# Supportare l'adozione di tecnologie nella didattica inclusiva in ottica di Progettazione Universale: studio su di un prototipo cartaceo

# Supporting the Introduction of Educational Technology in Inclusive Education Through Universal Design: a Paper Prototype Study

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*Questo studio descrive la prima fase della progettazione di un sistema software di supporto all'introduzione delle tecnologie didattiche in un contesto inclusivo. Soddisfare le esigenze di tutti gli alunni è una sfida che molti sistemi educativi raccolgono, non sempre con risultati totalmente positivi. Gli insegnanti sono tra i pochi nella posizione di poter avere una percezione chiara delle necessità specifiche dei loro studenti. Anche loro, tuttavia, possono perderle di vista nel momento in cui progettano attività didattiche. I dati presentati in questo contributo provengono da uno studio pilota qualitativo in cui sono stati coinvolti cinque insegnanti di scuola secondaria, ai quali è stato chiesto di provare un prototipo cartaceo di un'interfaccia software che mira a supportare un insegnante nella selezione delle tecnologie e delle metodologie da utilizzare nella didattica proprio per far fronte a necessità speciali.*

*This study describes the first step of a project aiming at the design and implementation of a software system to support the introduction of Technology Enhanced Learning (TEL) in Inclusive Education. Addressing the needs of all students is a challenge that many education systems undertake, not always with successful results. At the same time, teachers can have a clear perception of the specific needs of their students, but are also subject to the risk of failing in taking such needs into account while designing learning activities. The data presented here comes from a pilot study involving five Italian secondary school teachers, who were asked to try out the paper prototype of a software system that aims at supporting them in selecting effective TEL solutions and methodologies to address specific needs.*

**Parole chiave:** Prototipazione su carta, Instructional Design, inclusione, tecnologie didattiche, Universal Design
**Keywords:** Paper Prototyping, Instructional Design, Inclusion, Technology Enhanced Learning, Universal Design

*Articolo ricevuto: 23 agosto 2016* *Versione finale: 25 settembre 2016*

## 1 INTRODUCTION

Central to the idea of Inclusive Education is the concept of addressing the needs of all students, not only those with Special Educational Needs, by implementing teaching methodologies that facilitate the participation of every student (Passey, 2013; R. Rose, 2010). In this perspective, TEL is a very important resource, mainly because of the possibilities offered by Educational Technologies to diversify the strategies and the levels of access to learning content (Meyer & Hall, 2006). This research project, presented here at its beginning, aims at finding

a way to optimize the way teachers use what they know of their students in order to create learning content that is not only better tailored, but also more accessible to them. The paper prototype study presented in the following pages is intended as a quick and direct way for collecting useful feedback from experts in the field of teaching. The leading hypothesis is that it is possible to suggest novel TEL solutions and methods that are appropriate and convenient by connecting them to an analysis of the class group. Such analysis is not limited to the difficulties: teachers are encouraged to tap into the potential of their students.

Teachers often face with the dilemma of how to cope with the high variability of the classrooms they are responsible of, while struggling to comply with the requirements of the education system, mainly in terms of learning objectives. This is particularly true in a context so heavily oriented towards inclusion as the Italian Education System: class groups are composed by pupils and students with motor, sensorial, mental or learning disabilities, or coming from migrant families. There are gifted and struggling students, engaged and disengaged ones, but also "average" students that do not seem to excel nor to be completely unskilled. The learning goals they have to reach are the same, even though the specific case of the Italian Education System also contemplates the use of facilitations, described as *compensative measures and exemptions*, i.e. for students with Learning Disabilities (Ianes, Zambotti, & Demo, 2013). Teachers deal with such high variability every day, but many of them constantly highlight the difficulty in addressing the needs of their students, preparing lesson plans that are truly accessible and do not create barriers for them (D. Rose & Meyer, 2002).

