

Embedding Educational Narrative Scripts in a Social Media Environment

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Abstract—The impact of social media on teens’ mental health and development raises the need for educational interventions that equip them with the knowledge and skills to cope with dangerous situations. In spite of the growing effort to expand social media literacy among youngsters, social media interventions still rely on conventional methods that tend to prioritize cognitive skills while overlooking important socio-emotional competencies. To bridge this gap and offer innovative solutions to social media education, this article presents the narrative scripts (NS) approach implemented in a learning technology environment that integrates pedagogical strategies of authentic learning, narratives, and scripted collaborative learning within a simulated educational social media platform. A longitudinal study with 370 high school students in urban schools in Barcelona (Spain) was designed to assess NS in an intervention to foster the development of social media self-protection skills. The findings demonstrated that NS supported the development of social media self-protection skills, while the students expressed positive perceptions of their overall learning experience. The intervention notably enhanced the socio-emotional competencies of responsible decision-making, self-awareness, and social awareness. This research makes a valuable contribution to the design and development of technology aimed at facilitating authentic learning experiences for social media education, with a specific focus on interventions targeting socio-emotional competencies.

Index Terms—Authentic learning, computer-supported learning, narrative scripts (NS), social media literacy (SML).

I. INTRODUCTION

SOCIAL media (SM) has become an integral part of teens’ daily lives [1], offering them endless hours of entertainment and a means of communication, self-expression, and information

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dissemination. In a growing context of interconnection and hypermediality, SM offers users a multitude of opportunities to connect, share content, and interact with others, fostering positive experiences along the way [2], [3]. Contrariwise, SM can also expose users to potential risks, such as encountering toxic content, making contact with harmful individuals or groups, and engaging in problematic or even abusive online behaviors [4]. In addition, various design features of SM can foster problematic attachments that can potentially impact a user’s wellbeing [48]. Negative experiences of this nature can have significant consequences, including feelings of isolation and the potential to trigger stress, depression, and even suicidal behavior, particularly among adolescents [5], [6], [7]. Considering the significant amount of time adolescents spend online [8], [9], [10], [11], it is crucial to recognize the potential impact of SM use on teens’ well-being. This emphasizes the need to implement educational interventions that equip adolescents with self-protecting skills to recognize and effectively manage potential dangers and negative experiences.

Educational interventions targeting SM frequently encourage the development of SM literacy (SML) skills. SML encompasses the awareness, understanding, and knowledge needed to navigate and engage effectively in the world of SM platforms [12]. It extends beyond technical skills and involves critical examination of one’s role in the digital landscape, combining both cognitive and affective structures to help mitigate risks and maximize opportunities [12], [13], [14]. The design and implementation of interventions for SM education have so far proven to enhance users’ experiences on SM platforms [15], [16], [17], [18]. As a result, these interventions may foster SM-literate individuals who have the potential to maintain control over their online experiences and navigate negative situations more effectively [13].

When incorporating SML interventions in schools, there is typically a strong focus on equipping adolescents with the skills to protect themselves against online risks, such as cyberbullying, and misinformation [19]. However, socio-emotional competencies are often neglected, despite their potential as protective factors against SM risks [20], [21]. These competencies, which enhance affective structures, deserve attention due to their significant role in promoting overall well-being and resilience in the SM context. In the context of SM, affective structures refer to the emotional constructs or frameworks that underpin how individuals interpret, manage, and interact with SM content or situations [13]. Understanding and developing these affective structures

can significantly contribute to SM education. For example, Steffgen et al. [22] observed that adolescents with developed affective structures for empathy would be less likely to perpetrate bullying. Hence, evidence shows that affective structures can be instrumental in forming the emotional resilience and judgment needed to handle online interactions responsibly. Therefore, it is important for educational interventions to also focus on the development of affective structures, such as socio-emotional skills and prosocial behaviors against SM risks, or as referred to in this work, SM self-protection skills (SMSPS). Recognizing a gap in existing approaches, this study aimed to design and develop an innovative solution toward the acquisition of SM self-protection skills. It achieved this by exploring a technology implementation supporting a situated active learning approach that promotes this type of learning.

Drawing on prior research [13], the acquisition of SMSPS needs to go beyond educator-based interventions, as educators are less likely to stimulate affective structures in students due to emotion regulation occurring through personal experiences or by observing other people's experiences. In this context, the educational approach of authentic learning emerges as a valuable strategy. The authentic learning approach is characterized by teachers guiding students to acquire skills within real or simulated environments, effectively creating classroom settings that simulate real-world situations [23]. By exposing students to experiences that closely mirror real- or virtual-world situations, the authentic learning approach can effectively bridge the gap between learning and practical experiences [24]. Moreover, it can provide opportunities for students to develop the necessary skills for effectively navigating SM and addressing the challenges they may encounter.

The use of authentic learning experiences to target SM education entails engaging individuals in activities within SM platforms with the aim of developing strategies for cultivating and managing a positive online presence. This approach can also provide valuable opportunities for students to observe various situations, promoting the development of emotional regulation skills. However, it is essential to approach this practice with caution, ensuring that it does not compromise individuals' online safety. One promising approach to ensuring individuals' online safety is the integration of educational features within interactive environments that simulate SM platforms [25], [26], [75], [82]. While providing users with the freedom to explore a wide range of SML topics, mirroring SM platforms can offer unique opportunities for educators to enhance their educational interventions [27]. Hence, the aim of this article is to develop and implement an educational SM platform that fosters the development of both cognitive and affective structures in the context of SM education. Specifically, this article introduces the concept of narrative scripts (NS) as a novel approach that integrates authentic learning experiences, narratives, and collaborative learning activities [28].

To evaluate the efficacy of the NS approach, a study was conducted addressing the following evaluation questions (EQs).

EQ1: To what extent do NS effectively strengthen adolescents' self-protection skills in the context of social media?

EQ2: How do adolescents perceive the utility of this tool for acquiring knowledge and understanding of SM threats?

The present study sheds light on the effectiveness of NS in promoting adolescents' SMSPS and their overall perceptions of the platform's educational value. The evaluation results revealed promising outcomes. Implementing the NS learning technology within classrooms demonstrated positive impacts on adolescents' SMSPS while simultaneously providing a positive learning experience.

The rest of this article is organized as follows. Section II defines the pedagogical strategies behind the NS notion. Section III introduces the technical aspects of the NS platform. Section IV evaluates NS as an educational tool for the acquisition of SMSPS. Section V summarizes and discusses the key findings, insights, and limitations. Finally, Section VI concludes this article.

