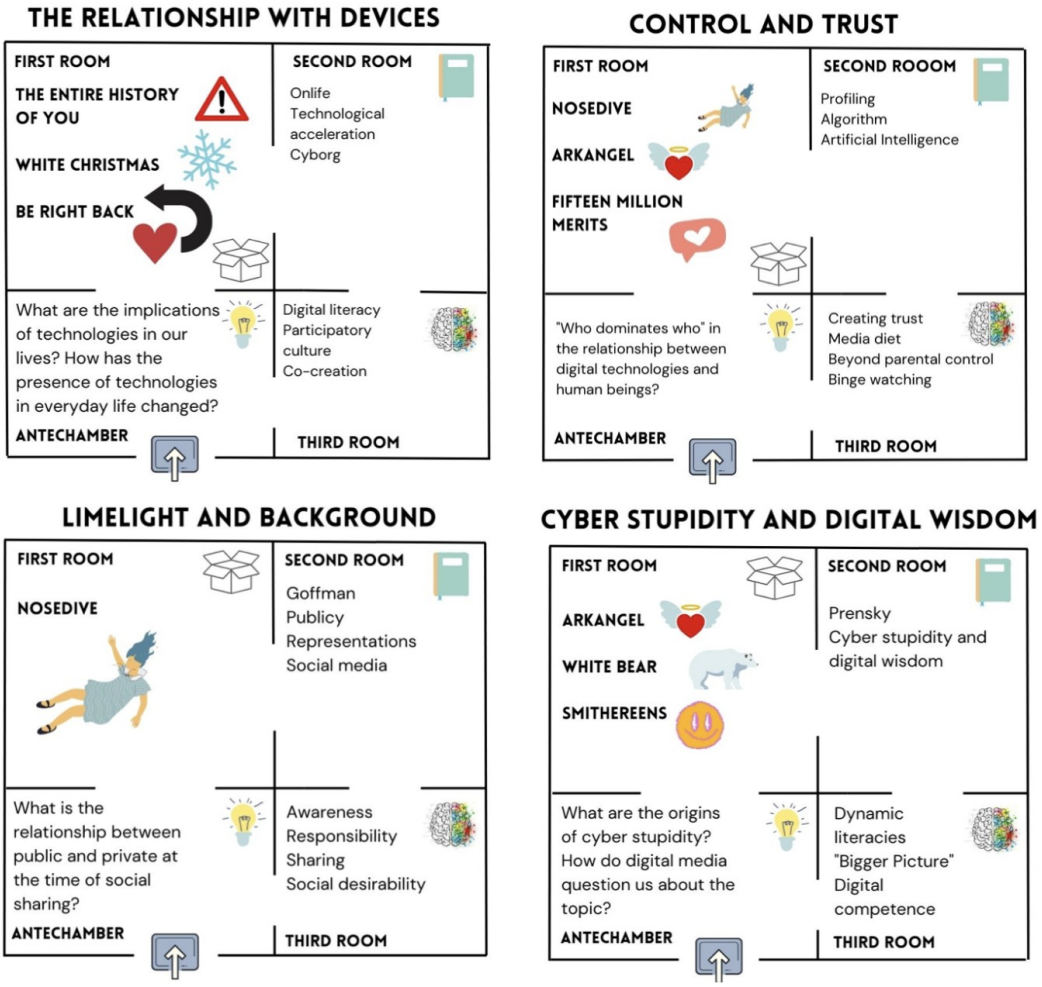


Figure 1 - Topics.

3.2 A set of resources

The activities have been designed from a selection of *Black Mirror* episodes, providing ready-made scenarios through lesson plans to engage adolescents and younger people. Meeting the demands of the school programs, the topics of the lesson plans intersect themes that are appropriate to fit within the "civic digital citizenship" courses as they can be easily intertwined within a broader work on digital culture, responsibility, and awareness aimed at building an attentive, creative, respectful attitude at all levels. At the same time, they can be used to explore specific themes within several subjects such as, for instance, the technological advancements of AI within a science course or the effects of social rating within a sociology or politics course.

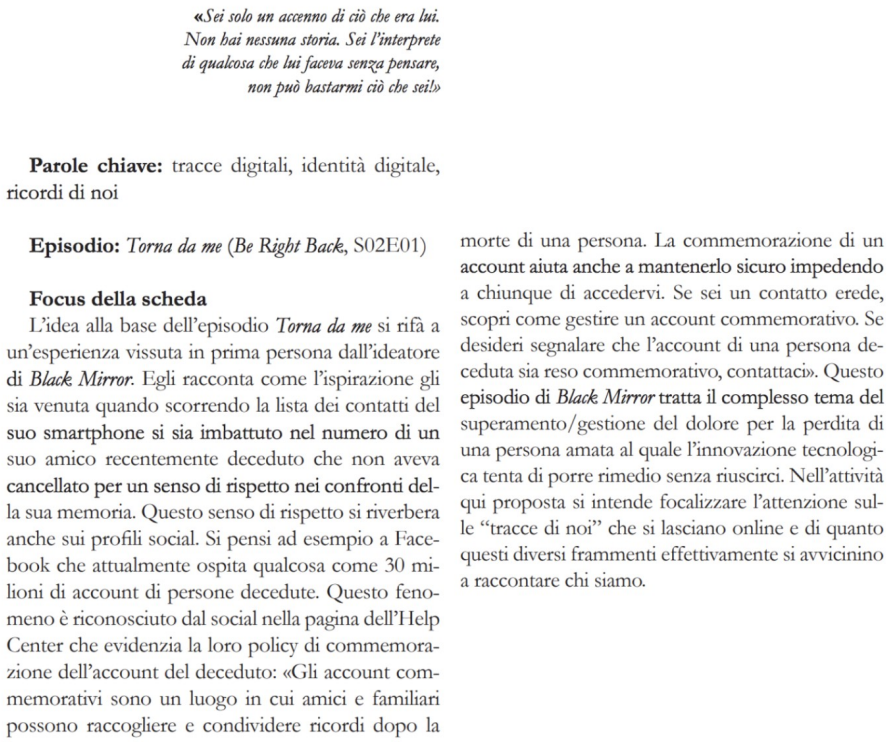
The resources can be used without personal changes, since each activity can focus on an aspect of the series and contemporary culture, or as a canvas, to weave the perfect textures more suitable for each context. In addition, it is possible to adopt a "one shot" approach (using a single activity) or to conceive the resources as part of a wider path. Since we are promoting the adoption of a posture and the reflection on behaviors, we certainly could not work on transmissive constructs: making and

producing are a bridge for thinking, passing by the relevant role of reflection, sharing, discussing, guiding (typical of the Episodes of Situated Learning chosen as methodological design framework). The challenge is not so much about the "thing" to teach, but especially about "how" it is taught, speaking the same language, and being on the same page (Marangi, 2004).

In addition to the ten activities, we have devised two scripts, one for schools and one for extra-school contexts (youth aggregation centers, social workspaces). Each script elaborates on visual and auditory elements, encompassing descriptions of settings, character actions, and dialogues, accompanied by detailed frame-by-frame descriptions

The scripts, therefore, are written summaries describing the actions teachers and educators will bring on stage, detailing focus, steps, stimuli, tools, materials, and outputs, but also the roles that each member of the teaching cast – we could say – should assume. As everyone knows, the transition from the lesson plan (Rivoltella, 2022) to real-life contexts is not so rigid, but certainly, it is a relevant guide. One script refers to the *systematic level* of audiovisual analysis, and the second to the approach based on the occasional reading (Rivoltella, 1998), which is the *non-systematic* level of analysis of films, and audiovisual products, with an interpretative approach and/or an *historical approach*.

We include an example of an activity: a quotation from the episode – in this case *Be Right Back* (S02E01) – opens the proposal, as a stimulus and starting point of the work. Then keywords frame the activity, followed by the title of the episode. The focus aims to present the topic, idea, and questions involved (in this case the role of technologies in keeping memories, even after someone's departure, and how human people deal with memories, personal identity, and data).



«Sei solo un accenno di ciò che era lui. Non hai nessuna storia. Sei l'interprete di qualcosa che lui faceva senza pensare, non può bastarmi ciò che sei!»

Parole chiave: tracce digitali, identità digitale, ricordi di noi

Episodio: *Torna da me* (*Be Right Back*, S02E01)

Focus della scheda

L'idea alla base dell'episodio *Torna da me* si rifà a un'esperienza vissuta in prima persona dall'ideatore di *Black Mirror*. Egli racconta come l'ispirazione gli sia venuta quando scorrendo la lista dei contatti del suo smartphone si sia imbattuto nel numero di un suo amico recentemente deceduto che non aveva cancellato per un senso di rispetto nei confronti della sua memoria. Questo senso di rispetto si riverbera anche sui profili social. Si pensi ad esempio a Facebook che attualmente ospita qualcosa come 30 milioni di account di persone decedute. Questo fenomeno è riconosciuto dal social nella pagina dell'Help Center che evidenzia la loro policy di commemorazione dell'account del deceduto: «Gli account commemorativi sono un luogo in cui amici e familiari possono raccogliere e condividere ricordi dopo la morte di una persona. La commemorazione di un account aiuta anche a mantenerlo sicuro impedendo a chiunque di accedervi. Se sei un contatto erede, scopri come gestire un account commemorativo. Se desideri segnalare che l'account di una persona deceduta sia reso commemorativo, contattaci». Questo episodio di *Black Mirror* tratta il complesso tema del superamento/gestione del dolore per la perdita di una persona amata al quale l'innovazione tecnologica tenta di porre rimedio senza riuscirci. Nell'attività qui proposta si intende focalizzare l'attenzione sulle "tracce di noi" che si lasciano online e di quanto questi diversi frammenti effettivamente si avvicinino a raccontare chi siamo.

Figure 2 - Example (Focus).

Then objectives are listed, in this case:

> *this episode shows a technology that allows us to mitigate the loss of a loved one, rebuilding a digital version through the use of intelligent software that collects and processes the traces we leave or save online on our devices. Through this activity, students are invited to think about the image/idea/perception they create on social media. What kind of image would the software described in the episode create of us? What*

> *would these images say about us? Would they return a true image to be delivered to posterity? (Carenzio & Farinacci, 2023, 187).*

After the step-by-step description of the activities suggested, each resource comprises the indication of tools and materials, and the expected output (storyboard, videos, images, posters, cards etc.).

3.3 An integrated model

> *Sooner or later, we know, cinema will enter the school, no longer merely tolerated as a pastime or a means to convey other knowledge, but appreciated and studied in its own right. On that day, cinema will be encouraged just as reading is encouraged now, and there will be no more issues [...]. We have no doubt that this will be the great popular school of tomorrow (Jean-Michel, 1954).*

Thus wrote Jean-Michel, founder of the first cineclub for young people in the aftermath of the Second World War. His hopeful outlook for the future of cinema to enter school curricula has hardly come true today. Although there are numerous attempts and independent projects to bring audiovisual literacy to the classrooms, they are still only fostered by individual teachers or institutes. This structural issue is also further complicated by the instrumental approach that widely characterized the teaching of film, which uses audiovisuals as a means to talk about something else (in the best case scenarios), to explain more clearly concepts discussed in class, or to substitute top-down lectures from the teachers.

In recent studies, this approach to audiovisual literacy has been integrated within a three-tiered model taking inspiration from the Media Education framework (Rivoltella, 2020; Carenzio & Farinacci, 2023). Firstly, educating about media, where the focus is on the examination of audiovisual content; secondly, educating through media, which involves using audiovisuals as tools to contemplate broader societal phenomena; and thirdly, educating within/for the media, where students actively engage in experimenting and expressing their creativity, aligning with a "learn by doing" perspective (Marangi, 2004; Rivoltella, 2001).

Within the contemporary media ecosystem, complexified by the acceleration of digital media and technologies, teachers are becoming increasingly aware of the need to consider audiovisual media not only as a pretext or a tool to talk about something else but as an autonomous object to appreciate and study. This kind of approach requires teachers to acquire more specialized knowledge not just of the audiovisual languages (semiotic approach) but also of the productive and industrial context where a film or a TV series was created. This awareness is best captured by the aesthetic, ethical, and critical framework (Rivoltella, 2020; Valgolio 2021; Carenzio & Farinacci, 2023). This approach amalgamates several elements including, a context-sensitive textual analysis that allows one to access and comprehend cultural forms within their sociocultural contexts (*aesthetic dimension*); an awareness of the broader dimensions of media production and consumption that influence both the audiovisual products themselves, and the way that spectators understand the world (*ethical dimension*); and an understanding of the power dynamics inherent in the media ecosystem (*critical dimension*). As aptly pointed out by David Buckingham (2019), this framework takes into account the dominance of powerful tech conglomerates (often referred to as FAANGs) that are progressively shaping the content of these products and exerting significant influence on how the world is portrayed. In other words, the critical approach is attuned to the idea that contemporary culture can be heavily influenced by the forces of "digital capitalism".

The teaching of audiovisual subjects should thus not undergo standardization to fit into the "mold" of the school curriculum but to become access points to the students' media consumption and personal lives. To know and discuss what students watch and how they interpret what they see is today a fundamental endeavor to disclose the way they perceive their being in the world, and what kind of citizens they wish to be and become in the future. Thus, our research project attempts to consider media/audiovisual literacy both as a learning experience transversal to all school subjects and as a bridge between schools and the outside world (the experience of reality is, after all, always mediated).

4. Conclusions

So, how can the case of *Black Mirror* fit within these transformation processes in Media Literacy Education? There are at least two broad areas of action worth considering: (1) the series acts as a barometer of today's media context by functioning as speculative storytelling that anticipates a variety of "possible universes" through which we can gauge the fears, problems, and contradictions of societies dominated by uncertainty and a constant state of emergency, and (2) the series allows for reflection on the media ecosystem of entertainment by revealing the practices of producers and viewers in contemporary times. From our perspective, *Black Mirror*, and TV seriality in general, opens the door to a plethora of educational and pedagogical avenues. On one hand, it allows educators to remain abreast of the latest trends in youth pop culture and the consumption patterns of their students. On the other hand, it empowers students to acquire a diverse set of interdisciplinary skills, enabling them to scrutinize audiovisual content with a more discerning and informed outlook. This equips them with a better comprehension of the mechanisms governing the media industry, encouraging them to become more conscientious consumers and producers.

These objectives require the joining of different, but interwoven, disciplines and expertise namely, Media Education, film studies, and cultural studies. Our project is thus propelled by the desire to address the needs of teachers and students alike to acquire instruments to better navigate the ever-changing complexities of the current mediascape in which they are embedded. The interpretative models and activities we propose wish to cater to the needs of teachers, who can quickly acquire the essential coordinates to approach audiovisual literacy. Furthermore, the theoretical dimension of the book is integrated and expanded through practical activities that are presented ad flexible scripts to enable educators to be tailored to their lesson plans and students' needs.

The efficacy of this instrument will be tested and validated through extensive experimentation with the future perspective of incorporating all the teachers' and students' suggestions into digital open-access tools and future publications.

Authors' contributions

Authors share the organization of the contribution and the *1. Introduction*. Alessandra Carenzio wrote *2. Materials and Methods*, *3.1 Topics and challenges*, *3.2 A set of resources*; Elisa Farinacci wrote *3.3 An integrated model* and *4. Conclusions*.

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Can a robot tame children's fear? A systematic review investigating the functionality of social robots in the hospital context

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Abstract

Nowadays, the interaction between social robots and children occurs in a wide variety of contexts, including homes, schools, and hospitals. The present systematic review analyses this interaction within the hospital environment to identify social robots' main features and uses with children. A search was conducted on April 5th, 2023 on five databases. The final screening was conducted on 369 results, of which 354 were excluded. Inclusion criteria pertained to the (1) typical development; (2) age range 4-12 years; (3) hospital setting; (4) type of robot (social); (5) type of publication: peer-reviewed journal; (6) language: English; 7) research studies. Through further systematic reviews, we identified and selected 3 additional studies.

We obtained 18 results that were relevant to the systematic review's objective. After reading the full-text, all documents were deemed eligible for the current review. In the results and conclusion sections, we discussed the studies by organizing them into three categories: "Social robots as distractors prior to or during medical procedures", "Social robots as informational and educational tools" and "Desirable features of social robots in the hospital context". Overall, the use of social robots in pediatric hospital settings to distract and/or inform children appears to be a promising research and intervention field. However, various theoretical and methodological questions, as well as ethical issues should be addressed when implementing similar research.

Keywords: Social Robot, Children, Human-Robot Interaction, Healthcare, Pediatric Settings.

1. Introduction

In recent decades, the increase in the use of social robots allowed further exploring their potential in various fields such as education and healthcare. While there are many different definitions of "Social robot" within the scientific literature (Sarrica et al., 2020), we propose that of Fong and coworkers (2003), "A social robot is an autonomous agent that can act in a socially appropriate manner based on its role in an interaction", which is particularly relevant for the purpose of our review. In this sense, social robots differentiate themselves from other types of robots by having a physical embodiment, as well as the ability to act semi-autonomously and interact with humans while adhering to the social norms established by the context or situation (Hegel et al., 2009).

In the realm of education, social robots are employed for both learning purposes and to favor a better understanding of the child's emotional states during their school life (Moerman et al., 2019; Dawe et al., 2020). In the domain of healthcare, they are used, for instance, in pediatric environments to enhance well-being and smooth medical procedures for the benefit of both children and staff (Logan et al., 2019). Specifically concerning children, robots can help distract them during complex procedures that might evoke fear and anxiety. Under these circumstances, the cooperation between children and healthcare professionals is often challenging, leading to extended durations for diagnostic and medical

procedures (Dawe et al., 2019). Scientific literature highlights that distraction is currently the most widely used technique in the majority of healthcare procedures (Rossi et al., 2020).

Many social robots employed for this purpose are humanoid, i.e., they have human-like appearances and the capability to interact through artificial intelligence systems (Formosa, 2021). Some of these robots, like NAO and Pepper, seem more capable than others in addressing children's emotional needs and establishing an interactive connection with them to aid in managing anxiety and emotional stress (Beraldo et al., 2019; Smakman et al., 2021; Rossi et al., 2022). However, the underlying mechanisms through which these social robots can alleviate anxiety, stress, and even pain related to hospital procedures remain uncertain. For instance, it's not clear whether such mitigation occurs due to the effective capabilities that a well-programmed social robot brings into play during the interaction with the child, or if it is because the social robot itself appears as a novel and unexpected item, thus operating the aforementioned "distraction" effect. As a first step to understanding the features and functionality of social robots in their interaction with children within the hospital context, we conducted a systematic literature review to evaluate the role of these robots in the pediatric healthcare field.

2. Materials and Methods

Based on the criteria provided by PRISMA guidelines for systematic reviews (Moher et al., 2009), a search was conducted on April 5th, 2023 in five databases, namely Scopus, WebOfScience, APA PsycInfo, Cinahl and PubMed, using the following keywords strings, TX (social robots or therapeutic robots or socially assistive robots or companion robots) AND TX (child* or kids or youth or pediatric) AND TX (hospital or acute setting or inpatient or ward). The search had no time limit. Four hundred and sixteen documents were identified in the databases. After removing duplicate records, the studies were screened based on seven inclusion criteria: (1) typical development; (2) age range 4-12 years; (3) hospital setting; (4) type of robot (social); (5) type of publication: peer-reviewed journal; (6) language: English; 7) research studies. Regarding the fourth inclusion criterium, it is worth noting that we categorized as "social robots" those complying with the definition by Fong and coworkers (2003) reported in the Introduction of the present article; for this reason, non-humanoid robots (e.g., pet robots) were included. The inconsistencies were discussed by the team of authors. After this process, 354 records were excluded; the second exclusion phase was defined by a single criterion: 1) out of scope. In this phase, 0 records were excluded. 3 studies were identified and deemed eligible through another method (articles derived from systematic reviews). Therefore, the full-text of *18* eligible articles was accessed. After reading the full-text, all documents were deemed eligible for the current review (Figure 1).

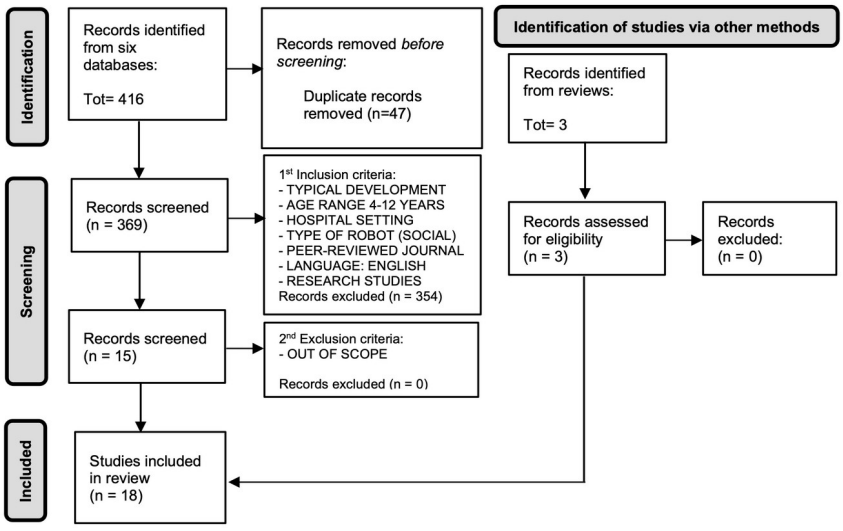

Figure 1 - PRISMA 2020 flow diagram for new systematic reviews which included searches of databases.

To better understand the features and functionality of social robots in the hospital context, as well as the issues related to them, we divided the included studies into three categories, namely 1) "Social robots as distractors prior to or during medical procedures", 2) "Social robots as informational and educational tools", and 3) "Desirable features of social robots in the hospital context". The first category takes into account all studies where social robots were used with children as distractors (e.g., informal interactions, playing games together) from unpleasant medical procedures (e.g., blood draws) both before or during the procedure itself. The second category focuses on those studies where social robots were used to deliver information on medical procedures ahead to the children or to develop their ability (e.g., self-efficacy) to cope with them. Lastly, the third category comprises studies related to how the different actors involved (children, parents, healthcare professionals) deem social robots should look and act to be effective in the hospital context.

3. Results

Regarding the "Social robots as distractors prior to or during medical procedures" category (Table 1), 9 results have been included.

Beraldo et al. (2019) conducted a preliminary observational study to assess the capabilities of two social robots, Pepper and Sanbot Elf, in entertaining and engaging patients aged 3 to 19 and hospitalized in a Pediatric Pain Management and Pediatric Palliative Care Unit. Data were collected before, during, and after many painful procedures, such as arthrocentesis, spinal tap, renal biopsy, venous access, bone marrow biopsy, bronchoscopy and gastroscopy. The results demonstrated significant reductions in negative emotions and an increase in positive emotions, up to 73.33%, after the interaction with the social robot. 78.57% of the participants evaluated the experience positively, and 85.71% expressed a desire to meet the robot again for further interaction and play. A significant reduction in negative emotions and feelings, such as suffering and distress, was also found in Beran et al. (2013), who tested the effectiveness of the social robot NAO in interacting with early primary school children during vaccination. The randomized controlled study included one group undergoing a standard procedure and another group engaging in interaction with NAO programmed to employ cognitive-behavioral strategies while the nurse administered the vaccine. Multivariate analyses of variance indicated that the group of children who interacted with the humanoid robot exhibited lower levels of pain and distress. Self-assessments filed by children and assessments filed by parents and nurses confirmed the behavioral data. Jibb et al. (2018) assessed the effectiveness of NAO in reducing pain and distress in children aged 4-9 with cancer during subcutaneous port needle insertions. The social robot was programmed to apply psychological strategies during the procedure, and most of the children responded positively to the active distraction provided by the social robot. The results demonstrate the effectiveness of this intervention and highlight some challenges related to programming NAO's cognitive-behavioral aspects.

Another study that explored the capabilities of NAO in mitigating anxiety and stress was conducted by Rossi et al. (2022) on children aged 3-10, awaiting medical procedures in the emergency room. The study aimed to compare the effectiveness of the interaction with a social robot, a nurse, or parents on children's stress management through salivary cortisol measurement. The randomized clinical study in the pediatric emergency room found significant reductions in the group interacting with the social robot; specifically, a greater decrease in females compared to males.

Smakman et al. (2021) also studied the abilities of the social robot NAO to mitigate pain and anxiety in children aged 4-12, before blood collection procedures. The programming of the social robot was based on the minimum requirements identified by healthcare professionals through focus groups. The interaction between the social robot and children, aimed at mitigating pain and anxiety before the venipuncture procedure, yielded optimal results among children aged 6-9.

Logan et al. (2019) conducted a comparative experiment with pediatric children aged 3-10 years. Children were randomly exposed to three distinct types of interventions: 1) interaction with a social robot; 2) interaction with an avatar version of a teddy bear, displayed on a tablet; and 3) a stuffed teddy bear. The results showed that children exposed to interaction with a social robot reported a

higher degree of positivity compared to those who interacted with an avatar or a plush toy. Interactions with the social robot were characterized by higher levels of joy and pleasantness.

Moerman & Jansens (2021) conducted a multiple-case study involving hospitalized children aged 4 to 13. The study explored the interaction between children and the pet robot PLEO (a dinosaur), assessing its potential to influence the well-being of hospitalized children. The interaction consisted of five play sessions during hospital visits and longer stays. Care professionals, children, and parents were subjected to interviews. Employing direct content analysis revealed six significant categories: interaction with PLEO, the role of adults, preferences regarding PLEO, PLEO as a companion, achievement of predefined goals, and the utilization of PLEO. This type of interaction contributed to improving the management of emotions and feelings such as stress and boredom. Additionally, the robot was perceived as attractive and engaging.

Okita (2013) conducted a study to investigate the potential of the seal robot PARO in reducing pain and emotional anxiety in pediatric patients. The patients' ages ranged from 6 to 16 years, and parents also participated in the study. The study identified a stronger empathic resonance and a significant reduction in negative emotional states when children and parents were involved together in interaction with the robotic companion. Furthermore, additional reductions in pain were observed when the parent acknowledged the need for improved pain management while accepting the presence of the robot as a companion in a new interactive experience.

Trost et al. (2020) conducted a pilot study on children aged around 10 years old who underwent peripheral intravenous cannulation placement. The aim was to assess the advantages and potential of a social robot in reducing pain and distress in hospitalized children. The study was designed with three experimental conditions: 1) no robot, 2) robot programmed to interact with empathy, and 3) robot programmed to interact in a distracting manner. The results revealed higher satisfaction among patients who received treatment with the empathic robot compared to those who received standard care treatment.