These ideas, and specifically the idea of *barrier to learning*, have already been addressed successfully by the paradigm known as Universal Design (UD) (Maisel & Steinfeld, 2012), which has also been successfully applied in the field of education. Despite the wide, high consideration that UD is held in, and the growing amount of empirical evidence about its effectiveness, there seems to be no common and formalized way of implementing it in classrooms (Mangiatordi & Serenelli, 2013; McGuire, 2014; Orr & Bachman Hammig, 2009; Rao, Ok, & Bryant, 2014). This is an attempt at designing an easy to access platform where information about students and lesson plans could be used efficiently to analyze where barriers to learning lay and to provide teachers with suggestions about TEL resources and methods that could fill the gaps in their Inclusive Education.

### *1.1 The problem*

Secondary school teachers know their class groups, or at least form a picture of what their students are good or bad at; they also know the subjects they teach, and often have a precise idea of what is the best way of teaching a specific topic. Besides the problem of prejudice (Croft, 2010), that can corrupt both these forms of knowledge, there is a second, less evident potential issue: when lesson planning does not take into consideration the former knowledge, giving prece-

dence to the latter, teachers risk to create barriers to learning for some of their students, or simply to let them out of the learning activity. Trying to understand best practices *within* the context in which teachers work is important because related literature shows that the focus for any new technology use should target a specific purpose that aligns with teachers' value beliefs associated with teaching and learning in their own classrooms (Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010).

TEL offers a wide range of opportunities when implemented in Inclusive Education (Passey, 2013), so teachers need a convenient way of linking technology and students' needs.

*1.2 The proposed solution*

This project aims at offering a design tool to teachers on the field, through the creation of a web based system that would act as a support for the creation of lesson plans that follow the principles of inclusion and of UD. Such system would essentially:

1. **help teachers in identifying the most relevant *strength* and *weakness* points in their classrooms.** Students vary widely, exactly in the same way users of a generic product or service have specific abilities, needs and intents that are not predictable by designers. As a first step, it is important to collect the most relevant information about the specific context in which the lesson is going to happen.
2. **allow teachers to evaluate their own lesson plans**. Keeping critical accessibility aspects as well as students' potential in mind while deciding how to present a topic is important but also quite difficult. Guidelines for addressing common issues abound, together with checklists that make it easier to track possible threats to access in a well-known context. Such resources could be integrated with the data collected at the previous step, to support the specific lesson design process.
3. **offer suggestions on how to effectively implement TEL solutions and methods in order to meet the needs of all students in a specific classroom.** The ideal system would be built on top of a repository of teaching tools and strategies, mainly but not necessarily based on ICT, classified according to the same accessibility requirements considered above. A match could be possible between the ideas of teachers, the actual needs of the class, the available resources and the possible use of a specific software or of a different teaching strategy.

Such a system would allow to monitor the most frequent barriers that learning poses for students. The project would provide a way for storing data about lesson planning and adopted solutions, allowing to trace progress and to model future intervention.

*1.3 Possible issues and implications*

Some problems and potential difficulties can be foreseen at this stage of the research project:

1. **Perception of technology.** Teachers' perception of technology can vary widely, from enthusiasm to complete rejection (Park & Yang, 2013). As the main objections to the implementation of ICT in schools involve the lack of specific skills on the teacher side (Legrottaglie & Ligorio, 2014), it will be of primary importance to communicate this kind of intervention as one that does not require a high level of technological competence, and that does not imply a time waste. Teachers should see it more as a benefit, a tool to assist them in their work, rather than as a constriction or as a possible source of technical problems.
2. **Digital divide in schools**. Despite the presence of ICT in schools is growing, they still suffer for the inadequacy of their buildings, where it is difficult to bring broadband connection, and in some cases even power supply. The project will address such issues by proposing a web based, responsive solution, accessible also from outside the school, and by supporting the adoption of free software.

In an educational research perspective, the use of such a system on a large scale would mean access to a previously unavailable data source: teachers would be collecting local information that researchers could use to assess the inclusiveness of teaching and, in general, of educational systems. Teachers would be supported and encouraged in finding new, original ways of teaching their subjects and of adopting a TEL approach.

## 2 State of the Art

The problem of designing instructional content and lesson plans that are truly accessible to all students is similar to that of designing accessible buildings: the designer does not know in advance who the users are, and what is easy and difficult for them, so human diversity must be proactively considered (Wilkoff & Abed, 1994). Taking difference into account while designing is the main idea proposed by architect Ronald Mace since the 1980s and commonly known as Universal Design (Maisel & Steinfeld, 2012). Economic sustainability is improved by such an approach, even though the initial resource investment can be higher (Nasar & Evans-Cowley, 2007).