II. PEDAGOGICAL APPROACH

In this section, we present and define the curated pedagogical strategies that underpin the NS concept, highlighting their significant benefits in promoting SM education.

A. Overall Conceptual Design: Interactive Educational NS Within SM

The NS approach introduces a unique learning experience that combines the pedagogical strategies of authentic learning, storytelling, and computer-supported collaborative learning (CSCL) (see Table I), with the objective of addressing both the cognitive and affective aspects of SML. This approach is aligned with the previous research that utilized active learning, multiple perspectives, and collaborative learning to promote awareness, positive attitudes, and desired behaviors in the SM context [19]. By integrating these strategies, the aim is to create immersive learning experiences for students through the utilization of fictional narrative-based scenarios [29], [80]. These scenarios are intentionally crafted to challenge dominant narratives [30] and foster collaborative activities enriched with argumentation [31], with the ultimate goal of shaping students' beliefs and behaviors in a purposeful and meaningful manner. Their integration within a simulated SM platform enhances the element of authentic learning and creates valuable opportunities for students to learn through the observation of fictional characters' experiences while providing opportunities for adaptive learning.

B. Concept 1: Embedding Learning in an Authentic SM Context

Authentic learning involves delivering educational material in a context that closely resembles the real world, capturing its complexities and limitations [24]. By presenting learners with experiences that mirror real life, authentic learning keeps the learning process connected to the real world [23]. This approach bridges the gap between theory and practice, leading to improved problem-solving skills and fostering a deeper connection with the learning material [32].

TABLE I
FORMULATION OF NS COMPONENTS WITHIN THE CONTEXT OF SM EDUCATION

Concept	Reasoning	Learning experience role
Authentic learning	Students gain knowledge and skills through immersive learning experiences [24, 33].	Creation of educational fictional profiles accessible to students to explore within the platform.
	Mirroring real life without dissociating learning from the real world [24].	Adaptive learning based on learners' behavior within the platform.
	Authentic experiences enhance problem-solving and learning engagement [32].	Mirroring of SM platforms' social interactions and interfaces.
	Controlled SM platform for exploring real-world SM situations [25, 34].	
Narratives	Bridge between the academic and everyday world [29].	Narration of real-life problematic behaviors in SM environments.
	Personal involvement with learning material [29].	Interactive stories, providing students with multiple option solutions.
	Change attitudes, beliefs, and learners' behaviors [35, 49].	
	Counter (toxic) dominant narratives [30].	
CSCCL	Building on the reasoning of one another [36].	Role-based discussions.
	Building consensus through discussion [37].	Multi-perspective discussions on SM situations.
	Individual preparation [38].	Scripted collaborative tasks.
		Manageable steps build towards learning goals.
		Learning path structured to slowly fade instructional support.

Thus, the adoption of authentic learning approaches can enrich the educational experience, fostering the development of practical skills and deeper engagement with real-world challenges.

Authentic learning strategies for SM education often rely on traditional classroom methods, such as teacher presentations, group discussion, and the distribution of fabricated SM profiles on paper [19], [39]. However, these approaches can sometimes seem exaggerated and unrealistic to students, as educators may overcomplicate the learning scenarios and fill them with overexaggerated situations [40], leading to a disconnect from the authentic SM experience.

Using real SM platforms to educate students about potential risks has been found to be ineffective for learning, as it lacks content control and does not offer direct learning opportunities [40]. Attempts to integrate learning opportunities within real SM platforms have also involved the implementation of

virtual learning companions that accompany users during their browsing [41], [42]. However, currently, these approaches are primarily focused on assisting individuals in analyzing content for misinformation and on targeting cognitive abilities.

To successfully integrate educational material into an authentic SM environment, it is crucial to maintain the complexity of the social network while ensuring that it enhances the learning process and addresses both cognitive and affective structures. In addressing the concerns raised in prior research, the NS approach proposes a combination of a real SM platform and a virtual learning companion. This integration occurs within a controlled environment, allowing curated content to enhance learning opportunities. As a result, educators can create profiles that align with their curriculum and learning activities, providing students with the opportunity to analyze them in a controlled, authentic environment. This approach also enables students to have an authentic SM experience, by engaging in social interactions, such as sharing, liking, commenting, and following peers.

Integrating a virtual learning companion to deliver educational content to students can provide opportunities for an interactive engaging agent to present fictional challenging scenarios for students to resolve and offer guidance throughout their learning journey. Previous research adopted similar approaches to deliver learning material and employed chat interfaces to lead students through missions narrated by fictional characters [43], [44], [45]. The integration of a fictional character directing students through a chat interface within a controlled SM platform offers a unique opportunity to deliver educational material in a context that can resemble the real world.

C. Concept 2: Narratives

Storytelling techniques can significantly enhance learning by fostering curiosity, critical thinking, and a deeper understanding of complex concepts [46], [29]. This approach bridges the gap between everyday experiences and academic content, allowing learners to connect with the material through their own beliefs and narratives [47], [29]. Consequently, it cultivates a deeper investment from students in the problems they are solving without impeding the learning process [80].

In SM education, narratives can introduce students to common problems in a safe, third-person perspective [43]. This allows them to learn valuable lessons and develop SMSPS without experiencing real-world consequences [50].

Furthermore, narratives can be transformed into interactive playgrounds [76], where students navigate a story using their choices, and shaping their own experience. This personalized approach can be further enhanced by integrating counternarratives that challenge dominant narratives and encourage critical thinking [30]. By encountering narratives that address biases and discrimination, or toxic dominant narratives [51], students are prompted to critically examine messages and attitudes, leading to a deeper understanding of social issues [25], [52].

However, it is essential to note that the integration of narratives within interventions can have varying effects on different ages. For instance, previous research examining the use of narratives for SM education has identified a negative correlation between age and narrative transportation [43]. Therefore, it is crucial to

explore whether students' maturity and cognitive development [70] can impact the effectiveness of such interventions, considering its implications for designing targeted and age-appropriate educational strategies.

D. Concept 3: CSCL Scripts

CSCL involves the formation of groups to enhance learning through social interactions facilitated by computer-aided environments. CSCL scripts guide collaboration, aiming to spark productive interactions, such as argumentation [53], which helps students reach consensus, develop critical thinking [54], and ultimately achieve productive thinking, conceptual change, and problem solving [55]. Different types of scripts exist, promoting argumentation through strategies, such as pairing students with diverse viewpoints [56] or distributing knowledge unevenly within groups [57].

