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The Use of AR in Secondary Education: Educational Augmented Reality Material to Enhance Students' Digital and Social Skills

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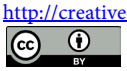


Abstract

The aim of this study was the design, the development and the evaluation of an innovative educational augmented reality (AR) material, in order to investigate the contribution of AR in increasing motivation and cooperation among secondary school students. At the same time, it was studied the possibility of enhancing the social and digital skills of the students in the context of an educational mobile learning scenario based on situated learning. The methodology that was used is Design-Based Research (DBR). Among other things, the usefulness and the ease of use of the material, its advantages, as well as the factors that could prevent its implementation in teaching practice were studied. Postgraduate students with excellent knowledge of ICT in education, teachers and secondary school students participated in its evaluation through interviews and questionnaires based on the Technology Acceptance Model (TAM). The major findings showed that the material achieves its purpose, develops skills, is easy to use and has been generally accepted by teachers and students; however, it requires improvements regarding its design and solutions for the technical access problems that arose during its practical implementation.

Keywords

Motivation, Cooperation, Design-Based Research, Mobile Learning

1. Introduction

In 21st century societies, the rapid spread of knowledge, the influence of the global market, the interdependence between people and the urgent use of technology have led to the need for acquisition of social and digital skills (Van Laar et al., 2017), which are basic for the future of education (Jackman et al., 2021)

and crucial for the development of the self and social life (Vila et al., 2021). Furthermore, the competitive job market demands workers with high qualifications regarding ICT, while security in cyberspace and privacy are some critical issues. The European Centre for the Development of Vocational Training stated that technology can influence the configuration of the competencies needed, but also a combination between "a healthy mix of cognitive (problem-solving, creativity, learning to learn) and socio-emotional (communication, collaboration) skills" (European Centre for the Development of Vocational Training, 2018: p. 15) are the key for future professional abilities. Nevertheless, there are only limited programs that achieve the correlation of knowledge with the development of social and digital skills (Jackman et al., 2021; Vila et al., 2021). Among other, factors that contribute to this situation are: 1) the teacher-centered methods; 2) the endorsement of competition and the lack of cooperation (Namaziandost et al., 2019); 3) the statical perception of knowledge (Koutromanos et al., 2020); 4) the lack of digital skills training for teachers (Napal-Fraile et al., 2018); and 5) the limited access to technological tools at schools (Tanik-Önal, 2021).

In order to overcome the above problems teachers need to design practices that connect goals to activities in formal and informal education in a way that will lead to meta-cognitive scaffolding (Dooly & Sadler, 2020). Between different techniques of education that could lead to this is the use of Information and Communication Technologies (ICT) in education, which offers significant advantages in user engagement, in social interaction and in increasing achievements via social motivated activities (Rashedi et al., 2022). Specifically, applications that are based in Augmented Reality (AR) can promote knowledge by using different senses of the user during activities in the context of a pedagogical scenario (Dooly & Sadler, 2020). Especially, Mobile Augmented Reality, i.e. AR which is accessible via mobile devices (Olsson et al., 2013), it is a widespread technology with significant advantages, providing added educational value in different educational environments (Garcia et al., 2018). Some of the elements that distinguish it from other digital technologies are the coupling of printed and virtual element (Radu, 2012), the visualization and the simulation of abstract concepts and facts, its ease of use, its promotion of human-computer interaction and its global spread in everyday applications in education, industry, etc. (Chen et al., 2019). Moreover, the promotion of storing selected information could satisfy global needs for online data storage (Chen et al., 2019) and may function as a perfectly organized digital library (Dalili-Saleh et al., 2022). At the same time AR through the realistic experience that offers, attracts more the interest of the user and leads to more effective learning (Chen et al., 2019).

Despite that, an essential need has emerged to investigate the development of AR applications according to the design principles of digital environments and to study their usability (Akçayır & Akçayır, 2017). Moreover, it is important to explore their association with activities that contribute to the construction of knowledge (Efstathiou et al., 2018) and to consider the use of different senses during the learning experience to cultivate skills, which are vital for learning and

innovation, everyday life, work and society nowadays (Papanastasiou et al., 2019).