Universal Design formalized these ideas by proposing a set of principles and guidelines providing directions on how to deal with the most common problems. UD guidelines have many points in common with the Web Content Accessibility Guidelines released by the W3C (Caldwell, Cooper, Reid, & Vanderheiden, 2008; Chisholm, Vanderheiden, & Jacobs, 2001). Similar guidelines exist also in the Education domain, and have been proposed by initiatives as Universal Design

for Education (Bowe, 2000), Universal Design for Instruction (Scott, Mcguire, & Shaw, 2003), Universal Design for Learning (D. Rose & Meyer, 2002), Universal Instructional Design (Yuval, Procter, Korabik, & Palmer, 2004). Research on UD effectiveness in educational settings is growing at constant pace, and interesting results have been reported, that involve both students and teachers: engagement and motivation can be improved on both sides (Mcguire, Scott, & Shaw, 2006; Orr & Bachman Hammig, 2009). Recent reviews highlighted that data is collected and analyzed by the means of different research designs: there seems to be no standard for assessing UD impact in this field (Rao et al., 2014).

Different tools based on Universal Design principles and guidelines have been created to support teachers and other content creators in building accessible instructional content and curriculum. The main projects in this sense are the University of Connecticut UDI e-toolbox[128] and the CAST UDL Curriculum Self Check[129]. The former provides information about the effectiveness and the appropriateness of different educational resources for inclusive education in post-secondary environments. The latter offers help in applying the principles of Universal Design for Learning by guiding educators in the review of their lesson plans.

More recent implementations of similar ideas involve the creation of a framework for addressing learner variability, called UDLnet. This system aims at solving the problem by collecting and creating best practices under the framework of Universal Design for Learning, to bridge the gap between policy and practice (Riviou, Kouroupetroglou, & Bruce, 2014).

## 3 METHODS

In order to collect useful and meaningful information from prospective users of the theorized system, a paper prototype was created and an exploratory session was proposed to five volunteers. This section describes how the prototype was originally conceived and what objectives were considered as a priority for this phase of the study.

### *3.1 Participants*

The participants were selected by geographical proximity from a list of twenty volunteers who answered an open call via a web form. The call for participation was originally diffused through mailing lists that had Inclusive Education and/or TEL among their topics. The idea for this phase was to enroll highly motivated teachers already adopting a variety of teaching techniques in their everyday activity.

[128] UDI e-toolbox, http://www.udi.uconn.edu

[129] UDL Curriculum Self Check, http://udlselfcheck.cast.org

The age of the selected volunteers varied from 32 to 55. Two of them were teachers in the first level of Italian Secondary School, thus working with pupils of the 11-14 age range. The other three worked in High School (two in Technical institutes, and one in a Foreign Languages school) with students in the 14-19 age range. Their experience in teaching varied from 7 to 33 years.

All of them had experience in using a wide variety of technological solutions, including Interactive White Boards, mobile devices and digital text books. While describing the methodologies they already used, all participants mentioned a mix of approaches, mainly including the use of frontal and dialogical teaching, as well as the use of digital content. Two of them mentioned the Flipped Classroom model among the methods used in their activity so far.

*3.2 Prototype and instructions*

The paper prototype that was tested with the five participants included some elements, presented in **Fig. 1** and described as follows:

1. a *classroom sheet*, made of a simple 29.7x42cm white sheet where the participants would describe the characterizing traits of the students in a chosen class;
2. a *lesson sheet*, made of four 21x29.7cm printed sheets with four questions on each page, respectively about the topics, the methods, the supports and the assigned homework involved in a teaching unit;
3. *green and red felt-tip pens*, respectively used for writing strengths and weaknesses of the students on the classroom sheet;
4. *strength and weakness tokens,* made of green and red cards of about 4x6 cm, used to represent the same strengths and weaknesses written on the classroom sheet;
5. the *help sheet*, used to simulate a specific channel of interaction between the user and the system.