However, effective argumentation requires scaffolding [58]. This involves structuring tasks with argumentative activities and gradually reducing support as collaboration progresses [58], [59]. Scaffolding exposes students to diverse arguments and fosters an equal knowledge base, while also allowing for individual preparation, crucial for effective collaboration [38]. Ultimately, reflection on these arguments can lead to changes in attitudes and behavior [60].

The integration of CSCL scripts within NS can benefit SM education by providing an environment that encourages collaboration and argumentation with gradually reduced support. For example, a CSCL script can be designed to expose students gradually to problematic SM situations, prompting individual reflection before initiating collaborative discussions and initiate individual reflection after collaboration to promote independent learning. While the use of counternarratives in combination with collaborative learning activities can emphasize learning driven by argumentation, the implementation of argumentative-based CSCL scripts within SM education can promote critical thinking among participants by countering students' individual dominant narratives and eventually lead to productive ways of thinking, conceptual change, and problem solving.

III. TECHNOLOGICAL APPROACH

Our conceptual design is realized through Instareal, a simulated SM platform, providing students with the opportunity to both socialize and learn about SM threats. This is developed using Pixelfed's open-source code [61] in an extension initiated by Taibi et al. [34]. Pixelfed mirrors Instagram's functionalities, providing users with the ability to create accounts, share visual content, and interact between them through follows, likes, and comments.

As a result, Instareal extends the social functionalities of Pixelfed and attaches a scripting engine that allows the integration of educational content into the SM facet. This integration provides opportunities for authentic learning experiences that target problematic scenarios on Instagram. Moreover, Instareal leverages various motivators and design principles, including profile ownership, cognitive challenges, and freedom for exploration, to enhance student motivation and engagement [77].

The platform has been developed as a responsive web-based application using the technologies of vue.js, PHP Laravel, and SQL. The responsive design of the platform allows for easy integration into in-classroom activities, as students can access it through school computers, laptops, tablets, and their smartphones.

A. Architecture of Instareal: An Educative SM Platform

As illustrated in Fig. 1, the architecture of the platform consists of the social facet of Pixelfed and the educational scripting engine. The chat interface acts as a bridge between the social and educational components of the platform and delivers to students' narrative-enhanced learning materials in the form of missions. To enable the integration of the counter narrative approach, we utilized the data communication model xAPI in combination with the learning record storage of Learning Locker [62]. This provides opportunities to trigger learning material based on the student's activity within the platform [52].

The educational scripting engine handles information packages, such as the scripting module and user behavior data. As a core part of the structural entity of the NS, the scripting module consists of information on how each script is structured. This provides information to the script engine regarding how each learning activity will be presented, the tasks and missions to be triggered, and the order in which the components should be shown to the students. The learning activities are delivered to the students through predefined dialogue tasks and can also trigger external components, such as mini-games and CSCL activities. The dialogue tasks follow a linear narrative progress based on a predefined path.

Educators can add educational material through the social facet of the platform and the scripting module. Within the social facet, educators can create fictional SM profiles and later associate them with a task through the scripting module. Within the scripting module, educators can upload their own scripts that contain the narrative and educational material, as depicted in the data model in the next section.

B. Conceptual Data Model of the Educational Component of the NS

The data model of the NS consists of three entities: the NS, the tasks, and the condition (see Fig. 2). The NS entity is described by a higher tier learning objective and an overall description of the script and the narrative. On its completion, it creates two outcomes in relation to students' engagement and knowledge. NS can be compiled by a variety of tasks, and therefore, they have a one-to-many relationship.

The entity of tasks is described by a lower tier learning objective, which feeds toward the NS' higher tier objective and has a distinct task description and narrative.

Each task can be of a different type, and the tasks are aligned with the pedagogical strategies presented in the conceptual framework of the NS. They include tasks that allow students to freely roam within the platform (authentic learning), guided roaming activities that instruct students to visit specific predefined profiles (narratives), group activities that provide

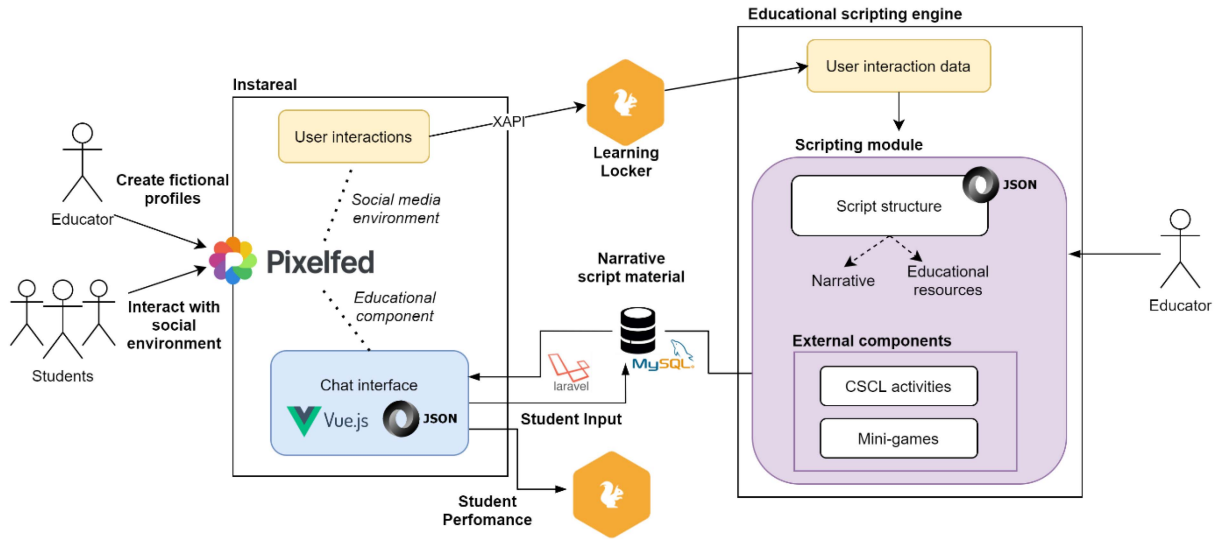


Fig. 1. Architecture of the NS embedded in a SM platform.