Regarding the 2nd category, "Social robots as informational and educational tools" (Table 2), 8 results have been included. Al-Taee & Kapoor (2016) studied the potential of the social robot NAO with children and adolescents aged 6-16 years suffering from type 1 diabetes. The study aimed to establish the level of acceptance of the humanoid robot by the patients. The overall acceptance rate was 86.7%, and this value varied depending on the age range. For instance, the age group between 6 and 9 years of age exhibited higher levels of acceptance, 94.8%, while lower levels were observed in the 10-12 and 13-16 age ranges, 85.0% and 83.0% respectively. Some features of the robot proved to be more accepted and desired than others; among these were providing advice on blood glucose levels and offering guidance on how to deal with blood glucose patterns.

Alemi et al. (2015) conducted a study to explore the effect of NAO as a therapeutic assistance tool in addressing the distress of children aged 7-12 who were oncology patients. The children were randomly assigned to two groups, the first interacting with NAO and the second in a psychotherapy group at two specialized hospitals in Tehran. The purpose of NAO was to perform various scripts in eight intervention sessions. In these sessions, the robot aimed to teach the children about their symptoms and demonstrate empathy towards them, as well as provide them with the opportunity to express their fears. The research group used questionnaires to measure anxiety, anger, and depression. The results highlighted a significant improvement in stress and depression levels and a positive attitude of the children towards the robot. Like other studies, this one also showed that following interaction with NAO, children cooperated more effectively with each other. Moreover, one session with the robot was dedicated to teaching the children some relaxation and desensitization techniques. The research conducted by Chang and Hwang (2023) is part of the body of exploratory studies on robot-assisted digital storytelling aimed at mitigating anxiety and stress in children, specifically during intravenous injections in a hospital setting. The average age of the children who participated in the study was 7 years old, and they were randomly assigned to two groups: the experimental group adopted the robot-assisted digital storytelling approach, while the control group received video-based health education. The results revealed the effectiveness of digital storytelling in reducing children's anxiety, as well as an improvement and greater openness of children in communicating their thoughts and fears regarding the medical procedure.

The article by Kaptain et al. (2021) consists of two sections: the first section presents a modular cloud-based robot control implementation. The robot's control architecture includes a common knowledge base, a database, a "hybrid artificial brain", an activities center, an embodied conversational agent (ECA, i.e., robot and avatar), and dashboards (for authoring and monitoring the interaction). In the second section, the system applied to a Personal Assistant for a Healthy Lifestyle (PAL) is discussed. This system is capable of supporting diabetic children aged 6-14.

The study conducted by Loijie et al. (2016) aims to design a scenario for interactive activities between diabetic children aged 6-10 and the Social Robot NAO during return hospital visits. The activities are playful and educational, distributed across three sessions that include quizzes, sorting games, video viewing, walking with the robot, and specific tests. Overall, both children and their parents appreciated the various activities, demonstrating a willingness to establish relationships with the robot. The results indicate NAO's ability to have positive effects on mood and to convey useful content to children for better self-management of their disease, particularly in terms of organization and attention to certain practices.

Neerincx et al. (2019) conducted a study presenting and developing a socio-cognitive engineering (SCE) methodology to guide human-robot interaction. This methodology was tested on the social robot NAO in a series of activities aimed at supporting the daily processes of children aged 7-14 with diabetes. Four partnership functions were identified and elaborated upon (joint objectives, agreements, experience sharing, and feedback & and explanation), along with a common knowledge base and interaction design for the extended self-management of the child's disease. The results highlight the feasibility of addressing the three fundamental needs of the Self-Determination Theory: autonomy, competence, and relatedness.

Russell et al. (2021) conducted a two-part study: the first part was conducted online, where the opinions of young individuals aged 10-14 with cystic fibrosis regarding the possibility of creating a book about their experiences with the disease were assessed. The second part consisted of a feasibility study in which the Social Robot NAO was tested, offering metacognition and narrative imagination (MINI) training. The results demonstrate improvements in anxiety and metacognitive beliefs related to concerns and superstitions regarding the disease. Parents positively evaluated the presence of the robot and considered it an easy-to-use tool for conducting this type of interaction.

Van Bindsbergen et al. (2022) explored the use of the Social Robot NAO as a means to develop an educational program on sleep hygiene. The interactive educational program addresses six topics and was tested on children aged 8-12 years at a pediatric oncology clinic during cancer treatment; the feasibility of integrating such a robot within the hospital context was examined. The results revealed positive perceptions of the robot, both from children and parents; specifically, 83% of children and 75% of parents expressed the desire to learn more and spend more time with NAO. Semi-structured interviews revealed that 54% of families reported applying the sleep advice once at home.

Table 1 - Social robot as distractors prior to or during medical procedures (N = 9).

Authors (year)	*Study type*	*Type of robot*	*Sample*	*Aim of the study*	*Measures*	*Main results*
Beraldo et al., 2019	Observational preliminary study	PEPPER and SANBOT ELF	28 patients aged 3-19 years old	Investigate the ability of robots to entertain patients in order to alleviate negative emotions	Ad-hoc self-report measures assessing 12 emotions	Reduced negative and increased positive emotions after the interaction in both groups; older children favoring Pepper
Beran et al., 2013	Randomized controlled study	NAO	57 children aged 4-9 years old	Investigate the ability of robots to alleviate children's pain by providing instructions and acting as a supportive friend	Measures of pain completed by children (Faces Pain Scale-R), parents, nurses, and researchers. Videotapes coded via the Behavioural Approach-Avoidance Distress Scale (BAADS)	The utilization of robots during medical procedures, such as vaccinations, significantly alleviated pain and distress in children.

Authors (year)	*Study type*	*Type of robot*	*Sample*	*Aim of the study*	*Measures*	*Main results*
Jibb et al., 2018	Pilot randomized controlled trial	MEDiPORT	40 children aged 4-9 years old	Investigate the effectiveness of MEDiPORT in mitigating children's distress during needle insertion comparing a cognitive-behavioral intervention with active distraction	Ad-hoc (Likert-type items and one open question) measures of pain, fear, and distress completed by children, parents, and nurses	MEDiPORT was acceptable to participants. No difference reported in pain between the cognitive-behavioral and the distraction conditions, less distress reported in the distraction condition
Logan et al., 2019	Pilot study	HUGGABLE	54 children aged 3-10 years old and their parents	Describe the introduction of a social robot in pediatric inpatient care (in comparison to a plush animal) and present acceptance data	• Intervention enrolment and completion patterns • Children's positive and negative affect (PANAS), anxiety (STAI), and pain intensity (NRS) • Qualitative feedback on the acceptability of the social robot from stakeholders	• Intervention completion of 93% • More positive affect expressed by children interacting with the social robot compared to the plush animal • Numerous benefits of social robots in pediatric settings reported by stakeholders
Moerman & Jansens, 2021	Multiple case study	PLEO (pet robot)	9 children aged 4 to 13 years old and their parents	Exploring how playing with PLEO can contribute to a hospitalized child's wellbeing	Direct observation of children-PLEO interaction, interviews with care professionals, children and parents	PLEO was enjoyed by children and useful in promoting their well-being when administered under guidance of a pedagogical care
Okita, 2013	Randomized study	PARO (pet robot)	18 patients aged 6-16 years old and their parents	Testing the effectiveness of PARO in reducing negative emotions in pediatric patients	Measures of anxiety (STAI, STAIC), and emotions (Wong-Baker FACES) self-reported by children	PARO effectively reduced negative emotions, with added benefits when children and parents engage together
Rossi et al., 2022	Explorative study	NAO	109 children aged 3-10 years old and their parents	Assess the impact of social robots on managing stress in children waiting for an emergency room procedure	Comparison of salivary cortisol levels before and after the intervention	Salivary cortisol levels significantly decreased more in the group exposed to robot interaction with respect to a control group
Smakman et al., 2021	Randomized controlled experiment	NAO	158 children aged 4-12 years old and their parents	Testing a social robot to mitigate stress and anxiety during blood collection in children	Children's self-reported Visual Analogue Scale (VAS) and the Face, Legs, Activity, Cry, and Consolability scale (FLACC)	Lower levels of anxiety prior to blood collection were observed in children who interacted with the robot
Trost et al., 2020	Pilot study	MAKI	31 children aged 9,6 years old	Reducing pain and fear in children with an empathic social robot during IV catheter placement	1) Self-reported pain and fear measures via the Medical Fears Scale, the Wong-Baker FACES scale, and the Children's Fear Scale 2) Measures of observed pain coded via the Face, Legs, Activity, Cry, Consolability (FLACC), and Children's Hospital of Eastern Ontario Pain (CHEOPS) scales	Lower average pain and fear scores in the group interacting with the empathic social robot compared to a no-robot or a distraction condition.

Table 2 - Social robot as informational and educational tools (N = 8).

Authors (year)	*Publication type*	*Type of robot*	*Sample*	*Aim of the study*	*Measures*	*Main results*
Al-Taee & Kapoor, 2019	Exploratory study	NAO	37 patients aged 6- 16 years old and their parents	Determine hospitalized children's well-being after being exposed to advice and education provided by the robot	Collection of verbal cues on children' well-being	Children appreciated NAO's advice on glucose levels; children verbally expressed more words associated with well-being
Alemi et al., 2015	Quasi-experiment	NAO	11 children aged 7-12 years old	Establish a friendship bond between a humanoid robot and young oncology patients as a means to alleviate their pain and distress.	Anxiety Children Scale (MASC), Children's Depression Inventory (CDI), Anger Children's Inventory of Anger (CIA),	Humanoid robots are proven effective in educating children about their illnesses and teaching coping techniques, including relaxation.
Chang & Hwang, 2023	Randomized controlled study	Robot assisted DS	47 children aged 7.24 ± 2.05 years old and 7.38 ± 2.06 years old	To compare robot-assisted DS health education with video-based education	Pediatric Quality of Life Inventory (PedsQL), The Modified Yale Preoperative Anxiety Scale (mYPAS), The Emotional Engagement questionnaire	Reduction in anxiety and positive effects on children's communication regarding intravenous injections
Kaptein et al., 2021	Design-test cycle; randomized controlled trial	NAO – Architecture of the PAL system	48 children aged 6-14 years old	Programming a personal robot assistant for the self-management of health in diabetic children	Diary of diabetes, educational quizzes, sorting games, monitoring dashboard, authoring tool	Children utilizing the system demonstrated an improvement in diabetes knowledge
Looijie et al., 2016	Field study	NAO	17 children aged 6-10 years old and their parents	Designing a scenario for educational activities during hospital visits.	Direct observation, Knowledge test, Self-Efficacy test, Memory test	Personalizing for a child's age, interests, and goals is crucial for interaction and questioning
Neerincx et al., 2019	Design-test cycle; randomized controlled trial	NAO-Architecture of the PAL system	160 children aged 7-14 years old	To develop a robotic partner supporting the daily diabetes management processes in children	Diary of diabetes, educational quizzes, monitoring dashboard	PAL proved to support on the three needs of the Self-Determination Theory: autonomy, competence, relatedness
Russell et al., 2021	Feasibility studies	NAO	8 children aged 10-14 years old	The potential of a social robot in reducing anxiety in children with cystic fibrosis	Prospective Story Telling Scale (PSTS), Robot Incentives Scale (RIS), Cystic Fibrosis Questionnaire-Revised, Hospital Anxiety and Depression Scale (HADS)	Study 1: A positive view of creating an experiences-based storybook about the illness. Study 2: The data suggests younger participants have more personal, detailed conversations with the robot
Van Bindsbergen et al., 2022	Feasibility studies	NAO	28 children aged 8-12 years old	Using a social robot to deliver sleep hygiene education	Semi-structured interviews; Children's Sleep Hygiene Scale (CSHS)	75% learned about food, beverages, and sleep routines thanks to the robot

Regarding the 3rd category, "Desirable features of social robots in the hospital context" (Table 3), 1 result has been included. Vallès-Peris et al. (2018) analyzed the imaginaries of 6-year-old children regarding human-robot interaction in the healthcare context, along with the social and ethical implications of the presence of such robots in hospital environments. The importance of exploring the imagination of young children lies in the capacity of imaginative aspects to become ingrained in

practices and influence technological design and applications. The results reveal children's tendency to anthropomorphize robots while also providing valuable insights into appropriate care. Furthermore, the ease with which they describe the characteristics, values, and practices that can emerge from interacting with these tools is described.

Table 3 - Desirable features of social robots in the hospital context (N = 1).

Authors (year)	*Publication type*	*Type of robot*	*Sample*	*Aim of the study*	*Measures*	*Main results*
Vallès-Peris et al., 2018	Qualitative analysis	Social-care robot prototype (HRI-imaginary)	30 children aged 6 years old	Produce a methodology to develop a participatory process to design a social robot for children's healthcare	Direct observation; Analysis of the imagined social robots' features	The analysis of the drawings reveals that children's well-being is linked to the presence of other individuals nearby

4. Conclusions

This systematic review aimed to identify the characteristics of the interaction between the social robot and children in a hospital setting. After screening 369 results, we excluded 354, resulting in 18 outputs. It's worth noting that scientific literature lacks a substantial number of studies that have delved into the subject of pain, anxiety, and stress mitigation in the interaction between a social robot and a human being. Sometimes, studies do not employ an experimental (randomized) design, and frequently, the studied samples are quite limited (Moerman et al., 2019). To better understand the different use and approaches that researchers adopted while introducing social robots in the pediatric hospital context, we divided the results into three main categories: "Social Robot as distractors prior to or during medical procedures"; "Social robot as informational and educational tools"; and "Desirable features of social robots in the hospital context".

The similarities among the studies within the same category raise some essential questions for future research in these experimental fields. Regarding the first category, we have developed two lines of discussion. The first one concerns *the ability to choose*. Research in the field of social robots as distractors should explore the ability of contexts and healthcare professionals to choose to introduce a social robot into the procedure only if it is genuinely beneficial. This implies the need to develop guidelines to help understand when it is or is not appropriate to incorporate an SR. Once sufficiently tested in an experimental scenario, these robots should be selected and activated in a specific context only if they are considered the best technology to meet the needs of patients, families, and healthcare professionals. By technology, we do not only mean state-of-the-art technological objects; we believe that even dated objects and artifacts can effectively respond as technologies. The second line of discussion concerns *assistance to healthcare staff*. As demonstrated by several studies discussed in the results, staff could benefit from social robots as facilitators and mood alleviators, especially in procedures with children that elicit aversive behaviors and profound distress. In this regard, the research could follow the procedure outlined by Smakman et al. (2021); in this study, time was dedicated to healthcare personnel through focus groups to prepare for the interaction between children and the robot. During the focus groups, healthcare professionals had the opportunity to express concerns and provide technical guidance, which was valuable for constructing the experimental phases.

Regarding the second category, we underline three lines of discussion. The first one concerns the *Zone of Proximal Development*. Through social robots, it is possible to more effectively develop personalized learning to help children understand their illness or simply inform them about what is happening during hospitalization. It is not sufficiently clear whether this type of learning endures over time, allowing the child to recall, much later, the salient information or verify the incorporation of learning related to managing their fears. The second line of discussion relates to the *curiosity phenomenon*. This is closely connected to the first line of discussion because it is not adequately specified why these robots ensure the levels of mitigation described in the scientific literature. The underlying question could be as follows: does learning occur because of the robot's effective ability to

convey and present information, or does the curiosity of having an unfamiliar object nearby transform the reception of information into an experience of enjoyment? In the latter case, it is once again useful to explore the first line of discussion. The third line of discussion concerns the *perception of roles*. Social robots can be programmed to assume various familial roles for the child (caregiver, peer, teacher etc.). In this regard, it may be useful to delve into the children's perceptions of the roles taken on by the robot to better understand the mechanisms of learning and relationships. A social robot can take on the role of a caregiver, but this does not guarantee that the child will behave accordingly; the child may continue to perceive and interact with the robot as if it were a peer or something else.

Regarding the third category, Vallès-Peris et al. (2018) highlighted central issues for a sensitive setting like the hospital environment. In this context, ethical considerations must play an even more decisive role than in other fields. To ensure this, it is essential to consider both the children's imaginaries, their desires, and their fears about what they already think and know about robots, to inform the designers directly in the pre-construction phase of these artifacts. Furthermore, by understanding what the child thinks and how they would like to interact with these new technologies, it is possible to gather additional knowledge to enhance the experimental setups.

In conclusion, the academic literature presents social robots as a valuable aid in the hospital context; among the articles considered, NAO is the most commonly used robot. However, there are limitations that the literature has not yet addressed, and we have attempted to highlight them in this final section. These limitations need to be taken into consideration when designing hospital interventions that respect all those who will interact with these artifacts. When interacting with children, the interaction should be sufficiently transparent and take into account their needs; for parents, the social robot must continue to be perceived as a facilitative tool for knowledge and education rather than an obstacle; finally, for healthcare professionals, the social robot should be programmed to provide the right and effective support in daily healthcare procedures, leading to a broader improvement in professional well-being.

Note

The present paper is derived from the conference abstract "The fear of blood draws: NAO's support to reduce anxiety and stress in children" presented at the Italian SYmposium on Digital Education (ISYDE), with the topic "Innovating Teaching & Learning. Inclusion and Wellbeing for the Data Society".

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Producing digital artifacts to counter "digital education poverty" in the logic of third space learning

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Abstract

Since 2021, the Research Centre on Media Education, Innovation and Technology (Cremit) has been proposing to use the new construct of "digital educational poverty", overcoming and expanding the concept of "digital divide". In terms of defining the paradigm, it should be emphasized that the concept of digital educational poverty is the result of the hybridization of two "digital competence' reference frameworks". One is based on a rights perspective, while the other focuses more on the dynamism and transdisciplinary nature of New Literacy, stressing how a segmented approach betrays the "citizenship vocation" of digital competence.

The study analyzes a sample of 214 digital artifacts produced by lower secondary school students from 100 schools, that are the outcomes of the newsrooms (Digital Writing: Wikipedia, Online Petition; Podcast: Review, Investigation; Digital Storytelling; Social Marketing), i.e. third learning spaces. They come from the project "Connessioni Digitali", created by Save the Children together with Cremit and Edi Onlus to combat digital educational poverty.

The artifacts will be analyzed both according to some indicators of the aesthetic, critical and ethical dimensions of digital competence and to the dimensions of the design and the implementation process leading to "Onlife Citizenship".

From the analysis of the artifacts of "Connessioni Digitali", emerge both the complexity of the concept of digital competence, and the need to equip oneself with multiple methodologies and teaching tools to place the creation of concrete media products and the planning of communication strategies.

Keywords: Digital Competence; Digital Educational Poverty; Digital Divide; Onlife Citizenship; Third Spaces Literacies.

1. Introduction: "digital educational poverty"

Since 2021 the Research Centre on Media Education, Innovation and Technology (Cremit) of the Catholic University of Milan has been proposing to use the new construct of "digital educational poverty", overcoming and expanding the concept of "digital divide".

With the concept of the "third-level digital divide" (Van Deursen & Helsper, 2018), researchers propose that digital inequalities should be interpreted using more than one indicator, going beyond the simple binary opposition of those who have or do not have access to the internet (first-level digital divide). This concept also extends beyond the mere promotion of digital skills (second-level digital divide) (Hargittai, 2002). In some cases, promoting access without paying attention to the outcomes can even increase social inequality (Van Deursen & Van Dijk, 2014). However, the concept of the digital divide is also broadening concerning the necessity of digital skills as new literacy in the post-media society to analyze the production and consumption of various digital content (Rivoltella, 2022; Pasta, 2021a).

The phenomenon of "digital educational poverty" is not solely understood as a lack of devices and access to the internet (Marangi, 2020), nor is it limited to the absence of participation in distance learning or integrated digital education during the COVID-19 emergency (Pasta, 2021b). Expanding on the concept of "educational opportunities" within each of the areas underlying the concept of "educational poverty", the term "digital educational poverty" refers to the lack of acquisition of digital skills, understood as a new form of literacy (Rivoltella, 2020) needed in the digital society to analyze

the production and the use of different digital contents by the "spect-authors". This deficiency makes it very difficult for the individual to access the opportunities offered by the digital and infosphere.

In other texts, the construct has been defined (Pasta & Rivoltella, 2022a; Pasta, 2022a), the measurability of the phenomenon has been discussed (Pasta, Marangi & Rivoltella, 2021), the tool Depend (Digital Educational Poverty in Educative Networking and Development) for assessing the Digital Competence Score (DCS) has been introduced, and the initial data from a survey involving 1,976 students from 112 classes in 39 secondary schools across Italy have been presented (Marangi, Pasta & Rivoltella, 2022). On the same sample, the characteristics of minors for whom the condition of educational poverty does not align with digital educational poverty have been investigated (Marangi, Pasta & Rivoltella, 2023).

The concept of digital educational poverty is the result of the hybridization of two perspectives for defining digital competence: the "rights-based" perspective and the perspective of "New Literacies", which will be discussed in Section 2. In this framework, the Digital Competence Score (DCS) is calculated based on 12 indicators related to the four dimensions of learning: for understanding, for being, for living together, and for an autonomous and active life.

In terms of defining the paradigm, it should be emphasized that the concept of digital educational poverty is the result of the hybridization of two frameworks for defining digital competence.

One is based on a rights perspective, in line with the *European Union's Digital Competencies 2.1 framework* (2017) and *2.2* (2022), associated with "the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society" (Vuorikari, Kluzer & Punie, 2022, p. 3; Council Recommendation on Key Competences for Lifelong Learning, 22 May 2018). It also complements the new *EU Strategy on the Rights of the Child* (2021) and the *General Comment to the UN Convention on the Rights of the Child concerning the children in the digital environment* (2021), with particular reference to the right to learning, to access to correct information, to privacy, freedom of expression and opinion, to protection and non-discrimination. This perspective can be found in the idea of "Digital Competence" of *Europe's Digital Decade 2030* (2021) and in previous European digital competence surveys, such as ICILS (2018) and DESI (2019) (Ranieri, 2022).

A different perspective that focuses more on the dynamism and transdisciplinary nature of competences is what Rivoltella (2020; 2022) calls New Literacy, stressing how a segmented approach betrays the "citizenship vocation" of digital competence (Buckingham, 2019). From a theoretical standpoint, he reinterprets digital competence on the basis of three dimensions: criticism (semantics, meanings, social and cultural sense), ethics (values, responsibilities, citizenship), aesthetics (codes, languages, narratives), while also relying on the concept of Dynamic Literacies (Potter & McDougall, 2017). In Italy, we can detect this vocation in the five areas that constitute the *Curriculum di Educazione Civica Digitale* of the Ministry of Education (2018); in the international and research arena, we find this approach in the work of the Stanford History Education Group (SHEG) of Stanford University, in *Students' Civic Online Reasoning* (2019) and *Evaluating Information: The Cornerstone of Civic Online Reasoning* (2016).

In this perspective, the Depend tool for assessing the Digital Competence Score (DCS) is calculated based on 12 indicators related to the four dimensions of learning: for understanding (technical knowledge, rules, data filtering, digital information, and content), for being (digital creativity, narrative skills, protecting digital identity), for living together (netiquette and cyberstupidity, algorithmic logic, collaborative knowledge), and for an autonomous and active life (citizenship: using the web for good causes, sharing information, critical thinking) (Marangi, Pasta & Rivoltella, 2022).

As a result, the transition from the "digital divide" to "digital educational poverty" corresponds to a shift from "Digital Education" to "Onlife Citizenship" (Pasta & Rivoltella, 2022b). On one hand, in the post-media time (Eugeni, 2015), citizenship education is no longer conceived as a transition to "life on the screen" (Turkle, 1997). By transcending the distinction between what is done online and offline and redefining it as "onlife" (Floridi, 2014), it is no longer seen as "one" of the citizenships but as an internal dimension of the singular citizenship that individuals hold. On the other hand, the contemporary prominence of platforms and data (Van Dijck, Poell & De Waal, 2018; Panciroli &

Rivoltella, 2023) expands the concept of digital citizenship to include new rights, such as accessibility, digital identity, digital residence, and digital transparency (Elliott, 2019).

In this way the fight against educational poverty is placed in a "holistic approach" to Onlife Citizenship, characterized by three modes of action of the media-educational approach: 1) an interpretative modality, which operates on the basis of systematic strategies of textual analysis according to a model of "extended semiosis", including, in addition to the cognitive aspects, also the affective, projective, ritualistic elements of media use; 2) a socio-cultural modality which, adopting a macro perspective, studies the media according to their socio-cultural, economic-industrial, ideological-political relationships with institutions, groups, individuals; 3) a creative modality which, in a micro perspective, integrates the critical-interpretative approach with the production of artifacts which enhance the personal experience of the subjects using different media and formats.

So framing the fight against educational poverty within the context of Onlife Citizenship means thinking, even in classrooms, in a dialectical way about the relationship between theory and practice, consumption and production, and criticism and creativity. This tension explains the dynamism of digital competence: practice is not just a way to illustrate or apply theory but should serve as a means to develop and even challenge theory (Pasta, 2022b). This perspective explains some of the criticisms of interpretations of digital competence that theorize its translation in a static manner (Rivoltella, 2020; Pasta, 2021a), basing assessment on indicators to be "checked off" as achieved, perhaps to obtain a "certificate" that falsely claims to certify expertise on the subject once and for all.

On the contrary, evaluative research in the field of Media Literacy Education has long demonstrated that media skills have a high specificity and must be measured in authentic contexts. It is challenging to set the goal of digital competence as recognizing fake news because it often requires very advanced detection skills. Instead, the aim should be to foster awareness among web users that there could be false information and that the authenticity of a fact cannot be guaranteed solely by a social media logo. With the concept of "incompleteness" of digital competence, what is meant is the need for this state of cognitive attention.

This presents a problem for any certification approach, which typically relies on information gathered in non-authentic contexts (the classroom) and non-real-life situations. The dynamism of digital skills is demonstrated in a continuum of performance and is co-determined by other subjective and contextual variables. Furthermore, they are subject to continuous changes over time, so there is a strong risk that a skill may seem to be possessed today but may not be detectable a few days later. For this reason, the media educational actions presented in this article are designed to operate in specific, real-world contexts and not in an abstract and general manner. This approach can be a useful tool for activating and accessing the opportunities of the social web, thereby combating digital educational poverty.