Each participant was given instructions on how to carry out the test. A core set of rules was given to all of them, while some minor variations were proposed starting from the second test. This was inspired by the idea of *iterative refinement* (Snyder, 2003): after each test a list of the issues that had emerged was created, then the prototype was slightly revised before the next test would start.

The core instructions set presented to all participants included four items, corresponding to four tasks in which the tester was actively involved:

1. *classroom description*: write down the strengths and the weaknesses of the students of one of the groups you teach on the classroom sheet, using green for a 'strength' and red for a 'weakness' (every strength and weakness was copied on a green or red card, accordingly); remember that these traits will be used as key elements in the design of a lesson plan, so try and formulate them in the most convenient way;
2. *lesson description*: write down a description of a lesson you plan to have with the group, listing the topics, the methods, the supports (both technological and

non-technological) and the homework in the relevant sections of the lesson sheet;

3. *strength and weakness resolution*: put the strength and weakness tokens on the lesson sheet, in the point that better describes what you are doing to support a specific weakness or to tap into a specific strength; it is possible to add information to the lesson sheet at any time;

4. *call for help*: put on the help sheet the strength and weakness tokens you could not place on the lesson sheet, so to ask 'the system' to help you in identifying possible strategies to address those specific opportunities and needs.

At the end of these four steps the researcher played the part of the system, suggesting tools for developing TEL in the described class context. Such suggestions were discussed with the participants and associated to the cards put on the help sheet.

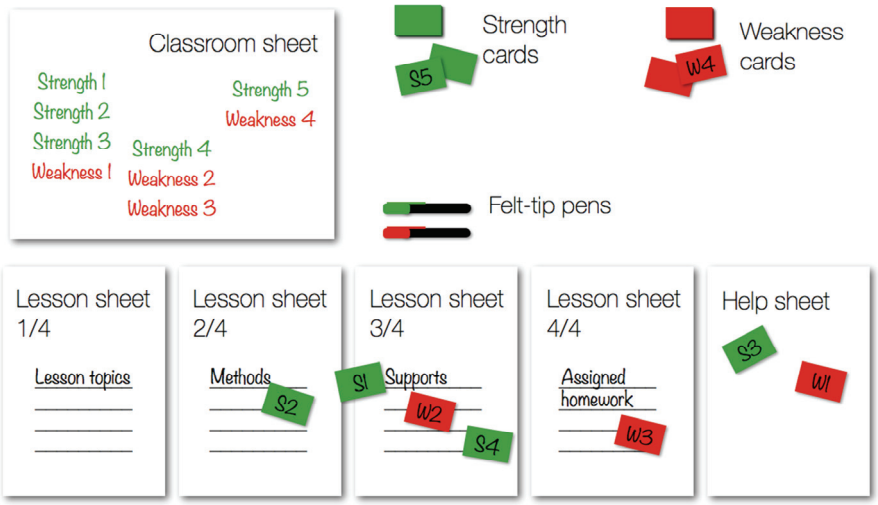


*Fig. 1. The paper prototype components as they would be arranged at the end of the test.*

At the end of the test, a short semi-structured interview was administered to the participants. They were asked questions about:

1. the convenience of using a labeling system;
2. the difficulties encountered in labeling the students;
3. the organization of information in the classroom sheet;
4. the organization of information in the lesson sheet;
5. the effect of the labeling system on their lesson planning.

Test sessions took an approximate time of 2 hours each.

## 4 RESULTS

This section offers a report of the observational results and of the relevant data extracted from the final interviews with the participants.

### *4.1 Observational data*

The mere observation of the participants interacting with the paper prototype allowed to gather some interesting insights on what a user could expect from a system that supports their instructional design.

Some strategies were spontaneously used by all of them. They asked to be allowed to keep a list of their students in sight, in order to prevent forgetting any of them, even though they were not explicitly asked to describe every single member of the class group. The participants also used similar strategies in organizing the classroom sheet: three of them preferred grouping positive and negative traits of the same person together, while one made two separate lists of strengths and weaknesses. These two lists were both ordered so that the traits of the same student were on the same line, so the method used to organize this information was slightly varied, but substantially equal. Only in one case (the fifth and last test) the listing was arranged differently, although still on a double list: this case will be discussed later as it was a direct consequence of an iterative refinement.