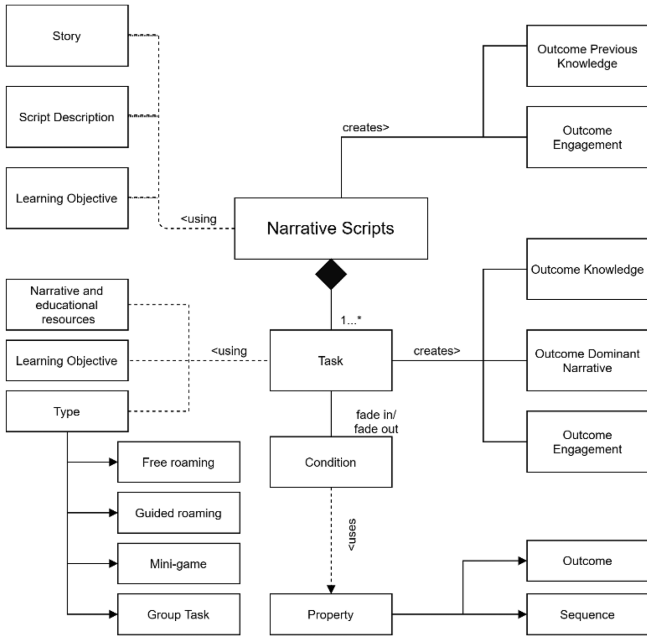


Fig. 2. Conceptual data model of the NS.

opportunities for students to collaborate (CSCL), and mini-games that provide learning material interactively.

The tasks appear to the participants in a predefined order orchestrated by the conditions entity related to a proposed fix or adaptive sequencing, depending on the learners' previous outcomes. For example, if a user has shown interest in fitness profiles (during free roaming), the NS can trigger tasks based on their new role to expose realities about SM fitness profiles. The completion of a task creates three types of outcomes that feed toward the generation of these roles, also referred to as counternarratives. In the following section, we describe in more detail the design of the tasks and how they have been implemented into a working prototype of Instareal.

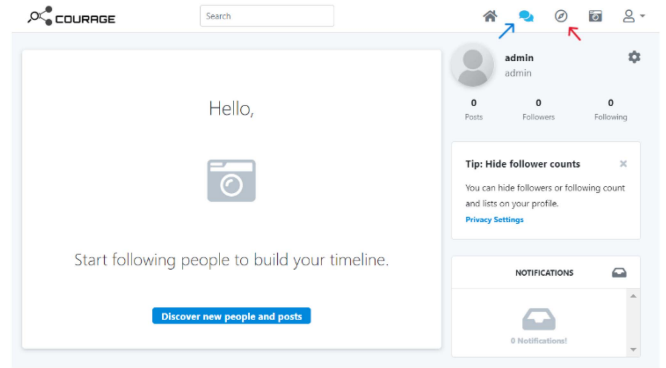


Fig. 3. Screenshot of Instareal's social facet: Explore user profiles (red arrow) and access educational materials (blue arrow).

C. Implementation of Instareal Embedding NS

A working version of the proposed system has been developed with the architecture described above. The current version of the platform accommodates the following social functionalities: image uploading, comments, likes, search features, and an explore section to look at different profiles (see Fig. 3).

The educational component is accessible via a button where a chatbot (Tom) delivers to students the educational material in the format of text, voice messages, images, or videos. Students can reply to the material with predefined options or, in some cases, with open text, Likert scales, or checkboxes (see Fig. 4). During the chat interaction, the chatbot directs students to the different NS tasks. In the current version of the platform, the following types of NS tasks are supported: free roaming, guided roaming, mini-games, and group activities. Each task has been designed following the pedagogical framework and has been utilized in the following formats.

Free roaming: During free roaming, students are encouraged to publish content, follow their peers or precreated influencers, and comment on or give likes to the content they see. This type of

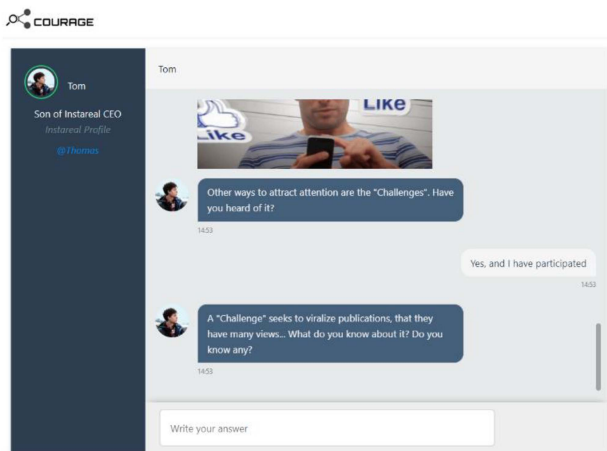


Fig. 4. Educational component of the NS: chat-based learning with multimedia content (influencer image by A.D. available at unsplash.com).

task provides opportunities for students to engage in an authentic learning experience and explore a secure SM platform while the system collects data to trigger counternarratives [52].

Guided roaming: This type of activity refers to roaming, where students are instructed to visit specific profiles to complete a task. For example, on the topic of fear of missing out, students are asked to analyze an influencer’s profile and reflect upon it. The type of profile assigned to each student depends on the types of profiles they have been interacting with in the social facet (counternarratives). The current iteration of the platform includes the profiles of eight fictional influencers categorized under fashion, travel, fitness, and neutral.

Mini-games: The use of mini-games as a type of task has been introduced to reinforce students’ learning at the end of each session. The current iteration of the platform implemented mini-games as a way to summarize and revise previously covered topics.

Group activities: Group activities describe tasks that provide students with opportunities to solve problems together. In the current iteration, Instareal supports the integration of two types of CSCL tools that facilitate the collaborative learning flow patterns of a pyramid and a jigsaw. In particular, the PyramidApp tool [37] has been integrated to provide students with an environment suitable for short agile knowledge-building activities. To foster collaborative experiences and encourage role-playing centered around counternarratives, external integration was introduced for EthicApp [63], a CSCL platform supporting the jigsaw flow pattern.

IV. EVALUATION

The successful implementation of the system provides evidence of the approach’s feasibility. This section focuses on validating the proposed system through two EQs that focus on effectiveness and engagement. By addressing these two aspects, the study aims to establish the efficacy and user acceptance of the educational approach, thereby highlighting its potential to enhance SM socio-emotional skills through innovative and engaging methods.

A. Evaluation Questions

The evaluation aimed to assess the effectiveness of the platform in the acquisition of SMSPS and to evaluate the platform from the student perspective. Considering previous research indicating the varying impacts of interventions and narratives on students of different age groups [43], [64], we explored both EQs from an overall perspective and based on different school grades.

EQ1: To what extent do NS effectively strengthen adolescents’ self-protection skills in the context of social media?

EQ2: How do adolescents perceive the utility of this tool for acquiring knowledge and understanding of SM threats?