2. Materials and Methods: "Connessioni digitali" project (2021-24)

The paradigm described forms the basis of the *Connessioni digitali* project (2021-24), carried out by Cremit in collaboration with Save the Children and the Edi Onlus cooperative. This project involved 100 schools, over 6,000 students, and 400 teachers. It integrates efforts to combat digital educational poverty into the civic education curriculum for the second and third years of lower secondary schools. The project utilizes various materials, including short video lessons, EAS (Episodes of Situated Learning - ESL; see Rivoltella, 2023), e-tivities, production tutorials, tests for different phases, learning games, e-portfolios, assessment rubrics, teaching materials, and video support for teachers. These materials are used to create cross-media creation workshops in four newsrooms: Online Writing (creating or editing a Wikipedia entry, writing an online petition), Podcast (media product reviews, local investigations), Digital Storytelling (visual, video, data storytelling, e.g., memes), and Social Marketing (online and static web dissemination). A platform developed as part of the project promotes collaborative peer exchange, which is a feature of social web opportunities.

Newsrooms put into practice a Media Literacy model that doesn't consider technologies as tools, but aims to understand the logics that underlie the design, circulation and use of digital artifacts (Buckingham, 2018). This educational proposal simultaneously promotes critical thinking in

consumption, covering areas from understanding algorithmic logic to recognizing fake news. It also emphasizes responsibility in production, including attention to copyright and giving voice to diverse perspectives. It incorporates technical, intellectual, citizenship, participatory-relational skills, and develops New Media Literacy by intertwining the critical (semantics, meanings, social and cultural significance), ethical (values, responsibilities, citizenship), and aesthetic (codes, languages, narratives) dimensions.

The recognition of these three dimensions (Rivoltella, 2022) is explicitly addressed with students in different phases of the cross-media workshops. The critical dimension involves thematic attention to the main and secondary topics addressed by the artifact, source analysis, the ability to frame topics, provide essential aspects of themes, and identify areas for further exploration. The aesthetic dimension assesses stylistic and narrative aspects, such as coherence between the chosen format and adopted style, the ability to create engaging products that utilize the expressive potential of the format, originality in aesthetic and narrative choices. The ethical dimension pertains to socio-cultural aspects, including elements that relate to the historical, social, and cultural context, consistency with the project's themes and methods, the ability to contribute to constructive debate, express a recognizable and original point of view, offer a pluralistic and open perspective that is not self-referential. Finally, the cross-media workshops also promote attention to technical and structural aspects, generativity in social web, and digital creativity.

3. Communicative production orients knowledge in the logic of digital plenitude

Analyzing the artifacts of the first months of activation of the newsrooms (December 2021-July 2022: 214, of which 72 Wikipedia entries, 63 petitions, 32 investigative podcasts and 47 reviews, although the same creation work in the newsroom can be understood as a third learning space (Potter & McDougall, 2017), on a strictly thematic level it is noted that 29.7% concerns the first space, i.e. daily life, 36.14% the second space understood as the school experience, 34.16% the third space characterized by a projection beyond the school walls, towards the territory and its forms of collective aggregation (primarily through the online petition). Only two newsrooms are considered here, since Online Writing and Podcasts are foreseen in the first year, Digital Storytelling and Social Marketing in the second.

On a quantitative level, it is interesting to identify how the different formats fit into the three reference spaces.

For Wikipedia entries, 71.23% concern the school space, while the third sociocultural space stands at 16.44% and the first personal space at 12.33%.

In the case of petitions, the great majority (84.34%) concerns the third socio-cultural space, followed by the school space at 10.94% and finally by the personal space at 4.69%.

In the case of investigative podcasts there is a balance between the first personal space, which stands at 50% and the second scholastic space, with 46.88%, while the third socio-cultural space appears residual, at 3.13%.

For podcasts that offer reviews, the prevalence of the first personal space is clear, with 68.09% followed by the second scholastic space at 27.66% and finally by the third socio-cultural space with 4.26%.

This quantitative data already offers some emblematic insights regarding the correlation between the types of media formats and the thematic communication characteristics of the contents addressed.

The declination of Wikipedia entries appears predominantly scholastic, since 47.95% of them concern the description of a monument or a place and 15.07% have to do with one's school. Without being able to go into the detail of a more in-depth qualitative analysis here, it does not appear to be a coincidence that in the first newsroom the attributions of the voices are more scholastic and centered on the development of more classic papers.

In the case of the petitions, which are very unbalanced in favor of the third socio-cultural space, it is significant that 43.75% concern public spaces, i.e. places and situations in the city, compared to half,

21.88%, which refers to schools. The protection of a monument stops at 6.25%, while general topics that go beyond the territory and concern civil, social and human rights rise to 28.13%. Also in this case the correlation emerges between the prevailing type of space and the topics covered.

The coherence between the reference space and the characterization of the formats is also evident in the case of the investigation, which records a substantial balance between the first and second spaces, i.e. the personal and the scholastic one. It does not appear to be a coincidence that the same percentages can also be found in the types of interviews, which in 43.75% concern school managers or teachers, while in 28.13% they concern specific topics and themes dealt with by the children and in 15.63 % the interview involves people who have nothing to do with the world of school. Only 12.50% are linked to phenomena linked to the territory.

Even in the case of reviews, the link between the reference space and the characteristics of the format is evident: 68.09% of reviews linked to personal space correspond to 65.96% of formats that talk about music, audiovisuals and books, products characterized by personal and daily use by students. In this case it is interesting to note that if the third socio-cultural space stands at only 4.6%, the reviews referring to the territory and cultural events together reach 25.53%. By contrast, reviews linked to historical authors stop at 8.51%, even considering that reviews relating to the second space reach 27.66%. Even in the more specifically scholastic space, the reviews are in themselves oriented towards a broadening of the perspective.

The definitive conclusions will have to take into account both the artifacts that the same classes will create in third grade with the other two formats – digital storytelling and social marketing – and the products created by the new cohort of second graders who attended the 2022-23 school year, cluster which will allow a direct comparison on the same types of format. However, some occurrences appear significant already starting from the numerical data just shown.

The format of the Wikipedia entry and that of the investigative podcast seem more coherent and practiced in a scholastic perspective, typical of the second space. The petition instead appears much more oriented towards the third socio-cultural space, not only in relation to the quantitative data, but also in reference to the topics covered which, although from an educational perspective, address broader topics and situations much more linked to citizenship, also in reference to the territory.

The reviews converge a quantitative majority linked to personal space with attention towards social and cultural media consumption typical of the reference age group, viewing, listening and reading, although it is interesting to note in this area how many schools have reworked learning scholastic in the form of a review, for example of historical figures or cultural events or places of historical or cultural interest in the area.

From this data two interesting aspects emerge regarding the category of “spect-authors” as protagonists of the new educational contexts in the digital age (Marangi, 2004).

First of all, it seems clear that the choice of format can guide the methodological approach and the topics addressed, while guaranteeing wide stylistic variety. This involves the ability to be able to propose different formats already in the design phase in which to experiment with multiple dimensions of work, from the more institutional and formal ones to the more personal and informal ones, recognizing the areas and promoting social and cultural awareness (Jenkins, 2006), even before digital. For example, the Wikipedia entry, the petition and the investigative journalistic podcast can make greater demands on formal skills and deal with topics of public interest, allowing classes to deal with expressive styles and thematic approaches less practiced in their daily lives. In a complementary way, the podcast with the review, the visual and video storytelling encourage the use of consumption practices and expressive styles that are often already experienced in the daily lives of students in an informal way, with the opportunity to learn in newsroom the ability to further develop coherence between the style adopted, the medium used and the communication objectives set. In this sense, the latest newsroom on social marketing brings together all these aspects, intertwining formal skills and informal expressive styles, paying particular attention to communicative pragmatics, which highlights the dialectic between communicative products, impact on recipients and awareness of the communicative environment.

The second aspect that emerges is the need not to fall into too rigid categories, since it is not only the format that determines the outcome of the communication product. In many cases the boys and girls –

with the contribution of their teachers and the Edi Onlus trainers who followed the project in the classes – demonstrated the ability and possibility of combining different perspectives of analysis and development. For example, the reviews are not limited to specific school reports, but in many cases deal with much broader themes, from the war in Ukraine to gender equality, from the struggles of growing up to the meaning of being superheroes in the contemporary world. Likewise, the investigations are not limited to interviews with famous people or reporting on news cases, but have a strong social and cultural vocation, with many recurrences of themes, such as respect for the environment or the sense of playing sport in a balanced way and not just competitive.

What clearly emerges from this sample is the phenomenon that Bolter (2019) defines as digital plenitude, that is, the richness and variety of topics, styles and approaches that definitively shatter the concept of high and low culture and unite apparently distinct and incoherent fragments with dimensions that instead propose a broader and more recognizable meaning. From this perspective, the measurement of digital competence cannot ignore the intertwined analysis of three dimensions that we will address in the next paragraph: criticism, aesthetics, ethics.

4. Rethinking digital competence in a dynamic and modular sense

In reference to a new dimension of literacy, the expression digital literacy was used for the first time by Gilster (1997), in a substantially cognitive and not purely technological perspective, identifying four key skills of digital literacy: knowledge assembly, content evaluation information, Internet search and hypertext navigation.

Paul Gilster defines digital literacy as "the ability to understand and use information in multiple formats from a wide variety of sources when presented via computer" and emphasizes that digital literacy involves "adapting our skills to a new medium evocatively, our experience of the Internet will be determined by the way in which we master its key skills" explaining that these skills are not just "operational" or "technical", but imply the ability to "master ideas, not typing on the keyboard" supporting the need to teach and learn "how to use the Web correctly and how to be critical" and that "we all need to learn this skill".

International literature has progressively clarified the concept of digital competence, according to a metacognitive and strategic vision of activities related to digital environments. Tornero (2004) underlines the intertwining of technical, intellectual and responsible citizenship skills; Buckingham (2007) develops the cultural, economic and social dimension; Midoro (2007) places emphasis on the participatory and sharing processes that digital competence promotes in the knowledge society.

With the advent of social media and the increasingly rapid evolution of technological potential in a communicative and productive sense, digital competence has taken on an increasingly complex dimension, in which three fundamental dimensions are recognizable: technological, cognitive and ethical (Calvani, Fini & Ranieri, 2009).

The development of social networks has generated new learning and knowledge sharing scenarios, which identify a fourth aspect of digital competence, the participatory-relational one. In addition to technological, cognitive and ethical skills, digital literacy today also includes the ability to share information, knowledge and intentionality on the web and in social networks, to interact positively with others both on the level of informative and cognitive interaction and on that of communication the emotional and social interaction, as Goleman (1995) points out.

In this perspective, Rivoltella (2020) proposes the category of new literacy, which should not be understood in the sense of developing literacy in the so-called new media, a dated concept that has been overcome by the constant evolution of media. Rather, Rivoltella places emphasis on the need for a new literacy in which the concept of digital competence intertwines the critical, aesthetic and ethical dimensions. The recognition of these three dimensions as key elements for building effective digital citizenship (Rivoltella, 2022) is explained with the students in the different phases of the cross-media workshops.

Based on the framework proposed by Rivoltella in the two contributions just mentioned, in the *Connessioni Digitali* project the three dimensions manifest themselves in a complementary way in the

design and production of the various products, realizing some peculiar characteristics for each of the three.

The critical dimension translates into a thematic attention to the main and secondary topics covered by the artifact, in the care of the sources, in the ability to frame the topics, to provide the essential aspects of the themes and to identify ideas for further investigation. The aesthetic dimension, however, highlights the stylistic and narrative aspects, such as the coherence between the chosen format and the adopted register, the ability to create an engaging product that uses the expressive potential of the format, the originality in the aesthetic and narrative choices. The ethical dimension concerns socio-cultural aspects, such as the presence of elements that refer to the historical, social and cultural context, coherence with respect to the themes and methods of the project, the ability to contribute to a constructive debate, to bring out one's own recognizable and original point of view, to offer a pluralist and open, non-self-referential vision.

The intertwining of these three dimensions is evident in the laboratory activity, which involves collaboration between students in group work; a third learning space is generated, characterized by the fact that formal and informal skills are shared, which promotes pleasure in what is learned, the closeness of the students with the topics covered, the possibility of translating what learned and the vocation to share what has been achieved with others, as well as attention to technical and structural aspects, generativity in the social web and digital creativity.

Media productions are central to the development of digital skills that are dynamic and rigorous, customizable in individual contexts, but also assessable in a transversal way. To activate an evaluation consistent with these elements, Cremit has developed an analysis and evaluation grid, shown below in Table 1 which combines the three dimensions – critical, aesthetic, ethical – with the 4 areas of educational poverty, in which the 12 indicators of digital educational poverty (Marangi, Pasta & Rivoltella, 2022), and with the indicators of the European digital skills framework *DigComp 2.2*.

The grid intertwines these 3 large areas to grasp the relevance of the various aspects that make up each media artifact in a perspective of dynamic and integrated digital competence.

The vertical columns indicate the four reference tools used to identify digital competence: column A shows the four areas used by Cremit and Save the Children to define digital educational poverty; in B we refer to the indicators of the Digital Competence Score, which allows us to identify different operational, planning and strategic skills; column C shows the attributions referring to the three dimensions analyzed in this paragraph: criticism, aesthetics, ethics; finally, column D shows the indicators taken from *DigComp 2.2*, which identify specific skills drawn from the different areas that make up this European document.

If instead you analyze the table using the horizontal lines, you will find 8 categories, in turn divided into 5 areas, which allow you to identify what characterizes each media and communication format. From area 2 to area 4 there are the three dimensions just discussed – criticism, aesthetics, ethics – each of which offers two indicators. In the first and last areas, 1 and 5, a single indicator was considered, which in the first case pertains to the technical and structural aspects and in the last case to the ability to produce communicative generativity.

The Table does not intend to propose a rigid and definitive model, but attempts to make different perspectives complementary, which at first glance might appear heterogeneous, but which precisely through the phases of design, production, distribution and communicative interaction of the newsrooms allow the identification of different digital skills when they take the form of communicative products and processes and not in a purely abstract or regulatory sense. From the analysis of the children's products, interesting data emerge regarding the crosses proposed here, which we will return to in a future publication.

This complementary articulation of different areas, dimensions and indicators goes in the direction of allowing students, but also the teaching staff, to be able to compose, depending on the didactic, pedagogical, social and cultural contexts, an approach and a method to the development and evaluation of digital competence through different methods.

To make more effective the work of analysis and evaluation of communication products, this basic table was adapted and articulated in a more specific way to the characteristics of each communication product, generating six more detailed tables that took into account the specifications of the various

artifacts and reference communication contexts: Wikipedia entry, online petition, investigative podcast, audio review, digital storytelling, social marketing.

Table 1 - Analysis and evaluation grid.

Products		A	B	C	D
		Digital Education Poverty Area	Digital Competence Score	Dimensions of New Literacy	DigComp 2.2
1	Technical and structural aspects				
	Ability to use applications and digital content respecting copyright	Understanding	Knowledge of rules	Criticism	Copyright and licenses
2	Thematic aspects				
	Care in choosing sources	Understanding	Filtering data, information and digital content	Criticism	Browsing, searching and filtering data, information and digital content
	Ability to identify the essential aspects of the topics covered and to be consistent with the project approach	Being	Narrative skills	Aesthetics	Integrating and re-elaborating digital content
3	Stylistic and narrative aspects				
	Ability to use the expressive potential of the format used through an effective narrative and stylistic register	Being	Digital creativity	Aesthetics	Developing digital content
	Ability to involve those who read, listen or watch	Independent and active life	Sharing information	Aesthetics	Creatively using digital technologies
4	Socio-cultural aspects				
	Ability to contribute to a constructive debate, expressing a recognizable point of view	Autonomous and active life	Web citizenship for good causes	Ethics	Interacting through digital technologies
	Ability to offer a pluralist and open, non-self-referential vision	Living together	Netiquette and cyberstupidity	Ethics	Netiquette
5	Generativity				
	Development potential to stimulate other people or groups to create further media materials or communication situations or to stimulate direct or indirect impacts on the territory	Living together	Collaborative knowledge	Ethics	Sharing through digital technologies

5. Discussion: Theory of Change through Media Literacy

Following the construct mentioned at the beginning, the fight against digital educational poverty occurs when educational interventions address all these different aspects of digital use: access, awareness, skills, and consequences. These four aspects are at the core of the Theory of Change through Media Literacy proposed by Julian McDougall and Isabella Rega (2022) and have been tested in other media educational intervention projects (Pasta, 2023). Due to the coexistence of these

dimensions, the *Connessioni Digitali* project employs various assessment tools, including end-of-newsroom quizzes, self-assessment checklists for students on their products, group work checklists for teachers, assessment rubrics for digital artifacts, and end-of-project tests.

Access is achieved when individuals understand what it means to be part of a media ecosystem and acquire the skills to change their media behaviors within it. It promotes citizenship by making informed choices about what to access within the media ecosystem through digital connection, technological access, and the ability to use the available media and technology. In the case under consideration, students experience the effects of access both in consumption and production, for example, when they have to choose which sources to access, how to use them within certain constraints, and create one of the digital artifacts mentioned earlier.

Awareness is reached when individuals understand how the media represent the world (people, environments, topics, places) from a specific perspective and the overall health of the media ecosystem. For instance, students are asked to understand how algorithmic logics organize information (Ferrari & Pasta, 2023), adapting central concepts of civic education for their age, such as echo chambers and filter bubbles, and placing the project within the field of "Data literacy" or "Algorithmic Pedagogy" (Panciroli & Rivoltella, 2023). For the second-year newsroom, awareness of how the media represent the world is experienced in the creation of various forms of digital storytelling and in the design of dissemination through social marketing. Therefore, considering the concept of "opportunity" around which the construct of digital educational poverty revolves, awareness of risks and, at the same time, strategic potential for using media and digital environments to articulate and express one's perspective and active participation in social and cultural life plays a crucial role.

In this sense, by drawing on the contribution of Freire, one of the major roots of Media Education (Rivoltella, 2017), to epistemology and social change in the age of onlife, it can be said that access and awareness drive change through a process of "conscientization" on how media formats and environments always propose an idea of communicative dialectics and relational confrontation that goes beyond the notion of coded narrative. This can manifest itself explicitly or implicitly, realistically or symbolically, intentionally or accidentally, with the layering of rhetorical and stylistic aspects, narrative and documentary aspects, pertaining not only to the aesthetic sphere but also the social and cultural sphere.

The third dimension of the Theory of Change through Media Literacy, capacity, involves the ability to use one's media skills for specific purposes, which, in the case of *Connessioni Digitali*, include collaborative knowledge construction (Wikipedia entry), civic engagement (petition), employability to highlight different perspectives (podcast), digital civic activism (digital storytelling), and community dissemination (social marketing). Across the newsrooms, it can be affirmed that *Connessioni Digitali* activates usage skills that facilitate the ability to vary strategies for using and producing communicative and narrative content.

Lastly, it is not automatic that digital uses result in positive outcomes, and these are not necessarily the unequivocal result of Media Literacy. In the model being tested, which expands the concept of the digital divide into digital educational poverty, effectiveness is not determined by the transfer of knowledge on an individual basis or the distribution of digital devices. Rather, it is about media literacy in collective terms and as a community effort because the fight against digital educational poverty is activated when a group can transform individual skills into social practices and the construction of a genuine interpretative and productive design that engages the class, the school, and/or the community outside the school walls. It is an important value, both for media education reflection (Buckingham, 2019) and for placing *Connessioni Digitali* in civic education teaching. The project considers digital skills collectively, almost transforming individual ability into collective action. Therefore, *Connessioni Digitali*, as a Media Literacy intervention, focuses not only on how students develop and enhance their digital skills but also on how they use these skills for positive changes in the entire media ecosystem.

6. Conclusion

From the analysis of the artifacts of *Connessioni Digitali* emerge both the complexity of the concept of digital competence (Pasta, Marangi & Rivoltella, 2021; Schofield et al., 2023), and the need to equip oneself with multiple methodologies and teaching tools to place the creation of concrete media products and the planning of communication strategies.

Assessment research in the field of Media Literacy Education has long since proved that media literacies are highly specific, which means that they must be measured in real-life contexts: we cannot evaluate digital competency unless we can, to some degree, observe it being applied to a specific issue in a real context. This represents a clear obstacle to any certification-based approach, which normally relies on information collected in non-authentic contexts (classroom) and in non-real-life situations. This approach was followed in the analysis of the artifacts produced by the *Connessioni Digitali* project. Furthermore, digital literacies are not static but dynamic (Potter and McDougall, 2017). This means that they emerge through ongoing use and are co-determined by other subjective and context-related variables; moreover, they tend to change continuously over time. Therefore, there is a tangible possibility that a literacy seemingly detectable today might not still be so a few days later.

Some cornerstones to follow are:

- cross-media logic and trans-media dynamics, which allow both to cross and experiment with different platforms and to adapt the same concept to different formats, with specific characteristics, rules and styles;
- the creation of third learning spaces, capable of bringing out the theoretical sense of processes and awareness of one's own skills, starting from laboratory operations, from the collective and collaborative dimension, from people's social and cultural consumption, in a continuous hybridization not only of the formal sphere with the informal one, but also of educational roles and postures;
- the need to rethink and renew some cornerstones of classical media education, such as the critical spirit, the creative capacity and the productive vocation, in an increasingly post-media and fluid context.

Authors' contributions

Stefano Pasta and Michele Marangi: Conceptualization, Methodology, Data curation, Original draft preparation, Reviewing and Editing. Stefano Pasta: Writing (Sections 1, 2, 5). Michele Marangi: Writing (Sections 3, 4, 6).

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Educational Networks as a lever for change. The Italian school towards a "new normality"

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Abstract

The service research carried out by INDIRE has long been based on the concept of Network both as a guiding principle for its institutional actions and as a cornerstone of the investigative activity conducted by its researchers. The recognition of the value of the networks of practice as a lever of change and as an essential training device for the development of teaching professionalism has led, in recent years, to the establishment of two large networks – Avanguardie Educative and Piccole Scuole – based on the exchange of didactic and organizational solutions and mutual support between schools. However, online training represents a privileged field of experimentation that INDIRE has explored since its inception and which has become a cornerstone of its institutional mission. The Institute has capitalized on the experience gained over the years and supported schools in the transition to distance learning through diversified actions of massive online education. The years of the pandemic have shown a trajectory of transformation of the Italian school system: from an initial situation of substantial unpreparedness for the sudden transition to digital, we have moved to a context of greater maturity of schools in technology-supported teaching. The investigations carried out by INDIRE in the post-pandemic period have highlighted some "beneficial" side effects produced by the forced transition to distance learning, such as the maintenance of some good distance teaching practices. This contribution discusses and presents some of the most significant results collected during the schools' return to the new "normality".

Keywords: School Networking, Digital Educational Practices, Teacher Professional Development, New Normality.

1. Introduction

The COVID-19 health emergency represented a moment of profound crisis in the global school systems, particularly in those countries where schools had not a well-established experience in distance learning, including Italy. Educational institutions had to respond to an unexpected and forced transition from face-to-face to distance learning by experimenting with new and unfamiliar online teaching practices (Carrillo & Flores, 2020; König et al., 2020). The suspension of in-person teaching activities and the introduction of distance learning have indeed brought out some new difficulties, but at the same time they have generated valuable opportunities for a rethinking and renewal of learning, teaching and organizational practices (Carretero Gomez et al., 2021; CENSIS, 2020; Sun et al., 2020).

The Italian school has arrived substantially unprepared to face the health emergency: surveys on the Italian school system have shown not only structural unpreparedness, but also a widespread lack of digital skills among students and teachers (INDIRE, 2020a; Lucisano, 2020) and a difficulty in redesigning teaching activities for distance (Ranieri et al., 2020). In Italy teachers prepared for distance learning were a "small minority" and this may have exacerbated that "destabilizing uncertainty" (Perla & Riva, 2016) produced by the interruption of traditional teaching methods and the need to necessarily reorient their actions (Mezirow, 2016).

On the other hand such lack of certainty has stimulated a new research on the meaning, purposes and methods of education in the light of the ongoing changes (Tramma, 2018). Unfortunately in Italy this rethinking has not always translated into concrete actions and practices of renewal. From surveys conducted during the lockdown period (INDIRE, 2020a, 2020b, 2021; SIRD, 2020), has emerged that teachers have rarely modified their methodological and didactic approaches and that a particularly

high proportion has used, even during distance learning, frontal teaching and a traditional/transmissive style, rarely exploiting the potential offered by active methodologies (Ianes & Bellacicco, 2020). In the majority of cases, the typical teaching practices were transposed to online teaching (SIRD, 2021; INDIRE, 2020a, 2020b, 2021).

2. The Network as a training device and a driver for innovation

INDIRE's action within the networks is carried out mainly through the observation and analysis of good innovation practices, which become the object of collaborative research among practitioners and professional researchers (Desgagné, 1997). The ultimate goal is to promote a virtuous dialogue and reflection on experience, leading to the formalization of theories for action (Mortari, 2010).

2.1 The value of practice networks

The research carried out by INDIRE has long been oriented toward the concept of the network, both as a guiding principle for its institutional actions and as a fundamental element of the investigative activities conducted by its researchers. Recognizing the value of practice networks as a lever for change and an essential tool for the development of teacher professionalism (European Commission, 2018), INDIRE has established two large networks: *Avanguardie Educative* and *Piccole Scuole*. These networks have found their distinguishing features in the exchange of best practices, reflective knowledge transfer among peers, and mutual support and guidance among schools (Nardi et al., 2022), also in the "*non-standard*" educational contexts (Mangione et al., 2023; Mangione & Cannella, 2021).

Working within networks supports informal learning and allows for the exploration of new self-guided learning modes for the involved parties (Nigris et al., 2020). Collaboration among schools can help overcome educator isolation by providing opportunities for sharing, professional development, and enrichment (Kools & Stoll, 2016). These networks typically consist of groups of educators, teachers, school leaders, along with others who, outside their regular practice community, employ collaborative learning to improve their teaching practices and student learning processes (Poortman et al., 2022). These networks are designed to bring together individuals who share and critically examine their teaching practices continuously, reflectively, and collaboratively (Stoll et al., 2006), identify common actions and shared goals, develop collective plans and strategies (Schnellert, 2020), becoming "active agents of their own growth" (Schleicher, 2012, p. 73).

The networks promoted by INDIRE are configured as Professional Learning Communities (Vescio et al., 2008) and Professional Learning Networks (Trust et al., 2016), hubs, aggregation points that connect different practice communities to achieve overall improvement in the education system through processes of scaling up and systematizing best practices, routines, habits, and evidence of effectiveness. At the core of the networking concept and the structures it may assume in relation to the connections between participants – centralized, decentralized, distributed – is always the concept of mutuality, mutual aid, and reciprocity (European Commission, 2018), as network cohesion and functioning largely depend on all actors recognizing the value derived from their participation.