Another common element between the five participants was an initial difficulty in choosing appropriate labels to describe their students. Even those who were allowed to see the strengths and weaknesses chosen by previous testers appeared to have initial doubts about what would be better suited for their descriptions. All of them were encouraged to think about elements that could be directly linked to the lesson planning phase.

Again, in the descriptive phase, the first tester came out with the idea of using a label in both a positive and negative way (specifically, she marked 'stubborn' both in green and in red), explaining that for her the same trait could be an advantage or a drawback *depending on how the teacher was addressing it.*

In the strength and weakness resolution phase, cards were disposed on different sections of the lesson sheet: while one of the participants concentrated her reasoning on the homework section (justifying this with the fact that the lesson she described adopted the 'flipped classroom' model (Sams & Bergmann, 2012)), the others distributed their tokens on more sheets, mainly methods, supports and homework. Nobody associated specific strengths and weaknesses to the lesson topics.

One last element that emerged during the tests concerned the problem of writing the same trait more than once for more students in the same class. The participants saw this redundancy as inconvenient, but at least two of them noted that it would have been useful to duplicate cards and to associate them with different aspects of their lesson planning (e.g., they thought that a specific difficulty

of the same student was addressable by both the methods and the supports they used). This was clearly a limit of the paper prototype, that could be easily overcome in a software implementation of the system.

*4.2 Iterative refinements*

As mentioned in section 3.2, some iterative refinements were applied, adapting the prototype and the rules to the feedback given by the participants. Such changes to the core set of instructions defined above were small and involved at first asking the participants to put all the unaddressed green and red cards on the help sheet, instead of putting them away as the first tester was originally told. This helped in grouping and re-conceptualizing the strengths and weaknesses, which in turn supported the suggestion of technological and methodological improvements at the end of the final part of the test. In the third and fourth tests, participants were allowed to view red and green cards used in previous sessions, in order to get some inspiration for the initial task. During the third session another possibility emerged: the volunteer asked for help to the system also for strengths and weaknesses that were marked as already addressed, implying that his perception of how he was addressing specific needs could use some help from an external source in order to improve the quality of learning for the group. This was added as an option for the two following tests. During the fifth and last testing round the volunteer was allowed to write down strength and weakness traits not only for single students, but also for the whole class group. She chose to focus only on group traits, moving the overall perspective from short-term lesson planning to long-term instructional design.

*4.3 Semi-structured interviews*

Semi-structured feedback interviews were administered to the participants at the end of the test in order to collect specific insights on the main elements of the prototype: the 'strengths and weaknesses' labeling activity, the format of the classroom sheet, the format of the lesson sheet, the overall impression about the convenience of the proposed approach.

The idea of writing down the traits of the students was accepted as a good way to describe a complex situation with reasonable accuracy, with a common initial difficulty in choosing traits that would be both synthetic and useful in the following phases of the test. One of the participants defined labeling as a 'necessary activity' for taking every need into account, and another defined the class as a 'collective entity made of individualities'. There was general agreement on the idea that it is important for labels to be changeable through time, as the knowledge a teacher has (or thinks to have) about a student could improve or simply change.

The classroom sheet, in its simplicity, was considered appropriated. By the way there were some suggestions on how to improve it: defining labels for the whole group, as well as per student, was the top priority in this part for at least

two participants. As mentioned in section 4.2, the last testing round adopted this suggested option, with significant consequences on how the test was carried out.

Another one suggested to implement a graphical representation of the classroom, where students' desks should be arrangeable on the screen to reflect their real disposition. This would allow to visualize possible changes in the organization of the classroom before actually applying them.

The lesson sheet was generally considered complete and exhaustive, yet some other suggestions pointed to the idea of including a final part in which the teacher would be able to add notes after actually performing the planned lesson. This would help users in reviewing their work and in examining their achievements. Another problem was represented for at least one participant by the vast blankness of the pages: the possibility to create a list of elements was proposed, which could be easier to implement in a digital prototype. Besides the structure of the sheet per se, one of the testers remarked the importance of an exchange of views with colleagues, both from the same schools (e.g., teaching different subjects) and from other schools (e.g., teaching the same subject in other contexts or school levels).