B. Design, Participants, and Setting

To evaluate the effectiveness of the NS platform, we designed a longitudinal field study across high schools in the Barcelona metropolitan area, Spain. The study involved an SML workshop exclusively centered around the NS platform, conducted from October 2021 to May 2022.

The workshop consisted of four monthly sessions, each lasting approximately 90 min and held during school hours. Students participating in the study ($n = 370$; 48.9% male, 50.8% female; ages 12–19, $mAge = 14.9$, $SD = 1.75$) from four different high school grades engaged with learning material and activities presented through the NS platform.

The students and their parents were informed about the research objectives and the use of an educational SM platform prior to the workshops. The students were asked to consent to their participation by signing an electronic form. In the cases of students under the age of 18, a parental consent form was also required.

C. Learning Scenario

The “My Digital Self” learning scenario NS was created to educate adolescents about the effects of SM usage on their well-being while targeting both cognitive and affective structures.

The following learning objectives were formulated based on the socio-emotional competencies of self-awareness (SeA), social awareness (SoA), and responsible decision-making (RDM).

LO1: Improve students’ SeA in online environments (critical reflection on how their feelings are influenced by SM).

LO2: Improve students’ SoA in online environments (perspective taking toward messages they receive online).

LO3: Improve RDM in online environments (sharing content online, cyberbullying, etc.).

To address the learning objectives, six tasks were designed that covered topics such as the fear of missing out phenomenon, digital footprints, online reputations, curated lives, SM well-being, and SM addiction (see Fig. 5). The tasks were inspired by the material provided by Common Sense Education [65] and were designed in alignment with the NS conceptual data model.

In the “My Digital Self” NS, the narrative introduced Tom, the fictional teenage son of the Instareal CEO, who was looking

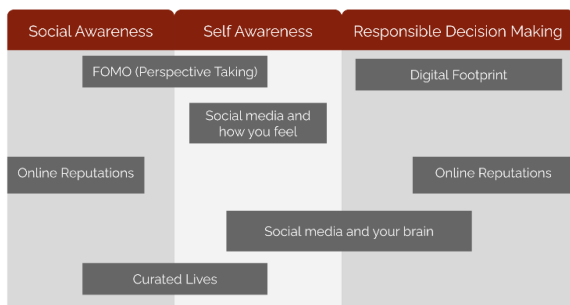


Fig. 5. “My digital self” NS categorizes six learning modules under three social-emotional learning objectives.

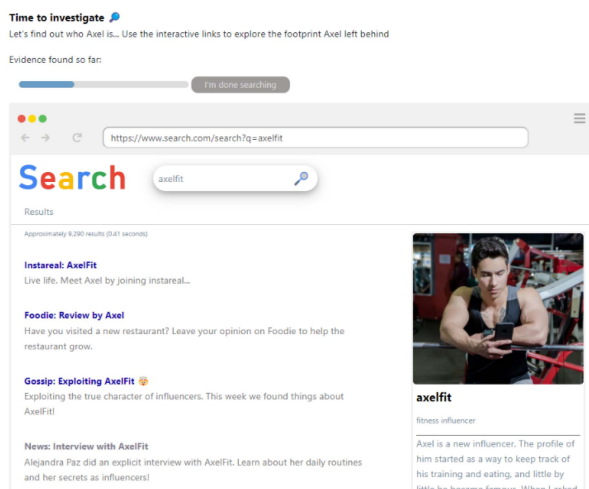


Fig. 6. NS task, exploring digital footprints: Students analyze three characters’ digital footprints on a mock Google search page, then collaboratively choose the best fit before individual reflection (influencer image by S.B. available at pexels.com).

to recruit new employees to help develop an SM platform focused on users’ mental well-being. The learning materials were disguised within this storyline. For example, the digital footprint activity introduced the students to three fictional characters who applied for the position, and the students had to decide based on the digital footprint they left behind who was the most appropriate candidate (see Fig. 6).

The “My Digital Self” NS was also enhanced with counternarratives that were adapted following the students’ social behavior on the platform during free roaming. The counternarratives focused on exposing the students to SM versus reality facts about fitness, traveling, or fashion influencers. This resulted in guided roaming tasks in which students were scaffolded into individual reflections after being directed to explore pre-created influencer profiles. On some occasions, this led to collaborative learning tasks in which students had to collaboratively build a solution with their peers (PyramidApp) or debate the best approach through role-playing (EthicApp).

The “My Digital Self” NS was designed to cover two tasks per session: one individual and one CSCL activity (see Fig. 7). During the field study, a welcome session was added to the workshop design to give students time to register on the platform and roam without any restrictions. The next sessions were constructed as

NS interventions that unfolded within the SM platform. The students accessed Instareal in the classrooms using either the school computers, laptops, and tablets or, in some cases, their smartphones.

D. Measures

SMSPS: To measure the effectiveness of the NS, an ad hoc questionnaire was developed to evaluate whether the learning objectives of the course were met. The questionnaire that was developed was based on previous scales measuring Internet skills and socio-emotional competencies [68], [67].

The questionnaire aimed to measure the adolescents’ SM socio-emotional competencies. The questions were formulated based on the socio-emotional competencies of SeA, SoA, and RDM [66]. In particular, the questions for each competence were adapted to reflect their value in SM and were inspired by the socio-emotional learning questionnaire [67].

To measure the students’ understanding of how SM works and its effect on their experiences, a set of questions adapted from the Internet Skills Scale (ISS) [68] was also included. This led to a pool of 18 items formulated as five-point Likert scales asking participants to rate their level of agreement or opinion. The ad hoc questionnaire was divided into four subscales, representing the competencies of SML, RDM, SoA, and SeA with items coming from previously validated scales [68], [67]. To validate the internal consistency of each proposed subscale, a confirmatory factor analysis was conducted. This led to the removal of two questions from the pool of questions due to not being significant. The final subscales produced the following cronbach alpha values (α): SML ($\alpha = 0.69$, six items),

Students experience: The students evaluated their experiences with the NS approach by answering two questions related to their overall experiences with the environment and with the learning material they received. Both questions were formulated as five-point Likert scales in the postquestionnaire. The scales were presented to the students as a visual rating tool, with 1 star being the lowest rating and 5 stars the highest.