Studies exploring the effectiveness of these spontaneous and informal aggregations of professionals, organized around common work practices, knowledge sharing, meanings, and languages (Sjoer & Meirink, 2016), have confirmed that belonging to learning communities (Hord & Summers, 2008) is a crucial factor in the development of teacher professionalism (Vangrieken et al., 2017). The implementation of these professional communities is considered one of the most powerful organizational strategies for achieving significant educational improvements, enhancing self-efficacy, satisfaction, and collaboration among teachers, which can then positively impact student learning outcomes (Darling-Hammond et al., 2017).

However, the aim of these networks is not just to achieve better student performance but also to serve as places for reflection and research on educational issues, such as the role of teachers, school well-being, educational equity, and more. Here different actors collaborate in a critical examination and revision of the curriculum goals (Brown, 2020).

These professional communities are spaces for activating a reflective stance and thinking (Schön, 1993) that allows their members to gradually emancipate themselves from top-down processes and become capable of analyzing and evaluating their own practices, developing autonomous hypotheses for problem-solving and change.

In this regard, professional learning communities act as "forces that promote teacher innovation" (Liu et al., 2022, p. 3), supporting reflective processes that encourage teachers to question their established routines, behaviors, and thoughts (Rubenstein et al., 2018). Collaborative learning and sharing increase intellectual stimuli and the possibility of obtaining new knowledge, fostering a proactive attitude towards experimentation (Holdsworth & Maynes, 2018) and developing an innovation mindset (Schley & Schratz, 2011). Shared responsibility for the school mission encourages the emergence of new ideas and approaches to improve organizational and instructional effectiveness, activating intrinsic motivations in teachers (Paletta, 2020) and promoting the consolidation of new practices, routines, and solutions without the need for material rewards (Lu & Campbell, 2020).

From this perspective, there is a significant body of research on the relationship between teacher professional learning and educational leadership that demonstrates that shared leadership practices – or related process such as distributed leadership, collaborative leadership, collective leadership, co-leadership – are more conducive to the enhancement of teacher professionalism (Admiraal et al., 2021), and that shared leadership is a crucial factor for learning in professional learning communities (Harris, 2014).

INDIRE has adopted the "Research-Practice Partnerships" framework as its guiding conceptual model for establishing its networks. The underlying idea driving the formation of these large- scale professional communities is that the wisdom of practitioners, comprising their expertise, innovations, and professional culture (Mazzoni & Ubbiali, 2015) is a fundamental resource for realizing educational innovation. This innovation is understood as a set of intentional and systematic changes undertaken to better and more sustainably achieve the goals of an educational system or to identify new ones (De Landsheere, 1979).

At the core of this vision is also the belief that *School as Learning Organizations* have structures that enable staff to grow as professionals, operating as communities based on a shared vision and the collective capacity of the staff to pursue continuous improvement (Senge, 1990) and collectively enhance their knowledge (Kools & Stoll, 2016). In this perspective, engaging with other members of the educational community allows schools to assess the relevance, feasibility, and sustainability of their change trajectories, making necessary adjustments as needed while for educational research, the comparison with actors within the education system is essential to systematically capture the voices of schools, emerging phenomena, common challenges, and the innovations employed to address them.

2.2 Avanguardie educative Network

Avanguardie Educative is a Movement and network of schools that, since 2014, has been supporting the processes of organizational and methodological innovation within the Italian school system. Its name explicitly references artistic avant-garde movements, with which it shares the same profound need for cultural renewal. This need is well summarized by the seven "cultural horizons" outlined in its programmatic document, the Manifesto of *Avanguardie Educative* (https://pheegaro.INDIRE.it/uploads/attachments/1946.pdf), which describes the foundational principles of the movement. It was through the mutual recognition and common adherence to the guiding principles of this Manifesto that INDIRE and 22 founding schools gave life to the Movement. Nearly a decade after its establishment, this cultural renewal remains the mission of *Avanguardie Educative*.

The *Avanguardie educative* Network has gradually become a national reference point for all those interested in undertaking processes of school change and counts today almost 1550 schools of all levels distributed throughout the national territory. Long before the pandemic events required a forced rethinking of the school model, with alternation and integration of learning situations between presence and distance and the use of new methodological-didactic solutions, *Avanguardie educative* promoted digital integration, in order to hybridize the transmissive lesson typical of the school in the presence.

The Movement has always been inspired by the encounter between the innovative drive coming from school institutions (bottom-up) and formalization processes and systematization of educational research (top-down). As underlined at European level (OECD, 2013), the transformation of the school system implies the transition from a top-down approach to a more contextualized approach, based on the analysis of innovative experiences of schools (bottom-up). It is a participatory and collaborative approach, in which all actors play a role towards change and innovation by generating sub-networks of schools that in their innovative performance are linked to the main network. In fact, the *Avanguardie educative* Movement contributes to promoting didactic and organizational innovation with a Gallery of innovative ideas (https://innovazione.INDIRE.it/avanguardieeducative/le-idee), training and dissemination initiatives that support a constant methodological reflection of the school system as a whole.

Through the "disruptive" and "generative" force of innovation ideas, the traditional school model, based essentially on the expository method of teaching, is transformed, triggering processes of change in teaching routines and rooting a culture of innovation based on new arrangements that reconfigure socio-educational ties and overturn the paradigm of the educating community, where the student becomes the active protagonist of the educational pathway. In this sense, the network is a "constantly expanding research laboratory" where best practices emerging from schools (bottom-up) are modeled and codified through action research processes carried out by INDIRE in collaboration with the schools (top-down): every year an average of 200 new schools (calculated over 6 years, 2015-2020) join the Movement and adopt at least one innovation idea, but over 40% have adopted at least three ideas.

The main objective of the AE Movement is the advancement of knowledge and shared experiences among the member schools, for a "systematization" on three levels: micro (in the professional practice of the individual), meso (of the class council(s) and/or department(s)) and macro (of the whole school in all its sub-articulations, in the relationship with the territory and stakeholders). In its 8 years of activity, the AE Network of schools has given rise to many forms of widespread collaboration, giving a significant contribution to defining the new role of the school for the 21st century as a flexible learning environment in an increasingly structured dialogue with the territory of reference and the stakeholders that act synergistically on it as "change makers" (Valera & Solesin, 2019).

Avanguardie Educative is a community of practice and research as well as, at the same time, an opportunity for professional training in service: the transferability of the organizational and methodological-didactic best practice, guaranteed by the researchers' constant observation, monitoring and assessment, is intended as a lever to tackle the "paradigm of complexity" (UNESCO, 2021), thus allowing schools to learn to move on and adapt continuously in order to offer new significant educational opportunities. Among its major objectives, the AE educational community of practices aims to bring to the center and problematize, in terms of support for critical and profound thinking, learning by experience, teaching as research in action and the relationship between practice and theory.

The idea driving the *Avanguardie Educative* Network is that educational innovation primarily spreads through a network organization in continuous renegotiation among its participants, capable of self-configuration according to the needs of its community. This network is characterized by a plurality of nodes rather than a single central node radiating tools and content. This pluralistic, loosely connected network structure promotes cooperative relationships among different network actors and the dissemination of a co-constructed culture of innovation (Biagioli, 2012). In contrast to traditional hierarchical network organization models, the loosely connected network structure of *Avanguardie Educative*, characterized by weak ties (Granovetter, 1983), allows cooperative relationships among various network actors, leading to the creation of a co-constructed culture of innovation.

The underlying idea behind *Avanguardie Educative* is that educational innovation is primarily realized through a fluid, decentralized, and continually renegotiating network organization among its participants. This network can reconfigure itself to meet the needs of its community. The regional nodes of the network, the "Polo" schools, contribute to decentralizing the network by serving as local hubs and providing on-the-ground educational support. The network's breadth, its diversity in terms of schools of all levels, sizes, geographic locations, and socioeconomic contexts, makes it particularly

effective in responding to the needs of individual nodes while pursuing common objectives for the entire network (Seddio, 2013).

Today *Avanguardie Educative* must confront the radical transformations triggered by the health crisis in the school system and the country. It cannot avoid conducting an overall assessment of its journey. Nearly ten years after its foundation, it is essential to evaluate the effectiveness of the actions and processes undertaken by the movement and the resilience of its fundamental principles in light of the ongoing changes in the school system. With this objective, *Avanguardie Educative* is currently updating its Manifesto to respond appropriately to the demands coming from schools engaged in the redesign outlined in the "School 4.0" plan. At the same time, INDIRE is assessing the maturity of schools in the network in terms of systematizing and anchoring educational innovation (https://www.INDIRE.it/progetto/processi-di-messa-a-sistema-dellinnovazione-nel-movimento-avanguardie- educative/).

2.3 Piccole scuole Network

The value of school networks in isolated territories plays a central role not only to improve the quality of teaching, but, in some cases, also for the survival of the school itself. INDIRE's research has made it possible to understand how in many European countries school networks in isolated territories represent the organizational forms capable of guaranteeing the quality of the school service as well as the continuous training of teachers (Mangione & Cannella, 2018; Cannella & Mangione, 2021). This is the case, for example, of the French network "Equipe Mobile Académique de Liaison et d'Animation" which provides teaching materials, digital resources to teachers who move from one small isolated school to another, or, in northern countries, the Network that revolves around the "National Society for Nearby Schools" (LUFS) similar to the "Colegios Rurales Agrupados" dedicated to schools with multi-classes or with incomplete school levels and different organizations from the dominant model (Mangione & Cannella, 2018; Cannella & Mangione, 2021). The need to understand the real need to create a National Network of Small Schools led INDIRE to work with four local networks: the Sbilf Network of Friuli-Venezia Giulia, the Amalfi Coast Network, the Ligurian Network "Scuole in Rete", and the Network "Isole Egadi". This collaboration made it possible to understand the need to build a network characterized by a fluid model (based on a balance between bottom-up processes and top-down directions) capable of responding to two important expectations: supporting the acquisition of knowledge and tools on specific methodologies set in the context of isolated schools and multi-classes and on the other hand, guaranteeing access to a repertoire of practices and professionalism for innovation in small schools. The birth in 2017 of the National Network of Small Schools (https://piccolescuole.INDIRE.it/), the result of an idea of research at the service of educational fragility in real contexts (Jones-Devitt et al., 2001) favors a participatory research in terms of service (participatory research), which takes as central the concrete problems of the school, creating a partnership based on the exchange of knowledge, resources and skills, and facilitating the diffusion and appropriation of pedagogical innovations (Froehlich et al., 2021). The National Network contributes to improving the quality of education and the well-being of the community, responding to the needs and challenges of educational and social contexts, and promoting participation and involvement of all actors (Stoecker, 2016).

The service research has therefore guided the establishment of the National Network Piccole Scuole, a Cultural Movement that rests on the exchange of teaching practices and on reflective transfer of knowledge among peers and on mutual 'accompaniment' between schools in the network. A cultural movement that has its own Manifesto (https://piccolescuole.INDIRE.it/il-movimento/manifesto/) in which are indicated principles or "trajectories of innovation". The principle of Community of memory and quality of learning wants to enhance schools starting from the relationship with the natural, social and cultural environment. The Community and the environment can represent a resource with strong innovative potential when it links learning to forms such as the so-called school in plain air, outdoor education, forms of schools in the woods and service learning. The principle The experience of multi-classes, a resource and not a limit promotes an open space for levels and ages in which to experiment with learning paths based on the unity and transversality of knowledge. Multi-classes represent realities to be valued, because they can be incubators of didactic approaches and organizational modalities functional also to wider contexts. The principle Technologies and social inclusion guides

training interventions and experimentation of modalities capable of extending the classroom and allowing an enlarged learning for projects or shared lessons, thus overcoming the limits deriving from isolation. Today the Network is configured as a "learning networking" (Sorcinelli & Yun, 2017) tool for informal teacher education (Kelly, 2019), mentoring (Geeraerts et al., 2015), peer coaching (Rhodes et al., 2020) and collaborative reflection (Clarà, 2015) that welcomes over 500 Comprehensive Institutes, 3,200 small complexes, 38,807 teachers and 275,687 students (Bartolini et al., 2023). The Network allows schools to access a place where they can recognize themselves and take part in innovation and research processes (Cannella & Belardinelli, 2020) collaborative on knowledge with the aim of describing repertoires, formalizing theories for action (Mortari, 2010) and understanding their effectiveness.

To strengthen the skills needed to face innovative experiences that can be equipped with unique pedagogical aids such as outdoor environments, multi-classes, distance education experiences capable of opening classes and cycles beyond the traditional classroom, the Network intervenes with continuous training paths for teachers in service in small schools. Adult workshops and collaborative dyads Adult workshops can be a solution to bring training where it is difficult to reach. The basis of the workshops are: face-to-face meetings in "presidio" schools oriented to work on the "cases" presented and reworked by the teachers in training; online analysis and collaboration activities in a reserved and articulated environment in classes/workshops where teachers have the opportunity to meet, reflect on cases and access support tools for a good design to be proposed in their school; accompaniment to experimentation and documentation in class; online sharing of formats for documentation and guides for experimenting with the didactic path designed by the teacher and implemented in his/her school. The didactic-pedagogical workshops, experimented within the framework of INDIRE's projects with small schools and places at the margin of the territory (Mangione et al., 2020) recalling the Atelier de formation in French and Canadian area implementing training paths based on "spaces of active construction of practice" in which over 1300 teachers and school principals have been involved to date. During the lockdown of Italian schools, INDIRE has made use of the experience of accompanying schools along processes of change and innovation gained over the years, and has designed activities and services aimed at teachers, students and families, focused on the value of "Network" as a system of mentoring. The National Network of Small Schools experiments, adhering to and supporting the Network of Solidarity between Schools formed during the pandemic year the realization of a systemic approach to training support and improvement of performance in the use of didactic methodologies and new technologies in distance learning (DAD). The action has given rise to a long-term strategy of development and implementation of digital integrated teaching (DDI) at school level.

The training model experimented recalls the so-called MOOC-Eds (educations) (Clark, 2014; Kleiman et al., 2015) widely used in the United States for teacher and educator training. Not simply courses, but sharing experiences of professional development that involve participants in implementing new teaching opportunities enabled by technology. The MOOC-Eds experiences have followed one another over time giving rise to numerous initiatives (from "Spaesi. Laboratory of Fantastic Geography" to "La scuola di Prossimità" up to "Dove sta di casa la scuola"?) (including basic resources and supplementary materials on a specific topic, also allowing great customization and flexibility (Mangione & Parigi, 2021; Mangione et al., 2022). Within the national network over 20,000 teachers and school principals have been involved to date who have experimented with self-directed learning, supported by peers, based on cases or projects.

3. Italian School Networks as an observatory of change during pandemic period

During the pandemic, Italian schools had to rethink their educational offer by reorganizing methods and tools for a new form of school, a distance school. The *Avanguardie Educative* e *Piccole scuole* Networks have played an important role in accompanying schools towards new teaching and organizational models and have at the same time represented an open-air observatory of the future of the school during post pandemic period.

3.1 The transition to online teaching

The restrictions due to the Covid-19 emergency led to significant changes in the management of educational practices, both in terms of the organizational and educational dimensions. At the organizational level, two main situations have emerged: on the one hand, services have been formally interrupted while, on the other, they have been reshaped to provide remote assistance. Where the activities of schools and educational services have not been interrupted, they have been redefined and adapted, even with the support of digital technology, in order to enable educators, teachers and other actors of the educating community to maintain and cultivate the educational relationship with their beneficiaries, while mitigating the sense of abandonment and social isolation. These "community technologies" (Rivoltella, 2017) have in fact allowed the community to be connected and sustained at a time of professional disorientation, guaranteeing peer-to-peer comparison and the sharing of good practices of "resilience" to the critical issues posed by the pandemic. With the transition to online teaching, educators and teachers have developed new learning needs and several initiatives have been organized to provide the tools to cope adequately with the transition to distance learning. In addition to professional training organized by schools for their staff, many institutions provided informal learning opportunities, mainly through the provision of free webinars for professional development and coaching. Voluntary participation in this type of initiatives can be regarded as a self-directed learning strategy, that has made it possible to reduce the skills gap perceived by the educational community. The interactive and relocated mode of online meetings also allowed to enhance peer-learning and tutoring, giving rise to small and large professional learning communities (Vescio et al., 2008). It is through the *Avanguardie Educative* and *Piccole Scuole* Network, and the response of participating schools, that it was finally possible to identify the challenges and most common practices during e post lockdown period.

3.2 The Avanguardie Educative and Piccole scuole in support of the Health Emergency

During the lockdown of Italian schools, INDIRE (National Institute for Documentation, Innovation, and Educational Research) leveraged its decades-long experience in guiding schools through processes of change and innovation. It promoted Solidarity Networks directed at different target groups: schools with all their stakeholders (teachers and school principals) and students with their families. Networks were chosen as a mentoring system because the explicit value lay not only in the exchange of teaching practices but primarily in accompaniment, thereby transferring knowledge reflectively between peers (teachers-teachers and principals-principals) or between culturally and methodologically distant worlds (researchers-students-families).

The Solidarity Network between educational institutions of all levels ("School for School", https://www.INDIRE.it/la-rete-di-avanguardie-educative-a-supporto-dellemergenza-sanitaria/la-scuola-per-la-scuola/) and the Network among public research institutes ("Public Research Institutes for Schools" - EPR, https://www.INDIRE.it/didattica-a-distanza-per-docenti-e-studenti/archivio-webinar-enti-di-ricerca/), evoking forms of mentoring networks, have contributed to the realization of a systemic approach to educational support and the improvement of performance in the use of teaching methodologies and new technologies in distance learning. This occurred at a time of widespread difficulty and disorientation in all Italian schools, which were unprepared not only for digital use but also for the design of educational experiences that could connect the classroom and promote different educational models through technology in a remote learning environment. The dialogue between schools and public research institutes now allows the sharing of content, tools, processes, and methodologies, fostering a long-term strategy to support the development and implementation of integrated digital education, moving beyond emergency situations. With the guidance of INDIRE researchers and experts, teachers and school leaders of Italian schools shared their good practices, derived from concrete contexts and uses, offering their colleagues practicable solutions so that each of them could, according to their own needs and specificities, continue their activities despite the closure of schools (Mangione et al., 2020).

Professional learning communities have proven to be particularly functional in facilitating timely adaptation to the contextual changes resulting from the lockdown (Paletta et al., 2022). During the pandemic period, INDIRE leveraged its years of experience in supporting schools and designed activities and services for teachers, students, and families, focusing on the value of the "Network" as a

mentoring system (Mangione et al., 2020). The *Avanguardie Educative* Network and *Piccole Scuole* Networks, played a key role in supporting Italian schools as they transitioned to remote teaching, becoming a reference point for technical and organizational support through online training, twinning initiatives, and virtual visits.

In response Network organized a coordinated effort involving over 180 schools of all levels, each having accumulated years of innovative experience, to support unprepared Italian schools in the shift to distance learning. Solidarity network based on MOOC eds (taxonomies by Pilli & Admiraal, 2016) to support schools during emergency situations but also to ensure continuing education moments for schools joining the movements, propose pathways in the form of MOOC-Eds (educations) (Clark, 2014; Kleiman et al., 2015).They shared educational practices, skills, and operational solutions in 211 webinars, which were attended by 45,961 teachers and school leaders for a total of 163 hours of online activities (Mangione et al., 2020; Mughini, 2020).

3.3 Piccole Scuole for "school that will come" observatory

In the Pandemic year, the public and policy debates about the Italian school system have been traversed by some dichotomies which have shaped both opinions and decisions, e.g.: the one between opening and closure, the one between the 'true' school of presence and the "false" school of DaD and so on. In the meanwhile, a wider power play is running about the future(s) of education (OECD, 2020; UNESCO, 2020) in the post-Pandemic world.

Starting from inventory proposed by Latour (2020, p. 3) during the first global lockdown, INDIRE with Small Schools Network, CNR IRPPS, and ANDIS propose a research tool whose aim was to stimulate school professionals' reflections about imagining the post-pandemic practice of schooling: a self-description exercise that asks them to take a performative position toward their own future(s), through the discursive fabrication of "new protective measures […] against bringing back business as usual". "The school that will come" (https://piccolescuole.INDIRE.it/iniziative/la-scuola-che-verra/) is a survey on the post- pandemic imaginary of teachers and principals of Small Schools, referring to the invitation to "take the annual inventory" to rethink the post-pandemic world launched by the French philosopher-sociologist Bruno Latour in the article "Imaginer les gestes-barrières contre le retour à la production d'avant-crise", collected thoughts and proposals of teachers and principals of "small schools" who were asked to think about school activities of the last ten years and reflect on a school that will come.

The exploratory research eschews a complex semantic field when the "opening-closure loop" we are living in was far to be imagined, which goes through four kinds of school practices: those not to be resumed, those to be resumed as before, those to be improved and those to be completely reinvented. From May to September 2020 are been collected 206 complete surveys that we then analyzed through the coding procedures of the Grounded Theory (Clarke, 2005; Tarozzi, 2008), letting the analytical categories emerge directly from the reflections of participants. Approximately 60% of the institutions participating in the "The School that will come" survey are small schools affiliated with INDIRE's Small Schools Movement.

The collected answers highlighted a "crepuscular vision" distant from the special effects of the rhetoric of innovation and from the dichotomies of public debate, in which new forms and objects, albeit still blurred, are supported by a pragmatic approach to rethinking school (Landri et al., 2021). There is a need to return to an "old normalcy", meaning the school as it was before COVID-19. There is a strong attachment to the school institution, particularly to established practices over the years.

However, making fruitful the experiences of DaD in the horizon of the present, this vision goes beyond the inadequacies of frontal lesson and transmission model, pointing towards some main areas of change: teaching methodologies, integration of digital technologies, centrality of body in curriculum, space-time of school and conditions of educational work in digital age. The representativeness of this vision is worthy to be further investigated, but we can say from now that it seems possible and still practiced in schools an approach that, aware of the cogency of change, is not resistant nor uncritically promoter of innovations, but prone to open yards of "metamorphosis".

4. The Italian School Network toward a new normality

The investigations carried out by INDIRE in the post-pandemic period have highlighted some "beneficial" side effects produced by the forced transition to distance learning, such as the maintenance of some good distance teaching practices. This section discusses and presents some of the most significant actions based networking supporting the schools' return to the new "normality".

4.1 Co-training & Exchanging with the Avanguardie Educative

These initial experiences of mutual support between schools continued in a series of webinars, "Formarsi e confrontarsi con le Avanguardie educative", which accompanied schools first through the forced transition to remote teaching, then in their digital transition, and now supports them in designing interventions under the National Recovery and Resilience Plan, known as "Scuola 4.0". This initiative, conducted between September 2020 and March 2022, featured 41 webinars with an average of 157 participants in each online session. The webinar series was designed for a wide audience, with the dual aim of involving school leaders, teachers and stakeholders also from outside the Movement, and of promoting reflection on cross- disciplinary topics, such as formative assessment, inclusion and integration, media education, orientation, soft skills, the transformation of learning environments as well as innovation ideas and methodologies. The webinars, led by INDIRE researchers with the participation of scholars and experts, provided the opportunity to give voice to the innovation experiences gained by the schools of the *Avanguardie educative* Network in a comparison with other Schools, not belonging to the same Network. Particular attention was given to teaching practices in schools at the time of Covid-19, with in-depth studies aimed at understanding the sustainability of innovation proposals in the context of distance teaching and learning. In order to promote the exchange of significant innovation experiences and to encourage discussion on issues that affect the entire school system, some events have been organized in collaboration with other educational innovation networks operating at regional and/or national level.

Following a large-scale open education model (Pilli & Admiraal, 2016), the webinars, led by INDIRE researchers and featuring experts from academia and the workforce, provided an opportunity to showcase innovation experiences from schools. Experts, teachers, and school leaders shared best practices derived from different contexts and concrete uses, offering practical solutions for each participant to adapt to their own needs and circumstances.

The participants (6,476 in total) were given a satisfaction questionnaire at the end of each webinar and a follow-up questionnaire to investigate emerging needs in training and professional development of this large professional learning community. The results show a high level of satisfaction with the proposed training offer, but also some thematic subject areas that certainly need further investigation (Nardi et al., 2022).

Contrary to what might have been expected, providing support with respect to the new distance learning methods is no longer a priority compared to other topics addressed during the meetings, such as, for example, didactic planning, redesigning educational environments and integrated digital didactics. These data show, first of all, a degree of professional maturity achieved in the two years of the pandemic by the respondents who are now largely oriented towards blended digital teaching (DDI) rather than simple remote teaching (DAD). Secondly, it can be claimed that the participants perceive this type of initiatives as a tool for continuous professional development (Poce et al., 2021) and thus as the acquisition of expertise which is functional to educational work even after the health emergency. As evidence of this claim, the respondents identify the accompaniment and professional development and the sharing of good practices among peers as the most valuable elements of the initiative.

In terms of the training usefulness perceived by the respondents, among the various topics proposed the one gaining the greatest interest is certainly the in-depth study of innovative teaching methodologies. Considering that more than a half of the participants, at the time the webinars were held, had not yet joined the AE network, this type of feedback is comforting not only with respect to the path taken with the training initiative, but also with respect to the broader objectives that have animated the Movement since its inception, and that have always recognized the centrality of methodological innovation in the school model (Nardi & D'Anna, 2018).

The value of the proposed training offer in view of professional development is also confirmed by the high networking rate promoted by the initiative. In fact, a large share of participants declare to have established both informal and formal collaborations following their participation in the webinar series. From this point of view, the peer-tutoring model adopted for delivering the contents seems to be a path to be followed and strengthened also in the future (Nardi et al., 2022).

4.2 Avanguardie Educative and Piccole Scuole Mentoring Cluster for ICT Innovation

In the field of studies on school innovation, reference is made to "mentoring networking" (https://mensi.eun.org/school-to-school-mentoring) as a grouping or partnership between two or more schools that wish to start a process of improvement benefiting from the experience or knowledge of expert teachers of schools that have already undertaken and systematized paths of innovation. Despite the value attributed to it, mentoring between schools based on networking is still little widespread and little studied (Armstrong et al., 2021) because in practice there are pitfalls and barriers that often hinder or prevent meaningful collaborative activity.

As part of a Pan-European research action coordinated by EUN (European School Network) that involved 6 countries and over 120 schools, INDIRE started an experimentation of mentoring networking forms involving 22 schools of the National Network (Sicily and Reggio Emilia for Piccole Scuole and Campania and Puglia for Avanguardie Educative).