Such an emphasis on collaboration was present in at least two interviews, where the participants complained about the general lack of collaborating attitude they saw in their workplaces, specifically when it comes to lesson planning. Multidisciplinary work was also described by one of them as something very useful, yet very uncommon in their work context.

All the five participants agreed on the fact that considering strengths is much less frequent than considering weaknesses, so they expressed their appreciation for the idea of taking those traits into account.

## 5 Discussion

The data presented in the previous section helped in shedding some light on the possible issues that could be related to the implementation of a system to support Inclusive Education and TEL implementation under a Universal Design perspective.

The difficulty in choosing strength and weakness labels that emerged from both the observation of the testers and the analysis of the data from final interviews was the main issue in all the five tests. It could be considered an 'experience issue', in the sense that users accessing the system for the first time could be disoriented, but they easily changed their views after the test was finished. In order to address it, a tutorial tour of the system could be implemented, together with clear examples of what could and could not be useful, especially in the *strength and weakness resolution* phase.

Another development hypothesis could be that of starting from the *lesson description* step, to subsequently highlight possible barriers to learning and to ask teachers to associate them with their students. This identification of barriers to learning could be based on the already existing Universal Design frameworks mentioned above, in section 2, and could be carried out by the system, provided that a formalized way of describing the lesson plan is defined.

Generally, the paper prototype was welcomed enthusiastically by the participants, who attributed a high degree of usefulness to it. They particularly appreciated the fact that they were encouraged in deepening their lesson planning activity, using a visual and interactive approach that at the same time allowed them to receive useful feedback and suggestions for new TEL solutions to try out. It will be important to integrate such a system with already existing tools and procedures: at the present time the Italian education system is experiencing the introduction of technology not only in teaching, but also in administrative tasks. Tools that keep digital records of all the school activity are bound to be adopted by all institutes by the end of next school year, so it would be useful to offer some degree of data interoperability. Unfortunately, there is no standardized platform to keep those records, so a future integration would face a high degree of fragmentation.

Collaboration with colleagues was a highly requested feature, mainly in the final interviews. This aspect had already been considered as a feature of the future software platform, but the feedback received by the tests described here allowed to focus on a different kind of collaboration: two participants expressed their interest for a system that would allow them to get advice from their peers in the form of an exchange of requests and solutions. They would like to be able to send requests of this kind: "I teach this subject, I am planning a lesson on this topic, and one of my students has this difficulty I don't know how to address". This was the kind of request that the system would address automatically in the original idea, matching requests and methods or supports. The participants asked for a mixed approach, including both automated and human suggestions.

At last this study showed that the class can be viewed as more than a mere group of students: it is an environment, in which strengths and weaknesses can be amplified or reduced by the relationships between the subjects that constitute it. Even though only two participants explicitly told that the classroom sheet should include group traits, all of them started by describing their class groups with general sentences ('this is a very good class', 'this is a very undisciplined group', 'the average level is …'). When one of the participants was allowed to use group traits, she focused on them and left out the students' traits. This isolated experiment suggested that this kind of feature would make the connection between traits and lesson plan someway looser than initially assumed. Class traits seem convenient, yet their usefulness needs further testing. The future development should use this information in order to help in refining the suggestions of TEL solutions and methodologies by taking both individual and environmental traits into account.

## 6 Conclusions and future work

This work had its obvious limitation in being based on a low fidelity prototype tested out by a small number of ideal users. In order to add significance to it, a larger testing activity needs to be carried out. At the same time, this kind of approach allowed to get a relatively high amount of valuable feedback by experts who work on the field every day. They were in the position to offer a realistic view of the needs of a teacher struggling to keep pace with the needs of their students and of their institutions.

At practically no development cost, it was possible to test the idea that it is possible to follow a Universal Design perspective while maintaining the attention on what is *here and now*, to optimize the efforts towards the use of TEL in an inclusive fashion.

Future developments will include the realization of another low fidelity prototype, this time using web technologies to implement the ideas discussed here in a way that makes them accessible via a web browser. Combining this with the Wizard of Oz technique, a larger number of volunteers will be recruited to help in refining the supporting system even further.

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