E. Data Analysis

We evaluated RQ1 by measuring the students’ overall performance in the SMSPS questionnaire and by observing each socio-emotional competency individually. Due to the sample size, it was important to determine the distribution of the pre- and postquestionnaires before choosing an appropriate statistical method. A Shapiro–Wilk test was conducted to assess the normality of both the pre- and postquestionnaire distributions to assess EQ1. The results indicated significant departures from normality for both the prequestionnaire ($W = 0.86$, $p < 0.05$) and the postquestionnaire ($W = 0.85$, $p < 0.05$). Consequently, we opted to utilize the nonparametric paired test of Wilcoxon signed-rank test, to compare the values of the pre- and postquestionnaires. For EQ2, we have utilized an independent t-test to compare students’ opinions between the different grades as the data were normally distributed.

Since the experiments were conducted over a long period of time, external factors, such as motivation, may have influenced

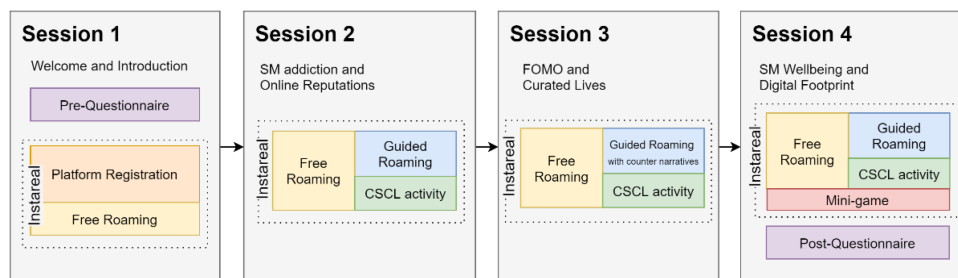


Fig. 7. Flow of the “My digital self” NS tasks and allocation.

TABLE II
AGE GROUPS OF THE SPANISH GRADE SYSTEM [69]

Age Group	Spanish Grade
12–13	1° ESO
13–14	2° ESO
14–15	3° ESO
15–16	4° ESO
16–18	Bachillerato

the data collection process. We excluded participants whose data were deemed unreliable due to abnormal behavior (e.g., deliberate wrong answers). This resulted in a final sample size of 317 students ($n = 317$; 47.6% male, 52.4% female; ages 12–19, $mAge = 14.9$, $SD = 1.78$).

Specifically, the final sample consisted of 78 students from 2° ESO, 81 students from 3° ESO, 36 students from 4° ESO, and 122 students from Bachillerato (For references to international school grades, see Table II).

During the workshops, a few students accessed the platform using tablets and phones. Despite this, the visual experience was the same on both tablets and laptops. Due to the small sample size, additional analysis on this aspect was considered redundant.

F. Results

Our analysis of RQ1, which examined the use of NS as a tool to enhance adolescents’ SMSPS, revealed significant differences in the pre- and post-questionnaire SMSPS scores between all participants ($mPre = 59.4$, $mPost = 60.7$, $p < 0.05$). A comparison of each competency individually between all the participants showed a significant difference between the competencies of RDM ($mPre = 4.25$, $mPost = 4.33$, $p < 0.05$), SoA ($mPre = 3.45$, $mPost = 3.61$, $p < 0.05$), and SeA ($mPre = 2.93$, $mPost = 3.02$, $p < 0.05$). No significant differences were found for the competency of SML ($mPre = 4.12$, $mPost = 4.12$, $p > 0.05$) skills.

A complementary analysis was then conducted to observe whether the NS affected each school grade differently. This analysis revealed significant differences in the pre- and postquestionnaire SMSPS scores between three of the four school grades (see Fig. 8). Specifically, students in 2° ESO ($mPre = 60.3$, $mPost = 61.1$, $p < 0.05$), 3° ESO ($mPre = 58.8$, $mPost = 60.3$, $p < 0.05$), and Bachillerato ($mPre = 59.8$, $mPost = 60.9$,

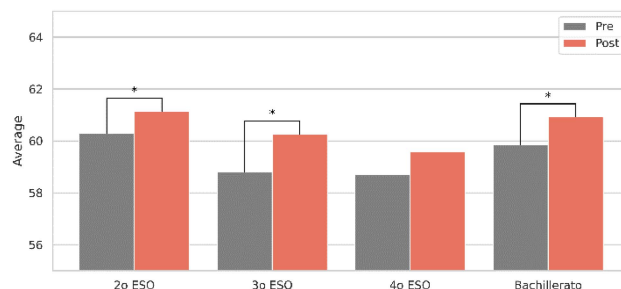


Fig. 8. SMSPS pre- and post-questionnaire per school grade.

TABLE III
DESCRIPTIVE STATISTICS OF PRE- AND POST-QUESTIONNAIRE COMPONENTS PER GRADE

		2° ESO		3° ESO		4° ESO		Bach.	
		m	sd	m	sd	m	sd	m	sd
RDM	Pre	4.35	0.88	4.21	0.86	4.23	0.95	4.22	0.84
	Post	4.41	0.82	4.33	0.83	4.38	0.75	4.28	0.83
SeA	Pre	2.99	1.32	2.90*	1.37	2.85	1.36	2.94*	1.36
	Post	3.04	1.36	3.08*	1.31	2.87	1.37	3.03*	1.32
SoA	Pre	3.32	1.02	3.42	1.01	3.57	1.15	3.52*	0.93
	Post	3.46	1.03	3.46	1.10	3.67	1.05	3.79*	1.01
SML	Pre	4.22	0.95	4.05	0.94	3.98	1.05	4.15	0.89
	Post	4.23	0.94	4.09	0.93	3.99	1.04	4.09	0.95

* $p < 0.05$ compared pre-test and post-test within the same grade.
m = mean value, sd = standard deviation.

$p < 0.05$) showed statistically significant improvements. However, for students in 4° ESO ($mPre = 58.7$, $mPost = 59.6$, $p > 0.05$), there was no significant difference in pre- and posttest scores. A closer look at the competencies of each school grade showed significant differences in the pre- and post-SeA competency of the 3° ESO students ($mPre = 2.90$, $mPost = 3.08$, $p < 0.05$), Bachillerato students ($mPre = 2.94$, $mPost = 3.03$, $p < 0.05$), and the SoA pre and post of Bachillerato students ($mPre = 3.52$, $mPost = 3.79$, $p < 0.05$) (see Table III).

A two-way analysis of variance (ANOVA) test was conducted to compare differences between the learning of each grade group and indicated a significant difference under the SoA component ($p < 0.05$). However, no further significant differences were observed.