The clusters were involved in an action research path on mentoring models to support the processes of didactic innovation through the use of ICT. The schools were supported by cross- cutting training actions for the scalability of ICT by mentor schools that accompanied the mentee schools through a work between territorial clusters. INDIRE led the accompaniment plan for the design of mentoring actions. The selected mentor schools have created a Continuous Professional Development Toolkit, making available resources and skills in order to offer the mentee schools in their territory a variety of training opportunities: workshops and pedagogical ateliers; learning snacks (eTapas) moments of visiting oriented to the observation of teaching practice or video documentation on which to build paths of critical analysis for the improvement of projects experimented in class (Cannella & Laghigna, 2022; Rossi et al., 2023).

During the first two years of work it was possible to investigate the different models of mentoring, involving schools and 120 teachers in innovation processes related to outdoor and active teaching integrated with digital and identifying good practices that are returned in the "Media" section of the Network and taken up in the School-to-School Mentoring Community (https://www.facebook.com/groups/mensi.school.to.school.mentoring/), a space for international comparison. The mentor schools also took part in the construction of "Beyond Networking: School-to-School Mentoring for Digital Innovation, European MOOC that involved over 600 teachers of any subject and level, school principals, interested in exploring innovative approaches to mentoring and networking strategies among teachers.

4.3 Piccole Scuole supports "Classi in Rete" experiences

The didactic and organizational innovation of small schools intersects with the question of the school form (Mangione & Cannella, 2021; Maulini & Perrenoud, 2005) and the need to rethink the characteristics of a dominant model by promoting the adoption of alternative visions of school. The Small Schools Network promotes a school of proximity, connected and inclusive, able to rethink an organization of classes for homogeneous levels. The need to help schools face the challenges associated with isolation (Cannella & Mangione, 2021) and access to digital resources (Johnson & Strange, 2007) has made it possible to identify over the years models and practices for the enrichment, opening and extension of the classroom (Alpe & Fauguet, 2008; Mangione & Cannella, 2021). The shared teaching experience proposed by "Classi in Rete" (Mangione, 2022) returns new "school scenarios" where technology facilitates the possibility of rethinking teaching activities for open and multi-level classes, proposing indications for rethinking the organizational management of the learning environment integrated with digital.

Classi in rete was born from the study of the École en Réseau model experimented in Québec since 2001 to rethink teaching in small and isolated schools (Pieri, 2022). It is characterized by working in "delocalized" classes called to prepare a common disciplinary path, throughout the school year,

involving groups of students in parallel in hybrid contexts (integrating virtual and real spaces) adapting calendars, spaces and roles of teachers. Classi in rete rests on a "hybrid setting", that is, on a system that alternates face-to-face social interactions with others that take place at a distance, mediated either by videoconference or by an online environment developed by the University of Toronto, to support the construction of knowledge (Cacciamani, 2022). The teachers of the delocalized classes share cooperative educational forms such as "peer aidants", "mentorat" or "delocalized teams" using virtual twinning environments, videoconferencing and innovative spaces for collective argumentation. The Network Classes work on real problems and develop a common understanding around big themes that act as integrating backgrounds for multiple disciplines.

In the 2020-2021, during post Pandemic year, INDIRE started the pilot experimentation (https://piccolescuole.INDIRE.it/progetti/pluriclassi-in-rete/) in small Italian schools (Mangione & Pieri, 2021) to overcome the educational limits that occur in situations of remoteness and to offer an innovative path capable of contrasting the judgment that students and families give to the service "education" as well as on daily pedagogical practices. As already highlighted by national and international literature, The Network involved, supported by USR Abruzzo, in the first experimentation, 12 small schools adhering to the Small Schools Movement and saw the active participation of 22 teachers (of which 16 of primary school and 6 of lower secondary school) and 222 students. The twinned classes, starting from a shared educational project, worked as a single class and the teachers assumed roles functional to the work for transversal groups also enhancing situations of high heterogeneity (Mangione, 2022). The experiences of designing shared teaching practice and working for "delocalized" classes allow to intervene on the definition of new school scenarios, highlighting the changes inherent in the didactic design for "themes" (working in a transdisciplinary and competence-based way), the work for multi-level classes, innovations in the organizational management of the classroom environment and the professional development of teachers in terms of epistemic agency through new technologies (Columbro, 2023).

As part of the international scientific collaboration between the INDIRE research group and the Quebec Network in support of small and rural schools, it will be possible for all teachers and principals of the institutes adhering to the Small Schools Movement to take part in the "Colloque de l'École en réseau" (https://eer.qc.ca/colloque-eer) an annual event that represents a very important opportunity to take a look at good practices, project proposals, international experiences that can enrich the research and training path in small schools.

5. The Italian school Network as co-research on practices and internationalization

The Toolkit and Notebooks aim to return practical knowledge to the Networks in the form of theories for action (Mortari, 2010). Periodic collection and analysis of experiences or results of experiments, reporting and discussion with practitioners and structuring of theoretical framework and evidence, guarantees a constant sharing of exemplary and anticipatory practices and their dissemination on the national and international contexts.

5.1 Avanguardie Educative enabling collaborative research processes

The educational value of the *Avanguardie Educative* Network is not only evident through the actual training and co-training activities promoted by its participants but also through collaborative research processes (Desgagné, 1997), where members of this co-research community (Alquati, 1993) actively participate in investigative processes to avoid the risk of "innovation without change" (Elliott, in Magnoler, 2012, p. 110). Within the Avanguardie Educative network, the research process typically begins with the identification of a significant educational issue, such as rethinking the traditional school model or reducing dropout rates. These issues are addressed by the Movement based on requests from an initial group of schools and form the basis for defining a common pedagogical intention (Parigi in Mughini et al., 2023). This intention is formulated in collaboration with teachers and school leaders and then formalized in the Ideas of Innovation Guidelines. These documents are the result of collective writing between researchers and teachers from "Capofila" schools (the head schools piloting the Ideas), and they provide guidance for implementing practices, making them

accessible to colleagues interested in implementing them in their educational contexts. The guidelines cover the motivations and purposes of the practices, the main challenges in their implementation, and the possible outcomes of their adoption. They also include documentation of experiences carried out in schools, illustrating a variety of cases related to the same practice but implemented in different contexts (different school levels, geographic areas, educational situations). The decision to present multiple approaches to the same practice is motivated by the risk that the practical recommendations presented in the documentation may be perceived as technical-procedural knowledge and interpreted as prescriptive to ensure the transferability of actions and results to one's own school environment. Subsequently, the schools participating to the *Avanguardie educative* network can choose to adopt practices already identified by the Movement or propose new experiences and teaching practices by submitting documentation of original research or adaptations of existing practices. The documentation sent by the schools undergoes initial analysis by researchers who assess its alignment with the fundamental principles of the network, as outlined in the Manifesto, and agreed upon when the school joins. Researchers also evaluate the extent to which the documented practice has been disseminated within the school, its sustainability over time, and the reliability of the reported outcomes. For experiences identified as potential new Ideas of Innovation or as "variants" of ideas already present in the Movement's repertoire, an in-depth interview is conducted, followed by on-site observation guided by a shared protocol aimed at ensuring alignment between stated intentions and actual actions. Following the collection of cases, a co-research phase typically takes place, involving a group of teachers, school leaders, and researchers. This phase seeks to identify common qualities among all the cases considered. It usually entails a research process that engages the research group over one or two academic years, during which observation, documentation, and reflection activities are carried out regarding the practices under investigation. Methods such as diaries, narrative interviews, and observation grids are employed. Researchers are responsible for systematically analyzing the documentation, producing detailed descriptions of the practices and the mechanisms that regulate them, and contextualizing them within relevant scientific literature, typically through narrative or integrative review (Souza, 2010).

5.2 Piccole Scuole for the enhancement of practices and internationalization

The need to return to the Network a practical knowledge available in the form of theories for action (Mortari, 2010) has pushed the research group to identify a documentation model capable of telling the school through the words and experiences made with the teachers. Thus, in 2019, "The Notebooks of Small Schools" (https://piccolescuole.INDIRE.it/quaderni/) were born with the aim of documenting the educational and educational experimentation activities of the schools participating in the Network. The Notebooks pay homage to the "Biblioteca di Lavoro" directed by Mario Lodi who published, between 1971 and 1979, numerous booklets and didactic cards, creating a real encyclopedia of the most significant experiences carried out in Italy. The repertoires of the "Biblioteca di Lavoro" found a great diffusion among the teachers of that time and were very important in the innovative development. With a simple and clear and essential language, they contributed to the spread of ways of doing active, inclusive and democratic school (Parigi et al., 2020).

The project of the Notebooks, well received by the reference school community, is divided into three Series. In the Stories series (https://piccolescuole.INDIRE.it/quaderni/storie/), practices are collected that are rendered in the form of testimony. Through the testimony of teachers, we intend to shed light on typical problems, identifying paradigmatic cases (e.g. "Small Schools in action for the objectives of Agenda 2030") to be shared or the presence of new visions of school to be investigated (e.g. Notebook Stories on "School as Learning Hub"). The Series "Tools" (https://piccolescuole.INDIRE.it/quaderni/strumenti/) represents a repertoire that emerges from a collective work carried out by INDIRE researchers with groups of teachers starting from an initial problematization and that are often also the subject of laboratory training that see the experimentation of methodologies (such as, for example, the Notebooks dedicated to the "Classi in Rete" model or again to Service Learning in small schools). A third series Studies (https://piccolescuole.INDIRE.it/quaderni/studi/), is dedicated to carrying out in-depth studies, systematic reviews, restitution of studies and monitoring on the context of Small Schools. This last series aims to provide teachers with a synthesis of formal knowledge and contextual information useful for practice, but also for building an identity awareness of professionalism with

respect to the reality of isolated schools (such as Notebook “From PON for school to PON for small school”). To foster the development of a Network of practice (Teigland & Schenkel, 2006), it was considered useful to guarantee a periodicity and open access in digital format on the website of the Movement and, in some cases, printed and distributed free of charge on occasions in conferences and training initiatives. The first survey on the use of Notebooks presented at the Seminar “From Mario Lodi’s Library of Work to INDIRE’s Small School Notebooks in the sign of continuity: tools at the service of schools”, highlighted not only the importance that these devices begin to assume with respect to professional training of teachers but also the main benefits. The Notebooks in fact represent for teachers who completed the questionnaire (150): “Concrete solutions to everyday problems” (30.56%), “Suggestions and operational indications on activities to be carried out in class” (37.96%), “Stimuli to reflect on purpose and objectives educational action” (20.37%), “Information to better understand specificities Small Schools” (8.33%), “Theoretical and empirical knowledge for educational research” (0.93%). The numerous international collaborations and awareness that Italy today plays an important role in European panorama in didactics in small schools has pushed INDIRE to translate Notebooks “Tools” into 3 languages in order to support their adoption also the Erasmus+ projects and training path oriented to the training of teachers of small schools as well as in the international networks that look at the Italian network as a model to inspire and from which to draw orientations [notebooks of Small Schools are today adopted within the EU Virtual Classroom project, an international community, a collaborative virtual space in real time where rural schools can support each other, filling their deficiencies in teachers shortage, content and activities immediately].

The need to develop a pedagogical thinking useful to the community and to put oneself at the service of all the practitioners who daily have to find solutions to the problem of educational action, has allowed the National Network of Small Schools, to internationalize experiences and research issues, intercepting organizations and networks with which to start a process of institutionalization of the network as a tool for improvement and innovation (Cannella & Mangione, 2020). In 2021, INDIRE promoted together with EUN a qualitative research process of a cognitive type, aimed at the birth of a Special Interest Group (SIG) dedicated to “small and rural schools”. After a first survey to identify the needs of small and rural schools, in which 13 countries participated, the absence of systemic actions emerged, such as specific training activities for new teachers or updating for teachers working in a rural context and only in a few have initiatives been activated aimed at education/schools in rural areas (France, Spain, Sweden, Poland and Italy). The European action of Special Interest Group “The Rural School under focus” (http://www.eun.org/news/detail?articleId=10124336) and related Report “Playing their part: Small and rural schools” (European Schoolnet, 2023) reports the results of a comparative research that has made it possible to intercept the opportunities on which to build new service research actions focused on the value of a European Network capable of finding common intervention cores and at the same time occasions for exchange of organizational models and teaching practices.

6. Conclusions and Remarks

INDIRE over the years has supported a service research to promote the improvement of educational practices by making Networks and different forms of networking, an epistemic place where to test didactic and organizational methods and models as well as the outcomes of research, bringing a contribution to pedagogical science and qualifying the different educational contexts. The consolidated generalist Networks such as Avanguardie Educative and the National Network of Piccole Scuole are configured as important spaces for comparison and reflection among teachers, managers, researchers and stakeholders of the school system and therefore as a meeting place between theory, research, practices and experiences in the field and take as central the concrete problems of the school creating a partnership based on the exchange of knowledge, resources and skills, able to facilitate the diffusion and appropriation of innovations. The predisposition of online environments also offers the possibility of using resources and materials for training and self-training, facilitating that legitimate peripheral participation that characterizes the social and collective learning process even after the pandemic. The trajectories of innovation in which schools recognize themselves, formalized through Cultural

Manifestos or through White Papers, project schools towards educational futures to be known and experimented through training paths, visiting and collaborative research and allow to intercept anticipatory practices and formalize theories for action through notebooks, toolkits, video practices and how-to.

Authors' contributions

The present contribution can be attributed for paragraphs "1. Introduction", "2.1 The value of practice networks", "2.2 Avanguardie educative Network" and "4.1 Co-training & Exchanging with the Avanguardie Educative" to Andrea Nardi, Researcher at INDIRE; paragraph "3.1 The transition to online teaching", "5.1 Avanguardie Educative enabling collaborative research processes", "5.2 Piccole Scuole for the enhancement of practices and internationalization" and "6. Conclusion and Remarks" to Laura Parigi, Researcher at INDIRE; paragraphs "2.3 Piccole scuole Network", "3.3 Piccole Scuole for school that will come observatory", "4.2 Avanguardie Educative and Piccole Scuole Mentoring Cluster for ICT Innovation" and "4.3 Piccole Scuole supports Classi in Rete" to Giuseppina Rita Jose Mangione, Researcher at INDIRE and Responsible for Innovation Networks.

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Unblack boxing Reality through Logic and Philosophy of Language: teacher knowledge and new paths for technology education

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Abstract

European policies on citizenship education are increasingly interested in media, data and education technology. This trend reflects the necessity to interact in a thoughtful and active manner with a multifaced reality composed of natural, social and technological worlds. To learn how to inhabit such reality – which is massively lived onlife – in this paper we suggest considering logic and philosophy of language as a basis for developing a new kind of education technology.

Keywords: Coding, Computational Thinking, Logic, Unblack Boxed Technology.

1. Introduction

This contribution will describe a research path aimed at equipping teachers with specific theoretical grounds which are useful to approach the technological features of the environment and of the school subject in a conscious manner. In our view, teachers training is necessary in order to make them able to lead students to achieve what we can call, quoting Blikstein (2018), an unblack boxing attitude to technology.

We identify in logic the very base of this equipment. Logic allows teachers and students to become familiar with the formal languages that are used in computer programming and coding; logic is at the basis of computational thinking, which plays a pivotal role in helping to learn how computer works; logical skills are arguably ubiquitous across all disciplines. The argument for this proposal hinges on exploratory research conducted in Italian schools.

In the first part, we will present the theoretical background with reference to national and European policies, as well as with epistemological and pedagogical models; in the second part we will present the steps of a research path which can lead to the construction of a teacher training model on these topics.

2. Theoretical Background

European policies on citizenship education are increasingly interested in media, data and education technology. The Council of Europe claims that young people are "born in a world in which the opportunities presented by the digital revolution are taken for granted". However, being in born in such world does not guarantee to be digitally literate. In fact, there is the risk of creating a growing gap between those who develop digital literacy and those who use of new technologies in a passive unreflective manner. The *OECD Learning Compass* (2019) inserts data and digital literacy, along with literacy and numeracy, among the core knowledge, skills, attitudes and values for 2030. The *Guidelines for developing and promoting digital citizenship education*, Education Annex to the Recommendation 10 (CoE, 2020, p. 8) underlies that we live in a "technologically-mediated and information-rich environment" and the Digital Citizenship Education Overview and New Perspectives in the incipit emphasizes that the internet and the new digital technologies will have a far-reaching transformative impact.

This trend reflects the necessity to interact in a thoughtful and active manner with a multifaceted reality composed of natural, social and technological worlds (Floridi, 2014, 2019; Ferraris, 2021). In order to learn how to inhabit such reality – which is massively lived onlife (Floridi, 2015) – in this paper we suggest to consider logic and philosophy of language as a basis for developing a new kind of media education and education technology.

We explore this suggestion from a constructivist perspective that emphasizes the value of active learning. In doing so, we draw a conceptual line which includes Freinet (1957), Papert (Papert & Harel, 1991), the perspectives of hackers (Himanen, 2001) and makers (Hatch, 2013). According to these perspectives, technology assumes a peculiar role both as an educational tool and as an educational object.

Frenet is the first to recognize technology and technological tools as an essential part of the student experience: technology is part of their environment and, more specifically, machines and techniques can be a functional part of their learning environment. Papert changes the epistemological perspective in an externalist sense: we no longer think of knowledge as a form of objective mirroring of a given external reality, but rather as a shared construction built in the interaction between the subject and the world. At the same time, learning is a shared process of construction, in which building and manipulating are fundamental moves. The hacker ethics opens to the world the expertise of the individual through the idea of open source to co-contract, manipulate and adapt the "code". The maker movement sees the process of understanding reality as active remodelling through making and coding practices.

Teachers as Designers of Learning Environments (Paniagua & Instance, 2018, p. 13) claims that "better understanding of innovative pedagogies is required in order to address contemporary educational challenges and improve teachers' professional competences" and consider computational thinking among the six broad clusters of pedagogical approaches.

To learn to write is to learn how to create the technological reality. This knowledge allows learners to appreciate what was hidden in the black box. We identify in the understanding of formal languages a basis for unblack boxing the reality we are currently living in. Our working hypothesis is that logic and philosophy of language can be powerful grounds that can help teachers in this respect.

There are several reasons that justify the focus on logic and philosophy of language.

First, logic is a formal language, and to educate children to understand formal languages is fundamental to understand how digital reality is structured and programmed. Logical literacy therefore allows children to become familiar with the formal languages that are used in computer programming and coding (Davis, 2000). This perspective can promote an active and critical engagement with technologies (as opposed to a passive uncritical experience).

Second, logical thinking skills are fundamental for computational thinking. Computational thinking, in turn, is regarded as crucial to help children to appreciate the way in which computers and other machines work. Again, a focus on logic education is instrumental for a digital education, supporting the promotion in educational path of computational thinking as structure and coding as language, where "structure" and "language" take on a different and deeper meaning than that in common use.

Third, logical skills are ubiquitous across all disciplines and throughout all compulsory education. The key role of logical and argumentative skills is highlighted in the documents that define the identity of Italian schools, that is, *Indicazioni nazionali e nuovi scenari* (2018). Logical and thinking skills are also crucial in secondary school – across the curriculum and in specific disciplines – and in the test that universities use to evaluate the enrolment of candidate students.

3. Materials and Methods

3.1 Research question and research methods

Our research question is the following: What kind of training can sustain teachers in developing this framework and use it as a basis for realizing teaching and learning experiences?

We try to provide an answer to this question through a research path that began with exploratory research structured along the lines of the Design Based Research (Design-Based Research Collective, 2003).

We scan the data emerged during the pilot (Di Stasio et al., 2022, 2023) using a SWOT analysis in order to identify possible features, *caveat* and changes for the construction of a teacher training model. Through a social tagging process conducted by three members of the research group we categorize strengths and weaknesses of the experimentation as well threats and opportunities. This allows us to connect the results of the pilot with a new training and experimentation process – which involves 15 school and 50 teachers – using the tags to analyze the very first interaction whit the new teachers, to compare them whit the previous analysis and to design on these bases the training model.

3.2 The exploratory research

In 2019, exploratory field research was launched involving different school grades and different disciplines related to the study of formal languages: analytic philosophy, philosophy of language and logic; the formal language of coding; and reflection on natural language through scientific grammar valency model. A selection was opened for so called *Istituti Onnicomprensivi* and identified the Convitto Nazionale Colombo, from Genoa, and the San Marcello Pistoiese, which is located near Pistoia: in total, the training involved 11 teachers from 6 schools (primary, secondary and high school). The course began with a three-month propaedeutic phase dedicated to training teachers on philosophical, thematic and disciplinary framework content through seminar and self-study moments. Teachers were then guided to design an instructional pathway consistent with their usual teaching practice, dealing with one of the project's foci (philosophy of language and logic, coding and valency grammar) and fitting into the proposed philosophical framework. The design phase was supported by the research team with numerous moments of discussion and rewriting.

The project included four phases: teachers training; design of teaching learning activities; experimentation and analysis. These activities were focused on the following nodes: ordinary language and its characteristics; ideal language and its characteristics; relationship between ordinary and formal language; relationship between the truth of declarative statements and their form; role of language in the process of thought; logical connectives. With respect to the activities of coding, we identified the following as main themes: the definition of coding; the use of symbolic languages; algorithms; the use of programming language.

During the experimentation we gathered data from multiple sources, such as focus groups with students, visual documentation of the lessons, interview with teachers, and a variety of structured observer tools. Working with a few teachers has made it possible to collect data with different tools and analyze material of different types. Teachers documented through logbooks, audiovisual materials and, where possible, were observed by a colleague or INDIRE. At the end of the experimentations, seven focus groups were conducted with the pupils of the classes involved and two interviews were conducted with the teachers who experimented with coding at the Primary.

3.3 The new training path

Starting from the described experience, the FiL project tries to design and test a model to involve teachers in teaching learning paths on these topics.

In spring 2023, we opened a call to the schools of the INDIRE networks. Logic and philosophy of language remain the framework in which to develop paths of grammar, coding and philosophy; each school could choose one or more paths.

20 schools belonging to the Avanguardie Educative Network responded to the call and 15 were selected with 50 teachers. Those selected to participate in the project come from regions in central, southern and northern Italy. The experimentation covered schools in the following regions: Marche, Puglia, Abruzzo, Lombardia, Calabria, Campania, Sicilia, Toscana. 18 Schools choose coding paths, which are open to all primary teachers and to teachers of mathematics, science, technology of secondary school as well as to those of the science and/or technology departments of the secondary school.

In answering the call, teachers must submit an abstract with a section on motivation and expectations and a section in which, starting from guiding questions, they reflect on the path in their teaching (Figure 1).

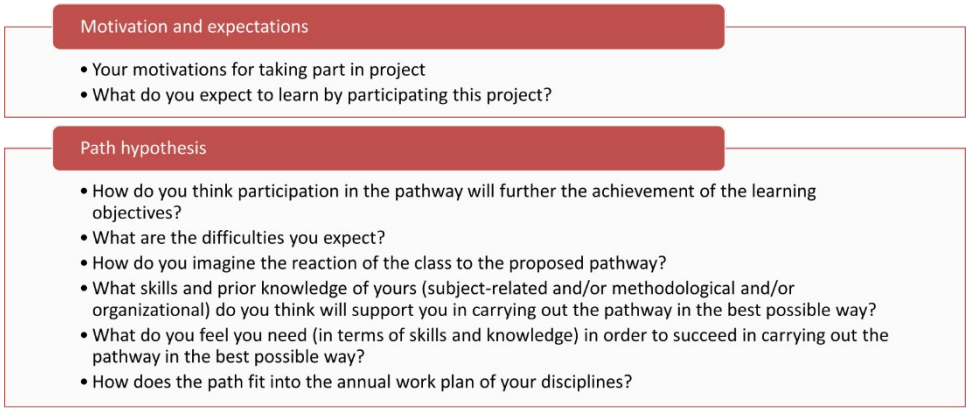

Figure 1 - Motivation and expectations.

4. Results

4.1 The SWOT Analysis

In this context, we focus on a SWOT analysis based upon two main sources: focus groups with students, and structured observer reports from teachers. Our main aim in writing this SWOT was to identify some tags that could then be used to analyze teachers' abstracts for the next stage of the project. The tags are written between square brackets.

Table 1 - First SWOT analysis.

STRENGTHS	WEAKNESSES
• Ease to fit reflections on languages and their use in various points of the curriculum [language in the curriculum] • Ease to show how reflection on language and its use matter for students' everyday life [language in everyday life] • Students gradually acquired the means to manipulate a variety of languages, symbolic as well as natural [languages manipulation]	• Lack of basic knowledge (on logic, philosophy of language and its applications in the context of education) [lack of knowledge] • Lack of communication and exchange across educational stages [lack of verticality] • Difficulty in managing documentation and data collection [documentation production] • Difficulty in managing students dialogue on a variety of topics according to a student-centered approach [teaching and learning strategies] • Difficulty in planning effective didactic strategies. [didactic planning]
OPPORTUNITIES	**THREATS**
• Occasions for dialogue among teachers participating to the training and experimentation [peer feedback and collaboration] • Knowledge and use of shared codes of communication [shared languages] • To appreciate the value of perspicuous language in providing instruction for human-technology interactions [language in human-technology interaction]	• Lack of time for training [lack of training] • Lack of continuity in teacher training and professional development [teachers' professional development] • Lack of continuity in student's learning paths on these topics [students' paths]

Since our aim in this paper is to discuss ways to implement effective teacher trainings, we shall comment only those aspects that concern teacher experience during the experimentation.

One general important feature is teachers' perceived difficulty in managing didactic activities related to logic and philosophy of language. This difficulty in turn might depend on two more specific difficulties. The lack of knowledge on logic and philosophy of language – which are not compulsory subjects in the training of teachers – and the difficulty in managing dialogic exchanges in the classroom. Although the latter difficulty is unrelated to the specific topics of the present project – as it concerns the general difficulty of favoring dialogic interactions according to a student-centered pedagogy which departs from traditional teacher-centered activities – we might hypothesize that it is exacerbated by the lack of strong knowledge about logic and philosophy of language.

4.2 The Abstract Analysis

Starting from SWOT results, we individuated a set of tags that could then be used in order analyze teachers' abstracts. In what follows I shall present the tags that had occurrences in the abstracts, I shall briefly comment each of them and explain how they relate to what we found in the SWOT analysis.