Finally, RQ2 aimed to evaluate the platform through the students' experiences. The students rated both the material/environment ($mRating = 3.77$, $SD = 1.67$, $mode = 4$) and their experiences ($mRating = 3.65$, $SD = 1.19$, $mode = 4$) positively. A closer analysis evaluated whether the younger students ($n = 197$, $mAge = 13.86$, $ageRange = 12$ to 15) perceived the material and the experience differently than the older students ($n = 125$, $mAge = 16.9$, $ageRange = 16$ to 19). The findings indicated that the younger students enjoyed both the material ($mYounger = 3.82$, $mOlder = 3.71$, $p < 0.05$) and their experiences ($mYounger = 3.73$, $mOlder = 3.56$, $p < 0.05$) significantly more than the older students.

V. DISCUSSION

A. Overall Findings

This study introduced the NS approach, which was implemented in a learning technology environment that seamlessly integrates the pedagogical strategies of authentic learning, narratives, and scripted collaborative learning within a simulated educational SM platform. The primary objective of this integration is to foster the development of SMSPS among students. To assess the effectiveness of NS as an intervention tool for SM education, a field study with adolescents was designed and conducted in urban schools in Barcelona. Two EQs were formulated, focusing on competencies acquisition (EQ1) and measuring adolescents' subjective experience (EQ2). Based on our findings, the NS have demonstrated their effectiveness in fostering socio-emotional competencies associated with SMSPS while receiving positive feedback from adolescents regarding their learning experiences.

The findings under EQ1 showed an improvement in students' SMSPS after receiving the NS intervention. This finding aligns with previous work on the use of narrative pedagogies to enhance SM skills [43]. This implies that the pedagogical method of narratives not only supports the development of SM skills but can also help enhance socio-emotional competencies for SM education. Although the results for EQ1 among 4o ESO students did not reveal significant differences in the development of SMSPS skills under the pre- and post-questionnaires, we attribute this lack of significance to the relatively low number of students in this grade. In comparison to other grades, only 36 students were included in the analysis for 4o ESO. This limitation hinders our ability to draw definitive conclusions about this grade of students and the impact of the intervention on their SMSPS skills even though a positive increase is visible.

A closer look into each socio-emotional component showed that the intervention was significantly beneficial toward the overall acquisition of SMSPS of RDM, SoA, and SeA. This could be related to the nature of the NS material, where the students followed stories narrating SM situations happening to other characters and students having to provide advice. This implies that the approach of the narratives promotes reflection on social behaviors and how they can affect other users' well-being in SM.

Regarding results related to SML skills, we observed no significant increase among the participants. This outcome may be attributed to the nature of the learning materials, which primarily aimed to enhance students' socio-emotional development rather

than providing direct instruction on SML skills. This observation does not imply a negative learning experience regarding SML development under the NS notion, but rather emphasizes the focus of the materials students received under the "My Digital Self" NS.

We observed mixed results when looking at each school grade individually. Specifically, participants in 2o ESO had minimal but no significant improvement of each individual competency under the SMSPS measure. Assuming a connection between experience and socio-emotional development, the insignificant improvement observed in 2nd year ESO students' SMSPS could be related to their potentially limited experience with SM platforms compared to older adolescents [78]. This lack of experience might have hindered their ability to reflect on past SM experiences when exposed to the NS content. Consequently, it is plausible that focusing on and contemplating their internal thoughts, feelings, and relationships within this context proved challenging [79]. After all, these aspects are considered crucial for socio-emotional development.

This finding highlights a potential limitation of the NS approach. While it can be beneficial for individual reflection for students already familiar with situations in SM, it might be limiting for those with less SM experience. Given the importance of SMSPS, such as SeA on user's mindfulness [71], further investigation is needed into how to develop socio-emotional skills in SM education for students who lack extensive experience with these platforms.

Finally, EQ2 measured the students' subjective ratings of the NS approach to learning about SM threats. The findings showed that the students rated both the material and their experiences positively. This implies that the NS approach is not only effective for educating adolescents but also that it is perceived as a positive experience by students. Moreover, our findings showed differences in how different age groups perceived the platform. The younger students ($mAge = 13.86$) rated the material and overall experience significantly higher than the older students did. Different aspects could have influenced this result. For example, this could have been caused by younger students not having previous experience with SM platforms due to age limitations and, hence, finding this opportunity more engaging than older students ($mAge = 16.9$). This aligns with Livingstone's [70] "age and stages" approach to SM education, which emphasizes the influence of age on distinct motivations for SM use. In addition, older adolescents might have perceived the narrative approach as childish and less engaging compared to younger students, as similar previous research also found a negative correlation between age and narrative transportation [43]. However, it is important to note here that the results obtained for EQ2 closely align with the mean value of the scale (3.5). Despite the most frequent response (mode) being 4, the presence of a high standard deviation indicates a wide spread of answers. This spread pulls the average score (mean) down close to the scale's midpoint (3.5), revealing a potential limitation of the chosen scale. While the mode provides some insight, future studies might benefit from employing a scale with a wider range or exploring alternative methods to effectively capture the full spectrum of attitudes or behaviors under assessment.

B. NS Concept

The results of the evaluation study offer further insights into the proposed conceptual and technical design for an educational SM platform. The three pedagogical concepts of the NS have proven effective in enhancing students' skills in various ways.

For instance, the use of the gamified element of narratives provided an opportunity to create and design problematic SM scenarios to educate students within the simulated SM platform in an approach that would otherwise be difficult to replicate in a real environment. The use of narratives allowed students to explore problematic situations from a third person perspective, allowing them to become critical of certain SM behaviors and evidently enhancing their SMSPS. SM education can benefit significantly from incorporating gamified elements to boost student engagement and enhance learning. Furthermore, gamified elements incorporated within the narrative aspect of the platform, such as points and badges, can potentially help to further increase students' engagement and improve online behaviors [82]. While the current NS platform lacks these features, future iterations could explore integrating such gamification elements to elevate the learning experience. In addition, analyzing user behaviors and in-game interactions could inform the customization of game-based elements within the platform, tailoring them to better suit individual preferences and enhance overall engagement [83], [84].

The inclusion of collaborative activities offered students a platform to exchange ideas and perspectives on SM issues. While prior research suggests that collaboration within SM education is not always advantageous [60], our study revealed promising results in strengthening their socio-emotional skills. However, to gain a more thorough understanding of its effectiveness, further research is needed to isolate the specific advantages and disadvantages of collaborative learning within the NS context [80]. This could involve comparing the collaborative approach with an individual learning mode within Instareal. By conducting such a comparison, future research could determine if collaborative learning offers distinct benefits over individual learning in terms of developing SMSPS.