- [Language in the curriculum] Some teachers fear that the proposed activities will not fit easily within the curriculum; some desire to put an emphasis on the interdisciplinarity of the project. In the SWOT analysis we found something different, for many teachers reported that it was relatively easy to fit activities on language in the curriculum. So, the abstract reveals what might turn out to be a false presupposition about the role of language in the curriculum. It is also interesting to relate this tag with the tag on the lack of verticality. One of the core hypotheses of the present educational proposal is that logic and philosophy of language play a foundational transversal role in the curriculum across all educational stages. One of the challenges for us is to help teachers in locating teaching activities related to logic and philosophy of language in the curriculum, both synchronically (across disciplines in one educational stage), and diachronically (across educational stages).
- [Didactic planning] Almost everyone expresses the need to receive advice about didactic planning. This point is linked with the previous perceived difficulty in managing didactic activities about logic and philosophy of language.
- [Teaching and Learning Strategies] Expectations include the desire to learn how to plan and to implement innovative teaching strategies.
- [Documentation production]. Many teachers feel the need to know how to produce documentation.
- [Peer feedback and collaboration]: Virtually everyone stressed the value of peer feedback and collaboration with other teachers and the need of receiving feedback from experts.
- [Lack of Knowledge] Interestingly, the felt lack of knowledge is generally mentioned as something positive – connected to the desire to learn – rather than as a weakness that might jeopardize learning activities with students. In the SWOT analysis the lack of knowledge was perceived as a difficulty and as a potential threat due to the brevity of training.

Table 2 - Second SWOT analysis.

STRENGTHS	WEAKNESSES
• [language in the curriculum] 13 • [language in everyday life] 2 • [shared languages]	• [teaching and learning strategies] 9 • [didactic Planning] 9 • [documentation production] 7 • [lack of knowledge] 4 • [lack of training] • [lack of verticality]
OPPORTUNITIES	**THREATS**
• [peer feedback and collaboration] 9 • [languages manipulation] 2 • [language in human-technology interaction] 1	• [teachers' professional development] • [students' learning] • [teacher's knowledge]

5. Conclusions

The analysis of teachers' abstract indicates some points which play an important role in the design of the model for teacher training.

The first point concerns teachers' need for dialogue and peer feedback both with colleagues and experts. Concepts of professionalism often hinge on individualistic assumptions, that is, they think that the most important aspect in teacher training is to help teachers to develop their knowledge, competences and attitudes. However, SWOT and the analysis of the abstracts reveal the importance of dialogue and collaboration in the service of teacher professionalism.

The second point concerns the need for a structured training on topics which are not familiar to teachers. We will address this need by offering:

- Training: with a common unit based on webinar and office hours on philosophy of language and logic; specific unit on the topics (coding, grammar and philosophy); a focus on the experimental path in teaching and learning activities;
- Individual study and feedback: with materials for the individual study, activities and tools for reflection;
- Dialogues: on theoretical general parts between teachers belonging to the same school; on the learning activities developed by teachers from different schools who focus on the same topics.

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Technological and digital capital of parents: a construct to analyze digital skills

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Abstract

Digital and technological capital are key concepts in education and the digital society. Technological capital encompasses access to digital resources and infrastructure, like computers, software, and internet connectivity, while digital capital involves using digital tools effectively and participating in the digital society. Parents' digital skills can impact their children's experiences, especially in virtual teaching. This study aims to demonstrate the multidimensional nature of technological and digital capital and analyze various variables to understand these concepts better. The analysis focuses on parents of students aged 6 to 18 and their engagement in remote collaborative learning. Questionnaires were administered in Italy, and the sample consisted of 282 parents. Each dimension of technological capital corresponds to specific questions, considering its multidimensional nature. Factor analysis using polychoric correlations is crucial for ordinal data, such as Likert scales. Preliminary analysis suggests that similar socio-demographic characteristics yield similar results in some dimensions but not others. Aggregating correlated dimensions and using composite indicators can enhance analysis. These findings contribute to understanding digital and technological capital and inform support for students in different learning environments.

Keywords: Technological Capital, Digital Capital, Parents, Polychoric, Factor Analysis.

1. Introduction

Digital capital refers to the ability of parents to leverage digital technologies, including their skills and knowledge related to these technologies. Technological capital can be broader, encompassing not only digital technologies but also other forms of technology and the ability to leverage them.

The level of parents' digital and technological capital can significantly impact students' educational experiences and outcomes. Parents with higher digital capital can more effectively support their children's learning, especially in a technology-driven educational environment (DiMaggio & Hargittai, 2001): a significant difference in digital inequality, highlighting that higher socio-economic status households had better internet skills, which can be seen as a form of digital capital. This difference in digital capital could impact how parents support their children's education. The technological and digital capital of parents could play a significant role also in the level and quality of this involvement (Livingstone & Helsper, 2007): for them, parental internet skills, a component of digital capital, are a significant factor in the level of parental engagement in children's online learning. Therefore, parents with higher digital and technological capital typically could have better access to educational resources, tools, and platforms that can aid their children's learning: this can affect parents' ability to navigate and utilize these resources, which can have a significant impact on children's academic success (Cullen et al., 2009). The implications of these differences in digital and technological capital are substantial. The disparities in access to and understanding of technology can exacerbate existing educational inequalities. Hargittai (2003) delves into the concept of the digital divide and examines how different social and economic backgrounds correlate with digital access and literacy. The emphasis here is on the various dimensions of the digital divide, not limited to access but extending to skills, usage, and participation. This work provides a foundational understanding of the disparities in digital access and capabilities. A few years later Hargittai (2010) focused on the variation

in digital skills within the younger generation. It challenges the assumption that younger people, being "digital natives", possess advanced and uniform internet skills. Hargittai's research underlines the nuanced differences in digital capabilities, even among those who have grown up with the technology, illustrating the variation in digital capital within this demographic.

Describing parents' digital capital from a statistical standpoint typically involves measuring various dimensions like access, skills, and usage of digital technologies.

From a statistical standpoint, these works collectively suggest a nuanced and multi-faceted approach to measuring digital capital and digital divide. Researchers operationalize digital capital by developing indices and scales based on quantitative measures of access, skills, usage, and attitudes. Structural equation modeling and multivariate analysis can be deployed to analyze the relationships between different components of digital capital and understand their impact on various outcomes, such as educational attainment and social inclusion.

Ragnedda and Ruiu (2020) offer a methodology to operationalize digital capital: they provide a framework to measure digital capital by considering aspects such as access, use, skills, and motivational attitudes toward digital technologies. It is a comprehensive model to understand and analyze digital capital empirically, emphasizing its multidimensional nature.

The nuanced understanding of the digital divide and digital capital brought forth by these studies accentuates the importance of considering diverse facets of digital engagement and literacy when assessing the technological adeptness of different demographic groups, including parents. The variation in digital skills within supposedly technologically proficient demographics underscores the necessity for continual assessment and enhancement of digital literacy across the spectrum.

The operationalization and empirical study of digital capital, as suggested by these works, are crucial for devising informed interventions and policies.

The present study aims to analyze the construct of technological capital within a sample of parents of students aged 6 to 18.

The study is part of a collaboration between the Department of Human Sciences of IUL (Telematic University of Studies) and the Department of Education of the University of Bath. The research collaboration between the two universities was born during the Lockdown with the International COVID-19 Impact on Parental Engagement Study (ICIPES), coordinated by the researcher's group from the University of Bath, in which IUL researchers were the contact persons for the Italian sample. The aim of the research had been to understand what role parents had played in supporting their children in education during the lockdown in the different countries: an online survey was conducted in 23 countries and had a total sample of 4,658 parents/caregivers (517 of them answered by Italy). The study involved the creation of a questionnaire with closed and open questions aimed at investigating parental involvement in supporting study and learning activities during the first lockdown period. To understand the structure of the proposed questionnaire and the key elements of the constructs measured, Confirmatory Factor Analyses were performed (Osorio-Saez et al., 2021).

Two years later, the collaboration between the two departments was renewed with the research project "Online collaborative teaching in schools: promoting networking and active participation in the context of the Covid-19 pandemic". The overall aim of this research was to investigate how teachers, principals, and parents have experienced online collaborative activities to identify meaningful and transferable experiences to promote active participation and relationships in virtual learning environments. Specifically with regard to parents, the role of the family context as a central aspect of a successful teaching-learning process in this perspective was explored. Also in this case, a questionnaire was created for parents consisting of open and closed questions. Within the questionnaire, the constructs of digital capital and technological capital were investigated, as shown below.

The aim of this paper is to analyze the factorial structure of this construct. These aspects may in fact constitute important elements for understanding how digital capital and technological capital can be configured as key concepts on which to focus not only in social, but also in educational policies.

2. Materials and Methods

The analysis of technological capital is part of a broader study, conducted in 2022, aimed at investigating how parents of students aged 6 to 18 have addressed issues related to remote collaborative learning during the Covid-19 pandemic (https://www.iuline.it/progetti/la-didattica-collaborativa-online-nella-scuola-promuovere-la-relazione-e-la-partecipazione-attiva-in-rete-nel-contesto-della-pandemia-covid-19/). The questionnaire for data collection and the segmentation of the concept of technological capital, were defined in collaboration with researchers from the University of Bath. The questionnaire was administered in Italy using a Computer-Assisted Web Interviewing (CAWI) method, and the sample under study consists of (n = 282) parents of school-age children and adolescents. The data were first screened for missing data; however, none was found. The main descriptive statistics of the sample can be summarized as follows: most of the sample is represented by females, who are the mothers of the students (n = 232; 82.3%) and (n = 50; 17.7%) were males, the fathers of the students. The age of participants ranged from 35 years to 61 years (median age = 47; mean age = 47.19; SD = 5.43).

The purpose of this study is to investigate whether digital capital should be considered a multidimensional concept, which would imply that individuals with different sociodemographic characteristics would record different average values in the items under consideration. Consequently, since the data collection comes from a questionnaire, each dimension of the multidimensional concept must correspond to one or more questions and any aggregation of the information obtained from them must be carried out considering the multidimensional nature of the concept (Maggino, 2007).

The theoretical starting hypothesis is that four dimensions contribute to the concept representation of technological capital: “Objective”, “Social”, “Embodied” (The digital Capital) and “Institutional”. The “Embodied “dimension can then be divided into four further sub-dimensions: “Attitudes towards technology”, “Operational skills”, “Information skills” and “Mobile skills”. The type of variables referred to the dimensions mentioned above is varied, some are discrete quantitative and others are categorical ordinals obtained through different Likert self-report scales. The factor Analysis that will be conducted must consider the ordinal nature of the variables considered; in fact, when working with Likert-type data, factor analysis utilizing Pearson’s correlations can result in factors that are solely derived from similarities in item distribution. Consequently, the items may give the impression of being multidimensional, despite not actually being so. Polychoric correlation coefficients represent the maximum likelihood estimates of Pearson’s correlations for latent variables that follow a normal distribution. Hence, according to research studies (Basto & Pereira, 2012), the raw-data matrix of polychoric correlations instead of Pearson’s correlations should be utilized for Factor Analysis dealing with ordinal data such as Likert items.

In order to determine whether each sub-dimension of digital capital should be regarded as a unidimensional or multidimensional concept, a Confirmatory Factor Analysis (CFA) (Agormedah et al., 2022) was conducted for each sub-dimension of digital capital. The factor analysis was carried out using the R package “psych” following Revelle’s method (2016), imposing a single factor to assess the goodness of fit for the one-dimensional model.

Finally, to determine whether the entire digital capital should be considered as a one-dimensional concept, the elements from each sub-dimension were combined into composite indicators using weighted arithmetic mean (Maggino & Mola, 2007), with factor loadings from the factor analysis used to determine the weights of each element (Sharpe & Andrews, 2012), and another CFA with a single factor was conducted using the previously created composite indicators as items.

3. Results

The construct validity of all the sub-dimensions of the digital capital was assessed using the factor loadings; while the following indices were used to judge the model fit: the proportion of variance, the Tucker Lewis Index of factoring reliability (TLI) and the Root Mean Square Error of Approximation (RMSEA) (Kline, 2015).

As previously mentioned, the Digital Capital consists of four sub-dimensions: "Attitudes towards technology", "Operational skills", "Information skills" and "Mobile skills"; each of them is characterized by a different number of items, all assessed using Likert scales at different points.

The details of the analysis for the "Attitudes toward technology" sub-dimension are presented in Table 1.

The proportion of variance is 0.55; the TLI is 0.785 and the RMSEA is 0.253. All the indices have adequate model fit values. Except for the "I feel comfortable using digital devices that I am less familiar with" item, for all the others, the loading is sufficient (Civelek, 2018). This demonstrates that the sub-dimension can be considered unidimensional, but it exhibits an outlier identified by the first item.

The details of the analysis for the "Operational skills" sub-dimension are presented in Table 2.

The proportion of variance is 0.68; the TLI is 0.701 and the RMSEA is 0.274. All the indices have adequate model fit values. For all the items, the loadings were sufficient. Therefore, the sub-dimension can be considered unidimensional.

The details of the analysis for the "Informational skills" sub-dimension are presented in Table 3.

Table 1 - Confirmatory Factor Analysis for the "Attitudes toward technology".

Item	*Factor Loading*
I feel comfortable using digital devices that I am less familiar with	0.36
If my friends and relatives want to purchase new digital devices or applications, I can give them advice	0.63
I feel comfortable using my digital devices at home	0.67
When I encounter issues with digital devices, I believe I can resolve them	0.88
If my friends and relatives have a problem with digital devices, I can help them	0.99

Table 2 - Confirmatory Factor Analysis for the "Operational skills".

Item	*Factor Loading*
I know how to open downloaded files	0.79
I know how to download/save a photo that I have found online	0.84
I know how to use keyboard shortcuts (e.g., CTRL-C for copy, CTRL-S for save)	0.81
I know how to open a new tab in my browser	0.85
I know how to add a bookmark to a website	0.66
I know where to click to access another webpage	0.86
I know how to fill out online forms	0.93
I know how to upload files	0.91
I know how to adjust privacy settings	0.69
I know how to connect to a Wi-Fi network	0.84

Table 3 - Confirmatory Factor Analysis for the "Informational skills".

Item	*Factor Loading*
I find it difficult to decide which are the best keywords to use for online searches	0.85
I find it difficult to locate a website I've visited before	0.69
I should take a course on online information searching	0.70
Sometimes I find it difficult to verify the information I've retrieved	0.82

The proportion of variance is 0.58; the TLI is 0.706 and the RMSEA is 0.295. All the indices have adequate model fit values. For all the items, the loadings were sufficient, so the "Informational skills" sub-dimension can be considered unidimensional.

The details of the analysis for the "Mobile skills" sub-dimension are presented in Table 4.

The proportion of variance is 0.73; the TLI is 0.355 and the RMSEA is 0.618. Both the TLI index and the RMSEA index show that the model does not fit perfectly into the data structure, but for this type of application it may be sufficient. For all the items, the loadings were sufficient, so the "Mobile skills" sub-dimension can be considered unidimensional.

Once composite indicators were obtained for each dimension and considering the item "I feel comfortable using digital devices that I am less familiar with" as an independent sub-dimension due to its insufficient correlation with the latent variable "Attitudes toward technology", a new CFA was conducted, and the results are summarized in Table 5.

The proportion of variance is 0.34; the TLI is 0.736 and the RMSEA is 0.135. Both the TLI and the RMSEA have sufficient values, while the explained variance is quite low. Furthermore, it is observed that except for the sub-dimensions "Attitudes toward technology" and "Operational skills" the factor loadings are all very low. These results suggest that the factor analysis approach is appropriate, but that Digital Capital cannot be considered a one-dimensional concept. While all the sub-dimensions that compose it, except for "Attitudes toward technology", which has one item unrelated to the others, are well represented by single-factor models, digital capital as a whole must be represented by a multi-factor model. Looking at the factor loadings of the model summarized in Table 5, it would seem appropriate to represent Digital Capital with a 4-factor model using the following items: "I feel comfortable using digital devices that I am less familiar with"; "Attitudes toward technology"; "Operational skills"; A composite indicator obtained by combining the sub-dimensions "Attitudes toward technology" and "Operational skills"; "Informational skills" and "Mobile skills".

Table 4 - Confirmatory Factor Analysis for the "Mobile skills".

Item	*Factor Loading*
I know how to install apps on a mobile device	0.90
I know how to delete apps on a mobile device	0.84
I know how to keep track of my app purchases	0.88
I know how to choose the most suitable apps for my needs	0.97
I know how to access the documents that have been downloaded to my mobile device	0.85
I understand what information apps have access to on my mobile device	0.66

Table 5 - Confirmatory Factor Analysis for the "Digital Capital".

Item	*Factor Loading*
I feel comfortable using digital devices that I am less familiar with	0.21
Attitudes toward technology	0.65
Operational skills	0.97
Informational skills	0.50
Mobile skills	0.27

4. Conclusions

Analyzing the factorial structure of a construct allows a better understanding of its meaning. Confirmatory analysis, especially Confirmatory Factor Analysis (CFA), helps in testing whether

measures of a construct are consistent to understand its nature. It is used to validate the construct, by examining whether the data fit the hypothesized measurement model, which is particularly important in the development and assessment of psychological scales and other measurement tools. In this paper, it was chosen to analyze the technological capital of parents as a construct that can be linked to factors such as the support of children in their success at school. The hypothesis of the contribution is that technological capital is a multidimensional construct composed of factors such as "Objective", "Social", "Embodied" (The digital Capita, composed of "Attitudes towards technology", "Operational skills", "Information skills" and "Mobile skills".) and "Institutional". Digital capital (Embodied) appears to be a multidimensional factor: the only two dimensions that correlate are attitudes toward technology and the actual operational capacity to use it.

Recent research shows a moderate correlation between parents' attitudes towards technology and their sense of self-efficacy in using it (Fidan & Olur, 2023): the fact that attitudes and behavior are associated reiterates the importance of raising public awareness of digital parenting concepts (Tosun & Mihci, 2020). In a context where more and more children and students use new technologies in their daily lives, it becomes important to understand how to support the possibility of parents acquiring their own digital competence. The fact that attitudes and actual use are associated in this sample leads us to reflect on the importance of thinking about parenting interventions where we reflect on the attitudes that parents have towards the use of new technologies, enhancing how they themselves use them daily. The present study certainly has limitations, first and foremost that the sample is not representative. Analyses could be deepened by understanding the structure of the construct of technological as well as digital capital.

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PNRR and school innovation between inclusive processes and potential scenarios

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Abstract

This paper aims to analyze the potential development of teaching practices and methodologies within the future perspectives of innovation in relation to the upcoming project implementation of the PNRR School 4.0. Starting from the inclusive educational act and the need for renewal we investigate to what extent the development of technologies intended not only as facilitators, but as a paradigmatic bridge of learning in today's society, can influence the learning standards of pupils in the Italian Education system. The difficulties that emerge are related not only to the absence of long-term planning, but are substantiated through two guidelines that characterize our education system. On the one hand, we have fragile territorial realities, where social marginalization, the absence of civic virtues due to easy deviance represent potential implementation obstacles; on the other hand, the reality of educators and teachers who are unlikely to be able in such a short time to train and update themselves to be able to apply these new teaching methodologies. A subsequent analysis of the field of inquiry concerns teachers' digital competence required for the implementation of new teaching practices through the use of new software and hardware. Recent studies have shown that teachers' basic digital skills, as measured through The DigComp 2.2, are lacking and teachers have difficulties in reworking them in a didactic key, including through metacognitive processes.

Keywords: Digital Skills, Inclusion, School 4.0, Innovative Methodologies, UDL.

1. Introduction

The process of renewing the Education System in Italy identifies the needs expressed by a continuously evolving society, which proposes new models of knowledge and sharing and which phenomenologically develops increasingly multidirectional and polycommunicative communication processes (Lo Iacono, 2020). The school system, representing within the society the training and educational pillar for children up to the age of eighteen, struggles to control and adopt innovations, as well as to incorporate and implement within the required times the innovations and progress proposed by the models operating in the community. The National Recovery and Resilience Plan (PNRR) is proposing an idea of innovation that the world of education will be able to understand only if it manages to arrange new developments in a structured and organic way.

Its true implementation cannot exclusively pass through the modernization of learning spaces; it must certainly be accompanied by collateral and simultaneous interventions supporting the construction of this new structural framework. In fact, the training of school staff is a further step in this direction. The new Futura platform actually offers courses dedicated to the transition to digital, enriching the teachers' skills, at least on a theoretical level. The application of these new required skills will certainly need to be monitored on a proactive and operational level over the years.

However, digital skills and cutting-edge tools alone will not be sufficient to fully support this change. In our opinion, the reconstruction and modification of methodological constructs and didactic practices in the work of teachers must be supported by a profound change in thinking. Innovation, and therefore the change in practical and mental behavior in schools, will be made possible only if the operators involved are deeply aware of the improvements required for their teaching action. The inner acquisition of a transversal idea of inclusion and of a strategic and methodological mindset, aimed at enhancing the teaching/learning process starting from the specificity of each student and capable of

educere, i.e. bringing out each child's potential, prefigures the success of the renewal process that the education system is preparing to face.

The new challenges will also be dictated by the ability to acquire a new digital teaching paradigm, complementing the static vision of technologies solely considered as tools and aids; a digital that becomes method and practice, which changes minds, ways of thinking and acting, which develops different, avant-garde trajectories. Furthermore, it will be necessary to monitor the implementation speed of these processes and their enactment, the ability to create structures and buildings suitable for the development and practice of the new methodologies and the risk of accentuating the gaps and disadvantages already present on the national territory.

2. From PNSD to PNRR: structuring a new digital paradigm

The process of digitalization of Italian teaching and school organization began over 15 years ago with the implementation of the first digital transformation measures, which introduced interactive multimedia whiteboards in around 35,000 classes (LIM Action), IT equipment for teaching experimentation in over 400 pilot classes (Cl@assi 2.0 Action), the creation of WiFi networks in schools, the launch of training courses for teachers.

But since 2015, with the approval of the National Plan for Digital Schools (PNSD) and the synergy with the European structural funds of the National Operational Program 2014-2020, the digital transition of Italian schools has experienced a strong acceleration and diffusion in all schools thanks to the implementation of the 35 actions of the PNSD.

With the funds of the National Recovery and Resilience Plan and the European structural funds of the 2021-2027 program (including those of the REACT-EU initiative currently being implemented) this process is now complete and, at the same time, a new, strong impulse, both for the relevance of the investments and for the systemic approach of the actions.

From 2014 to today, total investments have been approximately 1.9 billion. The overall funds primarily derive from the National Operational Plan PON 2014/2020 for the ESF projects, for the development of skills and the ERDF for the renewal of instrumentation and connections; subsequently from the PNSD for the implementation of the 35 planned actions and finally thanks to the funds allocated for the REACT-EU programming. The lines of intervention move through the creation of new learning environments, the use of innovative and engaging teaching strategies created through digital methodologies, the training of teaching staff and the development and improvement of connectivity through wired and wireless networks.

The PNRR goes in this direction and becomes the largest investment ever made in the radical renewal of the Italian education system. Mission 4 "Enhancing education services offer from kindergartens to universities" (MIUR, 2023) involves 5 lines of intervention which will have a direct and indirect impact on school digitalization processes:

- School Buildings - Investment 1.1
- Gaps - Investment 1.4
- School Personnel Training - Investment 2.1
- STEM Training - Investment 3.1
- School 4.0 - Investment 3.2

Within the School 4.0 line of intervention, 2.1 billion are intended for the construction of new digital-oriented learning environments, with two different operational programs: *nextgen classroom* and *nextgen lab*, through which educational institutions will be equipped with thematic learning environments or multi-functional laboratories. The Organisation for Economic Co-operation and Development (OECD) has defined some characteristics of physical learning environments, which must be adequate (meet minimum requirements to ensure the comfort, access, health and safety of users), effective (support the different teaching and learning needs to allow the school to achieve its educational objectives), efficient (maximize the use and management of space and resources to obtain the maximum result both for students and teachers).

The OECD has defined the innovative learning environment as an organic whole encompassing the learning experience organized for certain groups of students around a single "pedagogical core", which goes beyond a predefined class or program, includes activities and learning outcomes (it is not just a "place" where learning takes place), and has a shared leadership making decisions about how to improve learning for its participants. The role of teachers in the management of space is therefore of great importance, as it is enhanced by 7 learning principles which must be kept in mind to design innovative learning environments (OECD, 2017) (Figure 1).

Figure 1 - OECD's 7 principles of learning.

Learning environments will have to represent not only a physical and material product, studied and calibrated for the development of people's connections, relationships and cooperation through transdisciplinarity, but they will also have to be designed and calibrated as intelligent systems, capable of virtually modifying and redefining themselves, as a technological adaptive system which puts learners in the foreground, improves their learning experiences based on personal characteristics, preferences and progress achieved, promotes a growing commitment by increasing access to knowledge with adequate accompaniment and feedback, uses media and artificial intelligence resources, neural networks and smart technologies.

It is therefore clear how the nature of the structural intervention requires at the same time an expanded vision of the idea of technologies. This is made possible only by the birth of a new paradigm for the teaching/learning process which lays its foundations through the revolution of the didactic mindset. If on the one hand the resources and tools are needed, on the other the idea, its development and its practice are fundamental. Inclusive didactic action certainly represents the theoretical substrate on which to develop this new paradigm, which rethinks the digital as a methodology, developed through an ex ante modeled agency in the mental construction and re-proposed in the form of a method within a digital development. Inclusive action must become a systemic approach aimed at in-depth knowledge and understanding of the students' subjective configurations and their specificities emerging from the way in which their strengths and weaknesses interact, while at the same time considering their levels of emotional, social and physical maturity, the effects of any pathologies, disorders and needs and the influence of one's life context (Aiello, 2015). From this perspective, it is pertinent to point out how an already consolidated agency capacity of teachers specialized on special education activities should be transferred into the mental aptitudes of each teacher who will operate within this revolution in the education world. In fact, agency is identified with the acts intentionally performed by teachers, since they are provided with the faculty of generating actions aimed at certain purposes and with a creative, generative and proactive mind capable of creating worlds or at least having the illusion of escaping their own Umwelt (Berthoz, 2011). The concept of Umwelt therefore represents the key to understanding the new digital teaching paradigm. The environment moves from

an extrinsic representation to an internal perception, so as to create an inner microcosm, a subjectivity of universality, a manifest inner necessity. In the field of inclusion pedagogy and teaching, the concept of Umwelt has already stimulated reflection on the most effective ways to perfect and refine the learning process, creating the conditions for structuring the learners' subjective universe starting from their educational needs and possible tools for action (Sibilio, 2015; Aiello, 2016). Digital teaching will therefore have to absorb this idea within its development in the teaching/learning process, so that it becomes truly decisive and effective.

The vision conceived here is therefore closely linked to this concept of agency, which represents the only way to achieve incisive, plastic, effective teaching. The teacher must be able to mentally develop, organize and undertake sequences of operations necessary for effective teaching actions (Sharma et al., 2012). The mission will be to translate these dynamics within a new digital-oriented context, through the use of productive thinking developing innovative and high-performance digital methodologies within modular physical spaces, which can become learning environments phenomenologically corresponding to the students' inner environment, and which can comply to the Umwelt.

3. Towards digital didactics

The formulation of a new idea of teaching, of new methodologies aimed to create a learning/teaching process which is more suited to the abilities and specificities of the students, demonstrates how the simple idea of technologies is now disconnected from school contexts. Ultimately, the new model proposed hereby develops starting from the belief that digital is not merely technology, intended as tools and facilitators (Calvani & Cottini, 2020), and that instead technology technically supports the development of structured digital thinking, through new teaching practices in which mental constructs based on other variables are created. The idea of agency expressed herein above, the effectiveness of planning through the creation of an internally habitable Umwelt, the ability to develop positive and proactive inner environments for students as active subjects of their own didactic process, the construction of a teaching system starting from the needs and specificities of the individual, the transversal idea of inclusion (Cottini, 2017) are therefore fundamental elements for the realization of this process of change that the school system must bring to completion. Within this scenario – a paradigmatic bridge supporting a significant renewal of teaching practices – we must however consider the digital skills that will have to be increasingly present in the School 4.0 teacher's knowledge and skills.

The reference Framework is DigComp 2.2, which represents the measuring standard for digital skills within the European Union. The structure is divided into 5 areas of competence, with different descriptors relating to the levels of mastery. The 5 areas (Figure 2), as represented in the figure, semantically correspond to compulsory and consequential steps; in fact, competence is achieved through the intersection of knowledge, attitudes and skills.

The five dimensions represent the skills that every citizen within the EU should possess; the different levels of mastery are represented on a scale from 1 (Beginner) to 6 (Pioneer).

The latest EuroStat surveys (2022) (Figure 3) highlight that the competence level is inversely proportional to age. In the 24/54 age group, Italy has a percentage of less than 50% in mastering digital skills; the percentage drops furthermore, below 25%, if referring to ages over 54.

Recent studies point out that Italian teachers, particularly those qualified for special educational needs, have good skills in area 1 for around 60%, between the ages of 25 and 45; however, this percentage drops to 20% from 45 to 65; furthermore, in the subsequent areas the percentage of those with good digital skills is between 20% and 30% (Lo Iacono & Cardinali, 2022). Other studies in literature (Guillén & Mayorga, 2020; Montoro et al., 2015; Romero et al., 2019) prove that teachers possess a basic level of digital skills and that, within the different areas, some are quite deficient. Blayone et al. (2017) highlight that also technical skills (creating and editing documents and managing online accounts etc.), social skills (communicating via e-mail, sending and receiving messages and participating in social networks etc.), and information literacy (finding and using articles, news and

videos etc.) are deficient. In addiction, Amhag et al. (2019) point out that teachers do not use digital tools for teaching purposes and need extensive pedagogical support to create quality digital teaching.

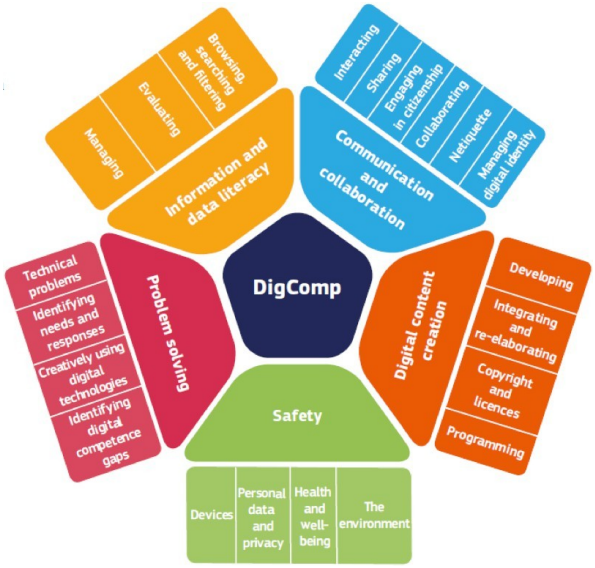

Figure 2 - 5 DigComp Areas.

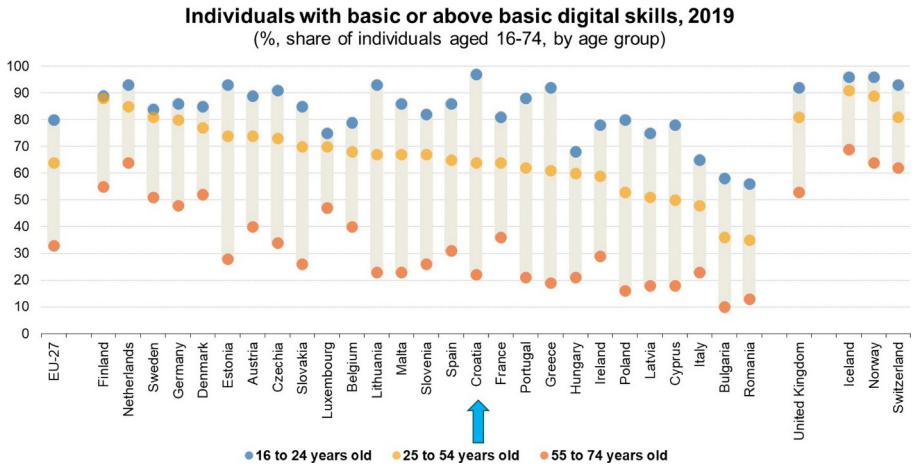

Figure 3 - Basic Digital skills in UE Countries

The poorest area is the one relating to Digital Content Creation, since it is clear that possessing basic skills cannot imply the ability to develop and create learning objects to be promoted through digital education, within teaching/learning processes. The use of dedicated apps and software, through which to conceive and manipulate contents and offer them within new classroom contexts promoting a creative, bidirectional, proactive transmission, entails such ability and agency, as said, which does not only imply possession of basic skills. The digital teaching methodology can be implemented only if it is rethought through the simultaneity of action, through the recognition of the individual Umwelt. Only a variety of knowledge, combined with attitudes and skills, will therefore lead the teacher to be able to design effective paths through inclusive (Calvani & Cottini, 2020) and equal (Rivoltella, 2020) digital processes.

Training therefore becomes the main path to follow. Nevertheless, it should focus both on transmitting skills to use and manage all the software applied within the new learning environments (such as immersive classrooms, virtual reality and STEM laboratories), and on providing a varied possibility of choice for the implementation of sustainable and effective paths (Calvani, 2013) through a metacognitive process that the teacher will be obliged to follow.

In parallel with the training promoted and disseminated through the new FUTURA platform, a movement should finally be created, for which teachers are first and foremost conscious digital citizens (Lo Iacono, 2022), citizens of a constantly evolving digital society whose perspectives are in the process of expanding, where innovations follow one another at twice the speed of their own possible implementation. The school must be ready to accelerate the metamorphosis and overcome digital educational poverty (Pasta & Rivoltella, 2022). Finally, a continuous field monitoring is necessary, aimed at supporting and directing the processes, at re-evaluating and modifying the divergent trajectories, and at ultimately supporting the ongoing methodological changes. The new teaching will therefore be carried out through a new digital methodology, supported by technologies but elaborated through new cognitive and communicative constructs, thus ontologically resulting from our society.

4. Universal Design for Learning in the didactic context

Universal Design for Learning represents a model for designing teaching materials, methods and strategies. Its main objective is to create a priori a tool which can be used by everyone, whose wide accessibility depends on a flexible approach that can be adapted and personalized and allows participation, involvement and learning, starting from personal abilities.

UDL's main objective is "to transfer the principles of design for everyone from the architectural and product creation area to that of education, through an action focused on study programs, which – when excessively rigid – constitute "a significant obstacle for the promotion of a truly inclusive perspective" (Cottini, 2017, p. 82).

Universal Design for Learning is based on three principles.

The first principle represents the "what" of teaching, given that there is not a single way of representation which is ideal for all students. This principle refers to the reasonable accommodation already expressed by the UN Convention on human rights of persons with disabilities, and therefore, "necessary and appropriate modification and adjustments not imposing a disproportionate or undue burden, adopted where needed in a particular case, to ensure to persons with disabilities the enjoyment or exercise on an equal basis with others of all human rights and fundamental freedoms" (United Nations Convention on the Rights of Persons with Disabilities, art. 2 paragraph 4). This principle, expressed in the field of education, commits institutions to prepare every necessary measure to meet everyone's needs. Concretely, it is possible to act on the physical characteristics of the information, on the provision of alternatives so as not to use only individual visual, auditory and textual mediators, on the preliminary explanation of terms, symbols, concepts to make them accessible to all, on the use of supports facilitating understanding (Cottini, 2019).

An example of practice reflecting this principle are digital books with expansions, in which the written text is accompanied by audio, video and image files. In this way the perception of the same information can pass through different languages.

The second principle concerns the "how" of learning, therefore providing multiple means of action and expression. This principle means that students are given the opportunity to choose how they decide to share what they have learned (Evans et al., 2010) and once this level is achieved, a very flexible curriculum and the use of forms of authentic assessment are required, through which students are asked to carry out real tasks.

A concrete example of this principle could concern the students' free choice of the form to give to a narration requested by the teacher, which means written narration, oral narration, or also video narration.

The third principle represents the "why" of learning; therefore its objective is to supply multiple means of involvement to provide students with different motivation incentives to learn. The student's involvement is achieved by connecting learning to real life problems, paying attention to the affective-relational sphere (Evans et al., 2010), which is taken into account for the quality of learning processes. An example of the realization of this principle is the explicit learning of control strategies, which allow students to self-regulate when they experience difficulties in the activity they are performing.

The pedagogical paradigm of Universal Design for Learning attributes a fundamental role to technologies as a support tool to allow accessibility to everyone.

Scholars Rose & Meyer (2002) outline four characteristics in digital media which are beneficial for teaching flexibility and which can be significantly used in the classroom.

These are:

- *versatility*: the ability to adapt to different tasks, i.e. everything that allows digital content to be represented in different formats such as text, still and moving images, sound, multimedia, without implying its modification;
- *transformation capacity*: the possibility for the content to transform, changing from one format to another;
- *marking*: the possibility of using markings in the content. The teacher thus prepares a passage in which important paragraphs or sentences must be selected, allowing the organization of contents and activities to be developed according to the students' needs;
- *connectivity*: the ability of digital technologies to connect. With respect to educational content, this function allows to relate topics, for example by going through a text and creating connections with other elements of the text, or even by establishing connections outside the document through links leading to images, videos, web pages.

In this way, through the Universal Design for Learning proposals, the student has various possibilities to interact with the educational contents.

5. Conclusions

The line drawn here therefore starts from a strong push towards renewing the strategic and methodological constructs of the Italian education system, supported by the remarkable work carried out by all the involved stakeholders in the last decade. The Ministry, researchers, INDIRE, avant-garde educational movements, training centers, regional school offices, territorial centers for digital innovation, schools and teachers, they all tend towards this revolution of "schooling", a programmatic line which for almost twenty years has promoted the students' centrality in the teaching/learning process, making them the protagonists and active subjects in their own educational process.

The new PNRR investments are therefore being implemented and the entire community has the task to encourage the genesis of this transformation within didactic processes, supporting their full realization through constant and analytical monitoring of possible critical issues. As mentioned, in addition to strengthening digital skills and acquiring the equipment and furnishings to create new learning environments, it will be necessary to simultaneously work on the ability to structure and implement new inclusive methodologies and processes, where the skills in creating varied and multifaceted digital didactic paths become fundamental. As said above, the paradigms of UDL, of inclusive didactic action, of the Umwelt, which will structure the foundations of change, must therefore the basis of these processes.

Attention will also have to be placed on possible difficulties arising from the complexities present on the national territory, on the possible causal effect of widening gaps and on the ability to redistribute human and material capital in a fair and sustainable way (Benadusi & Giancola, 2022) from the peripheries to the city centre, from north to south of the peninsula. On the one hand, the creation of new learning environments and of thematic and immersive classrooms, where each student will be able to independently choose the path to follow, develops reflective and metacognitive schemes in the students, making them active subjects of their own learning; on the other, it could trigger processes in which fragile or disadvantaged people may not be able to independently succeed and may need supporting paths which schools will have to provide. In addition, some doubts could arise if we intersect digitalization, inclusion and soft skills: in fact, in the attempt to adapt and align the standards, there may be a decrease in inclusive practices, a lesser development of the pupil's subjective learning potential and finally an impoverishment of students' transversal skills, thus reducing their social and emotional skills (Maccarini, 2023).

Authors' contributions

Although this paper is the result of joint work between the two authors, and each of them supervised and revised the work as a whole, individual paragraphs can be attributed as follows: 2, 3, 5 to M. Lo Iacono; 1, 4, 5 to R. Sgambelluri.

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MOOCs as part of a three-pronged approach to university orientation

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Abstract

In the context of a global knowledge society and an increasing need for a highly-skilled graduate workforce, there is renewed concern about low overall graduate numbers in Italy, especially in STEM, as well as high drop-out rates from degree courses. The institutions are responding with various initiatives and Federica Web Learning, the Centre for innovation in digital education at the University of Naples Federico II, has adopted a three-pronged, MOOC-based approach to orientation to prepare school-leavers for university or professional life, or a combination of both. This abstract presents a new experiment in MOOC design and delivery which places much greater emphasis on the third aspect of orientation: personal development, self-knowledge and empowerment.

Keywords: MOOCs, University Entrance, Orientation, Hybrid Learning, Self-Knowledge.

1. Introduction

Within the context of a growing need for a differently, and highly, skilled workforce for today's digital knowledge society, the importance of a university education is considered of strategic benefit on a national and personal level. In recognition of this, in recent years, there has been close monitoring on the part of European Institutions and member states regarding overall numbers of graduates and choice of discipline, actively encouraging orientation initiatives to assist school-leavers.

These efforts aim to address challenges such as high Neet rates, low numbers of university graduates, and high dropout rates. In fact, another measure that is considered highly significant – in terms of human as well as economic costs – is student drop-out rates and numbers of students changing university degree programs after one or two years of study.

And as a general objective, the EU Member States have pledged to increase the percentage of the EU population aged 25-34 who have attained tertiary education to 45% by 2030, according to Eurostat data.

Ultimately, the goal is to ensure a better match between the skills acquired by university graduates and the changing demands of the job market in today's digital economy.

In Italy, figures are still relatively high in terms of both dropout rates and changing program compared to other similar European member states as the official figures (OECD, Eurostat) report. And, at the national level, there has been growing public interest in this issue as is evidenced by the high number of recent articles in the national press. In May 2023, for example, the national newspaper *La Repubblica* reported Record numbers of University dropouts after Freshman year referring to Ministry of Education data (http://ustat.miur.it/dati/) that put the dropout rate of university studies after the first year at 7.3%, in 2021-2022. In the light of these figures, European and national initiatives, including the updated DEAP, Digital Education Action Plan (2021-2027), and Italian Ministerial recommendations, promote consolidated orientation strategies to address the issue, and guide students more effectively in the difficult choices they face regarding their future work or course of study. The orientation studies should also offer better support for the difficult transition from school to university, not only in terms of diverse study methods but also considering personal factors like aptitude, motivation and maturity.

It is in this context that Federica Web Learning, the Centre for Innovation, Experimentation and Diffusion of Multimedia Learning, at the University of Naples Federico II, has adopted a 3-pronged, MOOC-based approach to orientation to prepare school-leavers for university, professional life, or a combination of both.

In particular, this paper examines a more recent experiment in design and delivery, with a particular focus on the third aspect of orientation: providing engaging learning experiences for raising student self-awareness.

2. Federica multitarget: the multimedia orientation approach

In recent years, the team of specialists in online learning design and delivery at Federica Web Learning, the Centre for Innovation, Experimentation and Diffusion of Multimedia Learning, have successfully designed and produced over 500 MOOCs. These endeavors involved collaboration with professors and experts from the University of Naples Federico II, as well as faculty from prestigious universities and national and international partners.

Federica MOOCs are diversified and cover a wide range of disciplines and they increasingly focus on the lifelong learning sector. They intersect three main areas: orientation, university learning, and professional training, and are disseminated through its multiplatform federica.eu, an excellence in digital education, and the first single-university platform in Europe for continuous learning. The broad MOOC portfolio enable users to update their personal skills profile and enhance their knowledge-base, taking advantage of using an innovative learning approach and quality university content that is open to all, taking into account the specific needs of the different types of audience. In Italy alone, every year, five hundred thousand students sit the end of High School Diploma exam and therefore are involved in choices regarding their future university pathway. The implementation of a MOOC-based orientation strategy is based on the belief that online courses represent a valid opportunity to facilitate the identification of the most suitable pathway in line with each student's inclinations and abilities. Driven by the need to support students in their university choice and prepare them also for the intellectual demands of university life and study.

Starting from the issues and related needs of orienting high school students, and with the aim of reducing the widespread phenomenon of university dropouts, which is recognized as a priority by the EU, this strategy aims to bridge the gap between secondary school and university through a three-pronged approach, designed to address the three main issues facing school-leavers: choice of degree subject and institution; preparation for university entrance exams; and last but not least, self-awareness enhancement and psychological support to help them adapt to change as they shape their future.

The effectiveness of a MOOC based orientation strategy was already explored in our previous contributions (Merciai & Kerr, 2019; Merciai, Kerr & Melchionna, 2021), where we set out the three-pronged strategy that Federica Web Learning nowadays employs.

3. The first prong: accessing course content related to university degrees through Federica's MOOC offerings

Via its MOOC's catalogue of more than 500 curricular courses, authored by university professors from all partner universities, in a wide range of disciplinary areas, Federica Web Learning has offered, over time, experiential chunks of real university courses, thus demonstrating content type, learning approach and expected levels of attainment within different disciplinary programs.

By navigating the multiplatform federica.eu, in fact, it is possible to access single online courses or degree programs, for studying but also for experiencing university content and orienting oneself in various degree paths. This already existing opportunity is at the basis of the first prong in the Federica's orientation strategy approach, as a natural evolution of the process, offering an insight into degree content, didactic approach and possible career outcomes for specific degree programs, to guide school-leavers in their choice of degree subject.

Thus a classic orientation based on clarification of content and method for specific university degree courses and key strategic degree programs are available both for presenting real courses from Bachelor's Degrees and Two-year Master's Degrees, fostering the chance to choose a proper pathway, basing on more concrete aspirations and needs and thereby reducing the risk of dropping out, above all during the first year of university life.

These courses also represent strategic content designed to boost general knowledge and skills of particular relevance to study at higher education level, and aid in the difficult transition from school to university study methods, and they represent an effective tool for raising awareness of degree content in different subject areas to enable school-leavers to make an informed choice, especially in popular degree subjects that are not necessarily included in school syllabuses, like psychology, law, engineering, communication sciences etc.).

MOOC lessons also give a taste of the university classroom, with clear indications of expected performance and attainment levels via the accompanying assessment activities.

4. The second prong: MOOCs for skills assessment

For students and high-school leavers it is important to enhance their skills to prepare for university study and self-assess their current levels of competence, also considering that the EU set an EU-level target stipulating that the share of early leavers from education and training should be less than 9 % by 2030 (Eurostat, 2023).

In this context, the MOOCs related to the second prong, realized in partnership with CISIA – the Consortium Interuniversity for Integrated Access Systems, which is responsible for providing university entrance admissions tests at national level and comprises 62 Italian Public universities – are aimed at improving baseline knowledge, for better university access and performance, and providing preparatory courses in key areas, specifically mentioned by the Ministry of Education, where weaknesses have been identified, to support students in self-assessing and improving basic knowledge and skills, or indeed accompanying them through first-year university exams. This prong is particularly devoted to boost interaction between schools and universities to improve levels of college readiness on the part of school-leavers. Subjects identified include basic Maths, Chemistry, Physics, Language competencies and Biology.

Based on these subjects, the MOOCs that have been developed enable self-assessment in diverse contexts and represent the main core of the second prong orientation strategy, which aims at:

- improving basic knowledge in key areas.
- supporting students in preparing for university entrance and studies.
- providing preparatory or remedial study content in specific areas to boost learning and fill the knowledge-gaps, thus reducing the possibility of students finding themselves unable to cope with the level of intellectual difficulty posed by university study.

The design of the courses was aimed at a school-leaver audience and enables them to explore and clarify basic concepts in 7/10 engaging lessons. They would learn to use mathematical tools and practice scientific reasoning or become familiar with the fundamental topics of biology, from the basic phenomena of how living organisms function to the applications of biological sciences in everyday life.

Each of the courses provides a series of video lectures, where expert professors from universities affiliated with the CISIA Consortium break down complex concepts into more understandable segments. These videos serve as immersive learning aids, offering visual but also textual reinforcement of key ideas. MOOCs employ interactive quizzes and formative assessments to measure comprehension, facilitate active learning and also provide instant feedback, for accompanying students through the theory and practice in each of the topic areas.

Through the exploration of new educational formats, including the theatrical approach applied to the MOOC devoted to Physical sciences, students can be immersed in a firsthand experience, actively participate in science experiments, ranging from learning separation techniques for distinguishing

heterogeneous and homogeneous mixtures to the creation of a pH indicator using red cabbage, in order to illustrate chemical transformations. These hands-on activities not only enhance understanding but also foster a deeper engagement with the world of science.

Moreover, language courses in the students' first and second languages, equip students to deal with the complexity of textual structure, and guides them towards both understanding and composing texts in their native language or a foreign language.

For a comprehensive overview of the offerings in partnership with CISIA, please refer to the following page: https://www.federica.eu/partners/cisia/.

5. The third prong: towards self-awareness and self-empowerment

The third, and newer, approach in which MOOCs can provide support concerns the psycho-social and emotional aspects of decision-making, the importance of self-awareness for success in studying and university life, taking into account the vocational preparation aimed at raising self-awareness to manage the changes that the move from school to university represents.

Focusing on this approach, this paper presents a new experiment in MOOC design and delivery which places much greater emphasis on the third aspect of orientation: personal development, self-knowledge and empowerment.

The experiment has consisted in using the experience and empathy gained through long-term research and analysis to develop two courses that offer strategies and tools to help students manage their time, passions and work, and learn how to construct a matrix for their own priorities and aspirations, using a youthful multimedia language.

The first one, is "Guiding towards the future: Competencies beyond high school", it is meant to build a skills inventory as an opportunity for the student to review their study experiences, enhance skills and abilities developed in formal and informal contexts, and pinpoint their strengths and weaknesses. Starting from their study experiences and skills, students are guided through a journey of self-awareness, taking into account a hypothetical "self-project". This project should encompass their desired aspirations while also considering personal characteristics and the valorization of their study experiences, to orient themselves and make choices with dedicated and targeted support.

The second one, "How to tackle preparation for university entrance exams", has been projected as a "compass" to navigate the world of university entrance exams, helping students in understanding and navigating the Italian university system, discovering the various types of entrance exams and strategies for passing them and choosing the proper degree pathway.

The courses aim to respond to school-leavers' real needs within the context of the school classroom by providing parallel pathways for students and teachers alike. The courses are interactive and engaging, highly visual with enhanced video content, and are designed to be used in self-learning. However, they are also designed to include high-school teachers as multipliers, using the courses as part of a hybrid learning project, through a structured hybrid delivery mode. Teachers are provided with a series of worksheets and downloadable materials for engaging their students in the online content and in flipped classroom mode.

The two developed MOOCs aim to provide high school students with specific skills applicable to building an individual life project and choosing a university path, with a focus on guidance education.

Teachers have the opportunity to accompany students throughout the entire process and carry out in-depth activities with them, using accompanying materials and sheets in the "teacher path" section. These courses have also been designed to meet the needs of high schools that would administer targeted activities within the framework of PCTO plans, Pathways for Transversal Skills and Orientation. These paths have been defined by the Italian Ministry of Education to achieve cross-curricular skills and develop the ability to navigate personal life and social and cultural reality, they are mandatory and addressed to all students in the last three years of high school, in accordance with Article 1, paragraph 785, of Law no. 145 of December 30, 2018.

Additionally, it is also important to indicate that the instructional design includes a variety of reflection, interaction and group-work exercises focusing on self-expression, self-awareness, motivation and autonomous decision-making.

This parallel pathways approach, for students and teachers alike, to be used in self learning or through a structured hybrid delivery mode, will be furthermore investigated in the following months. It could possibly be usefully applied to other online didactic projects, where a hybrid approach could be requested.

Both courses are available at the following page on federica.eu: https://www.federica.eu/orientamento/orientare-al-futuro/ and the complete offering on orientation is available for free on the Federica Web Learning platform at https://www.federica.eu/orientamento/.

6. Conclusions

We have observed how MOOCs, in a dedicated format, following the three-pronged approach we envisioned and then implemented at Federica Web Learning, can provide guidance to students during critical stages like orientation, when they prepare themselves to face important decisions about their educational paths.

This experience is poised to be further explored and extended to the university community, in order to enhance the quality of answers to their questions and concerns as they navigate their educational journey and shape our collective future.

Acknowledgements

A special thanks goes to our beloved colleague Francesca Traclò whose guidance, vision and personality were fundamental in the development of these learner and teacher-centered pathways.

My collaboration and continuous professional exchange with my colleagues Tania Melchionna and Ruth Kerr at Federica Web Learning remain a constant source of inspiration for the evolution of projects around Orientation.

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Inclusive teaching: Blackboard Ally and accessibility in Catholic University

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Abstract

In the face of the ever-increasing complexity that has been characterizing Italian university classrooms for several years (students from countries with different cultural patterns, disabilities and DSA (Specific Learning Disorders), health, relational and social problems, various abilities and learning profiles, language differences and so on), accelerated by the Covid-19 pandemic, it is necessary to intervene with actions aimed at promoting inclusive teaching in order to encourage course participation and knowledge acquisition.

The Catholic University of the Sacred Heart, adopting the Universal Design for Learning (UDL) framework that aims to provide methods, tools and strategies for learning that are accessible to all students, has promoted the Ally Accessibility project: among its pillars, in addition to the "Design system" and the guidelines for teachers "Educational-Didactic Intervention for Students with Disabilities and Specific Learning Disorders (SLDs)", there's Ally, a tool integrated into the University's Learning Management System, Blackboard, which offers teachers guidance in improving course materials by structuring them in an accessible way, and students Alternative Formats of the same materials. The objective of the paper is to explore the Catholic University's path toward a culture of inclusion, focusing particularly on the adoption of Blackboard Ally and its implications.

Keywords: Inclusive Teaching, Digital Accessibility, Teaching Technologies, Learning Needs, Learning Management System, Universal Design For Learning.

1. Introduction

Complexity acts as a paradigm in Italy's university classrooms, which are increasingly populated by people from countries with different cultural patterns, disabilities and ASDs (Specific Learning Disorders), health, relational and social problems, various abilities and learning profiles, and language differences. Improper management of such complexity can have negative effects in learning and adaptation to university life.