Finally, the use of an authentic learning environment allowed the incorporation of educational material within an authentic SM environment without exposing the students to potential dangers. To the best of the authors' knowledge, no prior initiative has allowed educators to replicate problematic SM situations in an authentic SM environment in the same way. This also creates opportunities for educating adolescents about SM algorithms, not just by offering instructional resources but also by giving them hands-on experience of how these algorithms operate [25], [34]. This could result in adolescents who are able to comprehend and navigate the workings of SM mechanisms, as well as understand the potential impact of curated content on human behavior [72].

C. Limitations

The implementation of NS as an authentic SM environment designed for in-classroom activities had some important limitations related to both teaching and research practice.

During the field study, there were occasions when students were more interested in the social aspect of the platform and did not engage in the educational part. This shows the potential difficulties of implementing SM education in authentic settings, as students engage in social interactions that can disrupt the learning experience. In our case, to resolve this, a control system was implemented to allow the instructors to block access to the social aspect of Instareal and direct students to the educational component. Work that seeks to implement learning experiences within real SM platforms needs to take into consideration this limitation and plan activities to work around it. In addition, instances of inappropriate content upload (e.g., black humor memes, hypersexualized bodies, and satirical cartoons) required constant monitoring by research assistants, adding to the educators' workload. This underscores the need for sustainable solutions or support for such issues. Finally, students quickly noticed limitations in the chatbot's interaction options, expressing doubts about its intelligence. Future work of this type could see the integration of an intelligent virtual learning companion with enhanced conversational facets and more interaction opportunities along the educational flow of the script.

Moreover, as with any other empirical study, we have identified a few limitations of the study design that future researchers could take into consideration. To begin with, due to the longitudinal nature of our study, we had significant data loss due to students not participating in all sessions, missing either the pre- or postquestionnaires, or losing interest during the term. To overcome this, we propose the evaluation of similar interventions in shorter periods of time.

Given that our study took place within school settings, incorporating a control group would have posed challenges, such as limiting the available sample size and encountering practical constraints. Implementing a control group would have necessitated additional resources and coordination to ensure equivalent exposure to the (control/experimental) workshops. However, we addressed this challenge by utilizing a comparative approach. Instead of a traditional control group, we leveraged the data from the prequestionnaires administered to the students' one grade level above as the control group per grade. Given that the workshops spanned eight months, we reasoned that students not participating in the workshops would have equivalent knowledge (or experience) as students in the prequestionnaire of the above grade. Essentially, prequestionnaire data from 4o ESO become the control group for 3o ESO post-workshop results, and so on.

Taking this approach into consideration, and conducting an independent analysis, we observed statistically significant improvements across students in 2o ESO and 3o ESO. Students in 4o ESO demonstrated minimal change similar to the initial findings, and Bachillerato students lacked an equivalent control group for comparison. While this approach provided insights into potential workshop-related improvements in student performance (clearer in younger ages), it does have limitations. Namely, it does not account for external events that may have occurred during the year. We acknowledge that factors beyond the workshops might have also played a role.

Furthermore, our study saw the use of an ad hoc SM-SPS questionnaire based on other scales to capture students'

socio-emotional competencies in relation to SM education. As an ad hoc questionnaire, we found that this limited the analysis of the data from different perspectives and possible comparisons with similar previous studies. Finally, the questionnaire assessed the perceived socio-emotional competencies of the students, and there was no means of knowing whether the students used these abilities in their daily lives after the interventions.

As a final note, we want to note that the implementation of the simulated SM platform in schools faced resistance from some parents and educators who did not trust this method of SM education. Implementing virtual authentic learning experiences in schools may be more difficult until digital literacy is deemed essential for children's education [28].

D. Implications for Future Designs

Building on the insights gained from this study, future research and development could explore different directions to further enhance the effectiveness and reach of the NS approach for SM education.

Implementing SM education in authentic settings: Future designs that seek to incorporate educational SM platforms need to consider the challenge of balancing learning material with the distracting facet of SM. The integration of teacher control systems can allow instructors to restrict students from socializing and redirect students' focus to the learning material during classroom activities. Moreover, to ensure a safe learning environment, future designs should explore more sustainable solutions to handle inappropriate content uploaded by students. Integrating automated content review systems or adopting a peer-monitoring approach could help alleviate educators' workloads. Finally, such designs need to incorporate responsive design elements to allow students to access the platform from different types of devices to minimize the requirements for specific school equipment.

Learning design: The design of learning plans within such platforms should incorporate dedicated time for students to freely explore and interact with the social aspects of the platform. This will not only allow students to feel more natural when using the platform but will also facilitate better data collection to enable the assignment of personalized material, such as counter-narratives. By embracing students' contrasting perspectives within the platform, the learning experience can be enriched, encouraging students to question preconceived notions. Finally, careful consideration should be given to the session length, opting for shorter sessions to maximize students' attention and focus, thereby enhancing their involvement and overall learning outcomes.

Enhancing content delivery: Future efforts should focus on exploring the integration of artificial intelligence conversational agents. By integrating an intelligent virtual learning companion with enhanced conversational capabilities, the learning experience can be significantly enriched, resulting in higher levels of student engagement and active participation. While the incorporation of a more advanced companion based on generative artificial intelligence is a potential avenue for exploration, preliminary findings suggest that it may currently exhibit limited

reliability [73]. In addition, by leveraging machine learning techniques, we can create more advanced counter narrative approaches similar to those developed for countering hate speech [74]. Despite being in its early stages, this work shows great potential in benefiting various environments where countering harmful narratives is essential.

By incorporating these design implications and proactively addressing the limitations in future designs, the development of educational SM platforms has the potential to maximize learning outcomes, ensuring a safer, more effective, and engaging learning experience for students.

VI. CONCLUSION

In response to the growing need for SM education to step beyond traditional classrooms and embrace more innovative approaches that target both cognitive and emotional aspects, this article introduced the notion of NS. This novel technologically driven approach to SM education was specifically designed to guide adolescents through educational material within an authentic educational SM environment. The integration of narratives and CSCL activities within an authentic learning environment has been shown to be highly beneficial for adolescents, enabling them to acquire SMSPS. The feedback from the adolescents further confirmed a positive learning experience. The authentic approach taken by the NS represents a significant advancement in the field of SM education and paves the way for future interventions.

Our current and future works on NS include the evaluation of different learning formats (individual, collaborative, etc.) within the NS and the exploration of students' behavior within the platform to determine student engagement and social interactions. Finally, we are working on the creation of different NS scenarios to evaluate the effectiveness of the approach toward the acquisition of different sets of SM skills.

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