In this scenario it is therefore necessary to promote inclusion by sensitizing teaching staff to prepare accessible learning materials, as well as providing flexibility in ways to encourage course participation and knowledge acquisition.

Intervening in learning environments is another necessary action to deliver inclusive teaching also with the use of suitable technologies: these have had a significant acceleration in relation with the Covid-19 pandemic, when universities and educational institutions of all levels had to adapt – in an emergency – to the need to adequately carry out training remotely, not only through video lectures but also through the sharing of digital and multimedia content with their students.

In the last two years it appears necessary to acquire specialist platforms, designed to guarantee excellent training together with a high level of usability, in addition to a series of tools capable of offering all students equal access to content and study.

Accessibility can be considered as one of the measures of university's sensitivity to the entire student community: the Catholic University of the Sacred Heart has embraced and promoted this model, sharing the principles of Universal Design for Learning (UDL), a framework attentive to the use of methods, tools and strategies that give all individuals equal opportunities to learn.

Three are the pillars of the Accessibility project in Catholic University:

1. *Design System.* Set of rules and guidelines defined with the objective of ensuring consistency and continuity in terms of accessibility within the digital ecosystem in which the student is inserted: institutional websites of the University, applications such as the iCatt student portal or STEP, platforms and tools for learning (Blackboard, Panopto etc.).
2. *Guidelines for Teachers*. The document "Educational-Didactic Intervention for Students with Disabilities and Specific Learning Disorders (SLDs)", disseminated to the entire teaching staff of the University, aims to provide guidance with respect to Integration Services, offer ideas for collaboration between Services and Lecturers, and delve into the topic of preparing accessible teaching materials.
3. *Blackboard Ally*. Introduced in 2020, it is a tool designed to help spread a culture of a more inclusive focus in teaching practices in the University that can generate *Alternative Formats* that meet the learning needs of students and feedback to lecturers to improve the level of accessibility of the educational content created.

Starting from the original file, Blackboard Ally automatically generates alternative formats for the content posted by instructors in courses (including Electronic Braille, Audio, Immersive Reader, OCR PDF, Tagged PDF, Semantic HTML, ePub, Beeline Reader) and makes them available to students, who can choose to use the format that best suits their learning needs (Figure 1).

Blackboard Ally also measures the accessibility of each file posted in the online course and shows the Lecturer a visual indicator of the level of accessibility of the content (Figure 2). Each score consists of a percentage (from 0 to 100) and a colored indicator that reflects the number based on the severity of accessibility issues detected in the file. The lecturer can also drill down, deriving specific information about the type of accessibility issues detected and practical guidance for improving the document's accessibility score.

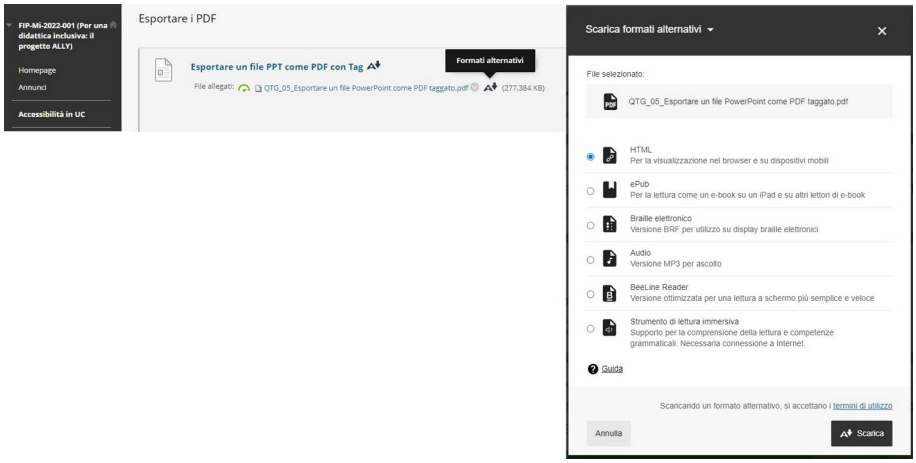

Figure 1 - Alternative Formats.

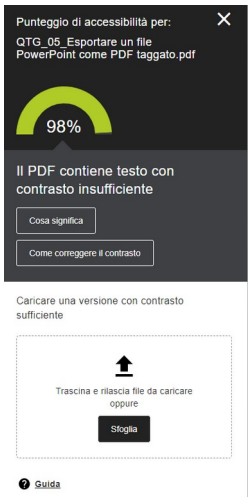

Figure 2 - Instructor feedback panel.

The higher Ally's score is, the fewer accessibility issues are found in the document. In particular, the feedback can be:

- Low (0-33%): There are severe accessibility issues.
- Medium (34-66%): The file is somewhat accessible and needs improvement.
- High (67-99%): The file is accessible, but further improvements are possible.
- Perfect (100%): Ally has not identified any accessibility issues, but further improvements are possible.

To complete the information provided by the accessibility indicators of the individual course contents, the course accessibility report provides the teacher an overview of the course accessibility level, which is particularly useful for identifying major accessibility issues and developing an intervention strategy by step and priority. The report (Figure 3) highlights the course accessibility score and number of contents by type; accessibility issues and number of contents affected; and the list of course contents sorted by accessibility score.

Finally, Blackboard Ally provides an overall comprehensive report (Figure 4) that is useful for the university to map the level of accessibility of the offered courses; highlight the types of content that have accessibility issues; track student access to alternative formats in quantitative and format-specific terms; thus, develop strategies to increase the accessibility level of the provided content and the utilization of the tools by both instructors and students.

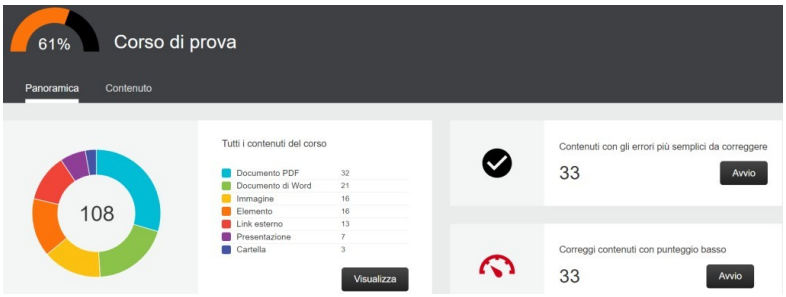

Figure 3 - Course accessibility report.

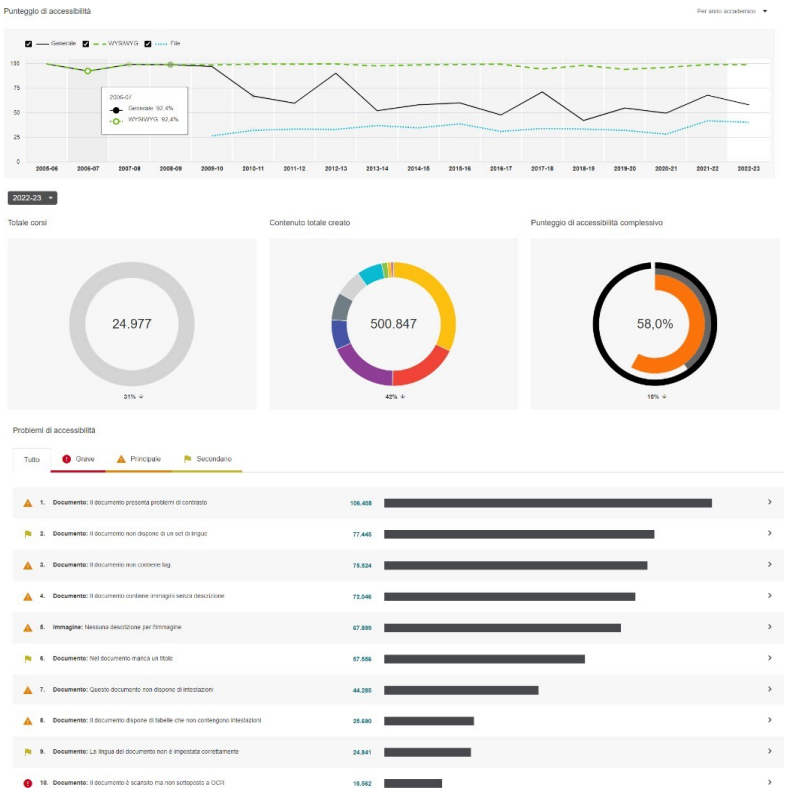

Figure 4 - Ally institutional report.

2. The Blackboard Ally project in Catholic University

Blackboard Ally's introduction plan is organized into three phases: a pilot trial, a consolidation and fine-tuning phase, activation on all Blackboard courses. The pilot was conducted from February to June 2021, involving 72 courses and 52 faculty members from all faculties, to ensure full representation of the different scientific-disciplinary fields. The pilot was built around three cornerstones: engagement and dissemination of an inclusive culture; training materials and in-progress support; activity and project monitoring.

The experimentation was activated with an initial meeting dedicated to raising awareness about accessibility on one hand, and the presentation of Blackboard Ally and its functionalities on the other. Instructors were supported in their journey through the provision of training materials and useful links published in a dedicated online environment, small group and individual training sessions, and ongoing assistance. Additionally, bi-weekly short training modules focused on specific accessibility topics were sent via email to all participating instructors during the experimentation.

The pilot's monitoring plan enabled quantitative and qualitative data to be collected.

The plan was to collect the data available through the University report and the reports of the individual online courses involved in the experimentation, with the production of an initial interim report. The delivery of two questionnaires – to faculty and students – together with a second quantitative data collection and analysis, led to the production of a final report.

Figure 5 illustrates the monitoring plan for the experimentation.

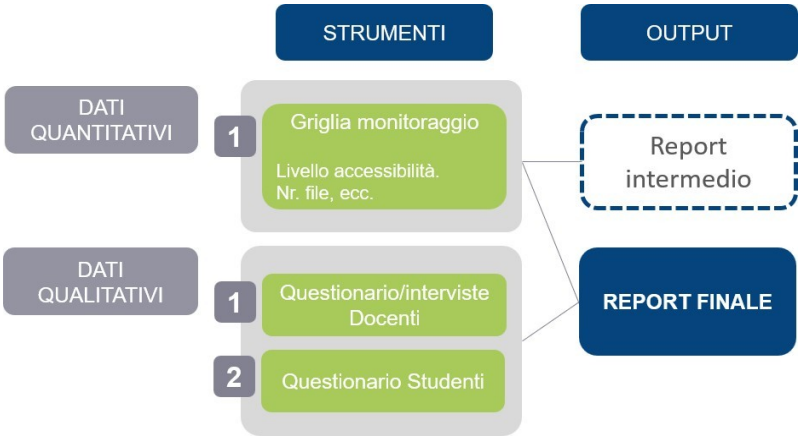

Figure 5 - Ally's pilot project monitoring plan.

On the quantitative side, the reports returned from Ally's University dashboard and the detailed reports allowed us to have a clear picture with respect to the average accessibility levels of the courses and content proposed by the teachers, with the possibility of highlighting the main recurring accessibility problems. Also interesting is the data regarding the main alternative formats used by students.

From the outset, the data analysis revealed the need for further investigation of accessibility and accessibility issues for some specific subject areas, such as the quantitative and linguistic areas.

For the quantitative area, in particular, a working group was formed that met in progress and after the experimentation to investigate critical issues related to files characterized mainly by formulas, graphs, tables and other mathematical elements. The group developed a guide with some useful suggestions for creating accessible files (for example, using Word for writing formulas and leveraging Office features for inserting tables and graphs; the Axessibility package for LaTeX documents developed by the Department of Mathematics "G. Peano" of the Polytechnic University of Turin: http://www.integr-abile.unito.it/en/axessibility/). The discussion on the accessibility of STEM content is still ongoing throughout the education area to enable students with disabilities, especially those with visual impairments, to utilize existing technologies to make scientific texts accessible and, therefore, inclusive.

The following graph (Figure 6) illustrates the levels of accessibility among the courses that participated in the pilot, categorized by scientific-disciplinary areas. On average, a good level of accessibility can be found in courses in the humanities and science areas, while courses pertaining to the economic and quantitative areas have lower accessibility scores. The comparison with the instructors of these disciplinary areas allowed us to highlight how the specificity of the topics covered, particularly the presence of graphs, formulas, numerical elements in the materials produced, leads to complex accessibility issues that are not always easy to resolve and deserve specific in-depth study.

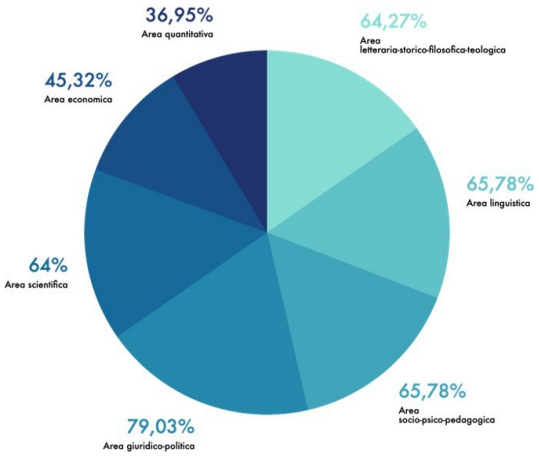

Figure 6 - Accessibility levels of courses involved experiment (final report).

Also interesting is the data regarding the main alternative formats used by students.

If some formats are related to specific needs (e.g., Braille - 47 downloads - for the blind), the trend regarding the most downloaded alternative formats allows us to highlight the most widespread learning needs among students and imagine a hypothetical identikit of them: a student who increasingly uses tablets and smartphones, needs to work on text (font, color, search) – hence the use of formats such as tagged PDF, HTML and ePub – and appreciates the audio format which allows them to listen to content rather than just reading it.

On the qualitative side, the administration of a questionnaire to the teachers and students who participated in the pilot allowed us to obtain important indications with respect to the teaching experience (difficulties encountered, best ways of support and so on) and the students' enjoyment of the initiative.

From the data collected through the questionnaire provided, it emerges that most of instructors approached the topic of content accessibility through two main avenues: making changes to individual content items based on accessibility indicators and suggestions provided through the Ally Instructors Feedback tool, or consulting the materials and training modules that were sent, focusing on specific accessibility topics, and then acting on their instructional content.

The data confirms what was highlighted regarding the use of Ally tools: the use of the Ally Instructors Feedback panel is more immediate, but there is a need for better communication/training regarding the potential of the Course Accessibility Report.

On the student side, data collected through the questionnaire provided reveals that curiosity about a new graphic element inserted next to the content uploaded on Blackboard led 9.4% of students to independently notice the Ally symbol icon. A smaller percentage (4.1%) noticed the icon following communication from the instructor, while 86.5% did not notice the presence of the icon.

The analysis of the experience conducted provided the working group with important insights, highlighting, for example, from the outset the need to investigate accessibility and accessibility issues for some specific subject areas, such as the quantitative and linguistic areas.

At the same time, before proceeding with the extension of Blackboard Ally to the entire university, the working team has revised and expanded the training materials offered to faculty, reorganizing the support team and designing a cycle of training webinars aimed at faculty.

In December 2021 Ally was activated in all Blackboard courses: an initial communication initiative of the project is structured, with the aim of reaching Lecturers and students, and officially launching it.

A first round of meetings targeting lecturers was proposed in March 2022, followed by targeted meetings for the two subject areas mentioned above: mathematics and language areas.

The diagram below (Figure 7) specifically shows the training initiatives conducted in general and for the group of teachers pertaining to the language area.

Figure 7 - Webinar series aimed at instructors.

Through discussions with the group of instructors in the linguistic area and the international Ally user forum, reflections emerged regarding the most effective alternative formats for language study. Among these, the audio format allows the reading of documents and presentations in over 20 languages (students can choose between male and female voices), enabling students to practice listening to the language. BeeLine Reader allows students to read text using various color gradients, focusing attention and making text reading smoother, proving particularly effective for new language learners, English Language Learners (ELL).

The second semester of the 2022-23 academic year saw the launch of a new communicative proposal, aimed at bringing attention back to Blackboard Ally and more generally to the topic of accessibility; enhancing the dissemination and awareness work already carried out, enriching it further; accompanying teachers in the process of discovering and using Blackboard Ally tools.

The initiative took the form of the production of short video-pills dedicated to the in-depth study of one of the themes and/or tools of Blackboard Ally, to be added to the previously produced material, sent via e-mail to instructors every two weeks.

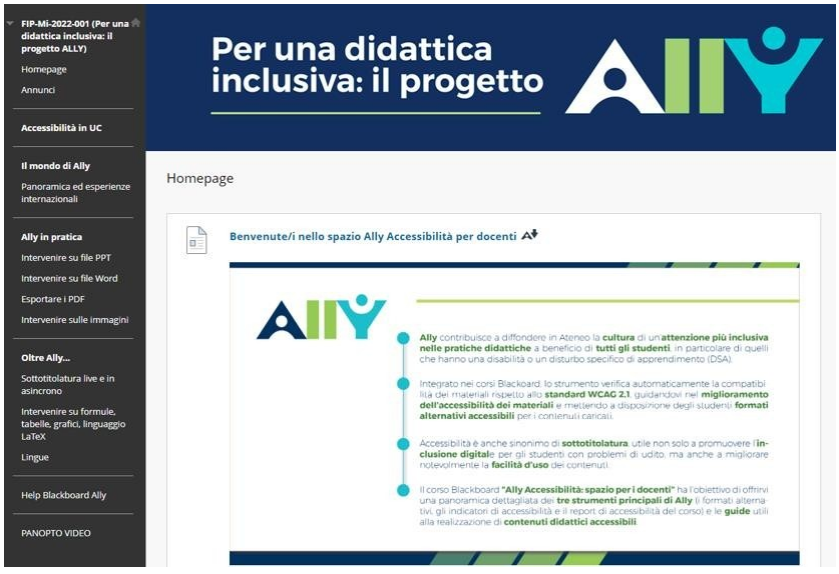

Figure 8 - The Blackboard course for instructors: "Per una didattica inclusiva: il progetto Ally".

Figure 9 - Training materials for instructors: examples of formats produced.

The new training pills were emailed to instructors on a fortnightly basis, according to a previously developed communication plan, depicted in detail in the diagram below (Figure 10).

In parallel, the project team worked on the development of an ongoing monitoring plan to check the progress of the project and the level of accessibility of courses in the University, and to map out the next steps in the Catholic University's path toward inclusion. The plan involves the systematic collection of data pertaining to three macro-areas: accessibility; use of Blackboard Ally tools on the faculty and student side; access to the online course dedicated to faculty training and published resources.

The diagram below (Figure 11) returns a concise and comprehensive view of the monitoring plan.

Febbraio	Marzo	Aprile	Maggio
24 Comunicazione iniziativa Presentazione Prof. D'Alonzo **Tema**: Alla scoperta di Ally	10 **Tema**: La funzione *Verifica accessibilità di Office*	14 **Tema**: Inserire le descrizioni alle immagini, tabelle, grafici o SmartArt	12 **Tema**: Inserire i tag in un file PDF
	24 **Tema**: Inserire le intestazioni in un documento Word	28 **Tema**: Verificare il contrasto	

Figure 10 - The initiative's communication plan.

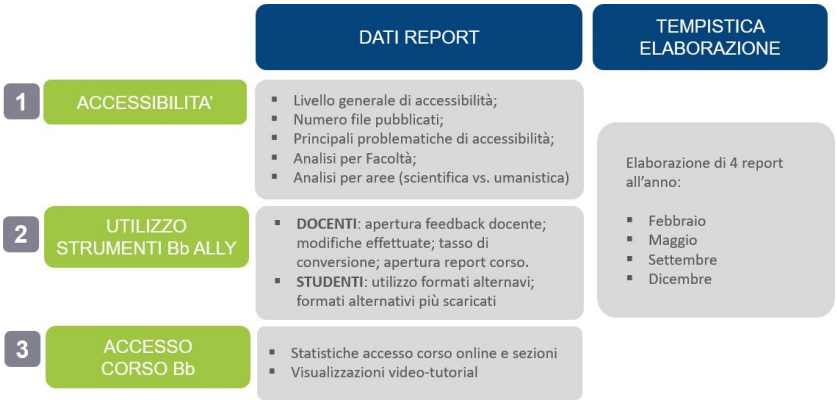

Figure 11 - The steady-state monitoring plan.

The latest monitoring report processed (July 2023) shows a good level of general accessibility of the materials offered within the courses provided by our university: out of 10,679 active courses for the academic year 2022-23 and against 229,653 published files, the average level of accessibility is 66

percent [Data taken from the "file score" by which is meant to indicate the accessibility score that Ally derives from university courses (different from "overall score", which is data related to any element uploaded by faculty, even external ones on which it is not possible to intervene in terms of accessibility. In this case, the overall score is 74 percent)].

The analysis of the level of accessibility by Faculty, while showing some differences, does not reveal any critical situations, as can be seen from the graph below (Figure 12).

The top three accessibility issues most detected were insufficient contrast (26 percent); absence of tags in pdf files (19 percent); and absence of description in images (18 percent). Figure 13 details the accessibility issues detected in the University and the relative percentage.

Finally, the data on students' use of Alternative Formats (Figure 14) is interesting. During the analyzed monitoring period (April 24-July 7, 2023), the panel of Alternative Formats present in the courses was opened 52,909 times and there were 34,059 downloads, resulting in a conversion rate of 64.37 percent (Percentage of downloads compared to the total number of times the panel was opened).

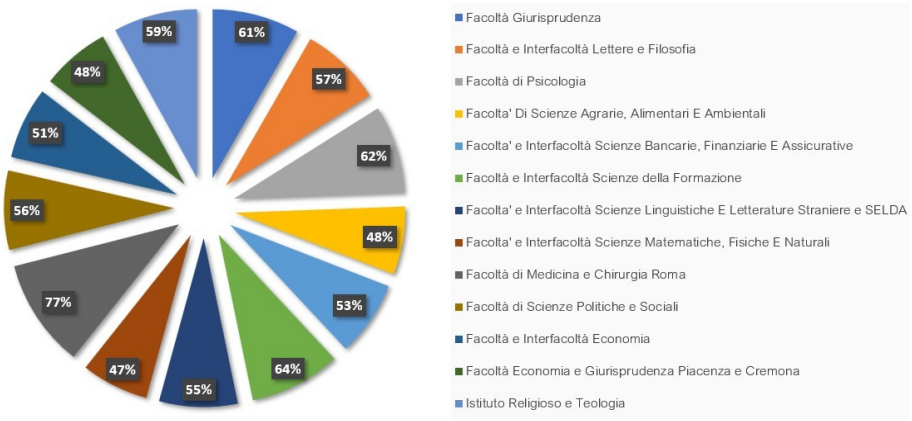

Figure 12 - Accessibility levels by faculty.

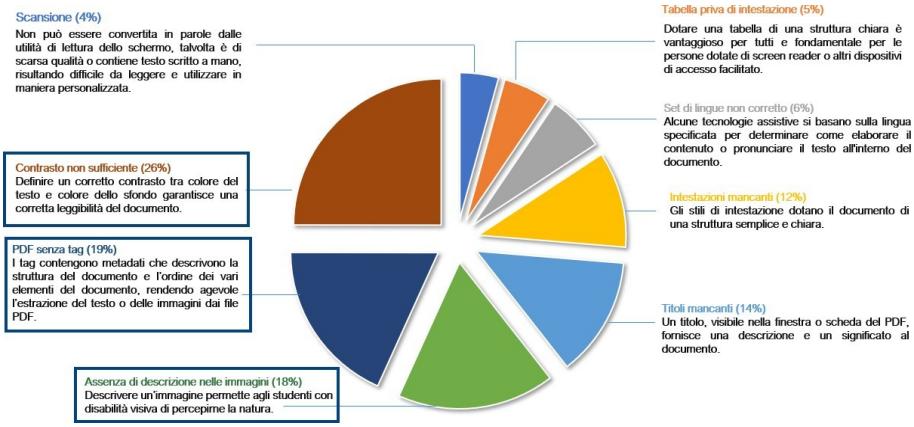

Figure 13 - The main accessibility issues.

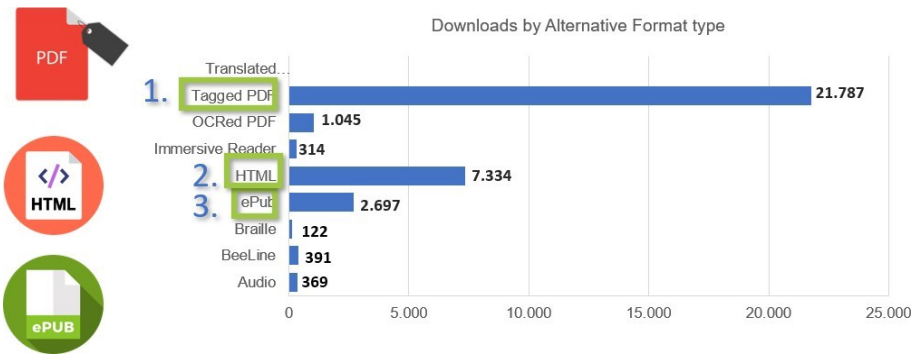

Figure 14 - Alternative formats downloaded by students.

Out of 2,573 courses with Alternative Formats downloads, the most downloaded ones are confirmed to be tagged pdf files, HTML version of the content, and ePub. These three formats outline the identikit of students who need to personalize their study, structuring documents functionally according to their needs.

The constantly elaborated monitoring reports are allowing us to verify the progress of the project and the level of accessibility of courses in the University, and to map out the next steps in the Catholic University's journey toward inclusion.

3. Blackboard Ally in Catholic University: working hypothesis

The road to accessibility needs to be taken one step at a time, day by day. This, in short, is what we, as a university, have learned from the experience conducted so far. We are aware of the importance of continuing to provide encouragement and opportunities for instructors to delve into this topic, and most importantly, to raise awareness.

Before addressing the practical and technical aspects, accessibility is an instructional approach. In the coming months we intend to start again from the monitoring data collected: on the one hand, to analyze the types of files most used by faculty, thus providing targeted indications; on the other hand, imagining training initiatives by Faculty or for specific courses of study.

Sharing a selection of monitoring data with teachers is one of the initiatives we are working on, along with the idea of resuming the delivery of educational nuggets, as it has proven to be one of the most effective initiatives we have experimented with.

Finally, we intend to focus on students: envisioning specific initiatives aimed at them, but also involving them to gain insights into their perspective on alternative learning formats, aligning them with their learning style and educational needs.

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Sitography

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