The aim of this study was the design, development, and evaluation of an educational augmented reality material, in order to examine its contribution to increasing motivation and cooperation among secondary school students. Moreover, it was studied the possibility of enhancing the social and digital skills of the students in the context of an educational mobile learning scenario based on situated learning. The methodology that was used is Design-Based Research (DBR). Experts in ICT, teachers and students of secondary education from two different schools of Crete were the basic sample of the research. The objectives were to evaluate the educational augmented reality material in terms of its usefulness, its ease of use and the purpose it serves, to investigate its acceptance by teachers and students, to study the factors that prevent its utilization in the teaching practice, to examine the intention to use it in education in the future, to investigate the increase of motivation and cooperation among students and to highlight its advantages.

This article presents at Section 2, AR applications that were developed for pedagogical reasons in the past. Then, it describes the methodology of the research that was conducted at Section 3, the educational augmented reality material at Section 4 and finally the results of the evaluation at Section 5. Lastly, Section 6 proceeds to conclusions and Section 7 makes suggestions for future work.

2. AR Applications in Education

Augmented reality (AR) has been used in the past in different levels of education for humanity or science subjects with significant learning advantages and some limitations too (Pathania et al., 2023). Indicatively, a digital game called "Clavis Aurea", which is about the history of Naxos, uses mobile devices in order to augment the historical monuments (Koutromanos et al., 2020). The researchers found that the game increased students' motivation, because they made them feel positive feelings like joy, satisfaction and enthusiasm, while the interaction between them was better too (Koutromanos et al., 2020). Moreover, in the subject of Literature the use of AR is effective, because research showed that its use in teaching English increased the understanding of terms, made learning a pleasant experience, declined stress levels, reinforced imagination and creative thinking and improved unity and connection between students (Shaumiwaty et al., 2022; Wedyan et al., 2022). On the other hand, another app of AR could make a 3D visualization of the human body and was used for applying properly medical therapies (Ahmad et al., 2022). AR was used in Geography so that solar system and planets could be studied in details within the most updated software and also in Mathematics too helping students to acquire higher problem-solving abilities (Fitria, 2023). Lastly, AR use in Chemistry lead to perspicuous representation of the atoms in order to expand pupils' knowledge in this domain and finally in Computer Network Informatics in order to support future professionals to perceive adequately the topology of computer networks in a simpler and faster way (Fitria, 2023).

In Dechsling et al. (2022) review, it was observed that technologies like AR are promising regarding the development of social skills, because they promote social interplay and emotional skills. Moreover, in several studies it was found that even people with autism have been benefited by training social skills using augmented reality as an educational mean (Dechsling et al., 2022). Between others, Young et al. (2020) have built a chatbot, where children after talking to the virtual character, they changed their attitude towards school bullying. Kriglstein et al. (2020) designed two educational games that enhance the acquisition of appropriate behaviour and captivate children's interest. Another one is the "Bully", a virtual reality environment that attempts to help users handling everyday problems by practicing in simulation environments (Ivanov & Ramos, 2020).

As a result of the above, it was observed that there have been important attempts to use AR in education with encouraging outcomes. However, these applications need further improvements relevant to students' participation in the augmented reality experience including teamwork in a pedagogical context. Moreover, in accordance with Carlisle et al. (2021) a gap was spotted in digital skills counting the use of augmented reality as well. There have been designed educational programs that could develop the ICT skills of students (Jackman et al., 2021). Hence, the term "digital literacy" was not widely accepted in different countries, so as a consequence of this, the programs were not fully efficient, despite the fact that technology has been established in schools since COVID-19 pandemic (Jackman et al., 2021). Finally, the educational community is absent regarding the design and implementation of educational augmented reality applications incorporating them in their classroom. This study aims to fill in these research gaps.

3. Methodology

3.1. Sample and Data Collection

The sample of the research was consisted of experts in ICT, teachers and students of secondary education who participated gradually in different cycles of the formative evaluation of the educational augmented reality material as shown in more detail in **Table 1**. In particular, the main sample was 15 participants out of whom two were graduates, 12 were postgraduate students or holders of master's degree in various subjects related to educational technology and a PhD candidate in technology. Out of these, seven were teachers of secondary education.

Moreover, in the research participated 49 students from two secondary schools in Crete, out of which 18 (36.7%) were boys and 31 (63.2%) were girls. Out of these, nine (18.3%) had used augmented reality in two of their school courses in the past and one child had used it (2%) in three courses, while also nine (18.3%) had used augmented reality in one of their course this year and one child (2%) in three subjects. Finally, regarding the availability of mobile devices in school, 22 children (44.8%) answered positively. At the same time, the two teachers of

Table 1. Description of the stages and the actions of Design Based Research.

The stages of Design Based Research	Actions
Stage A: Recognition and analysis of the problem	• Review of the bibliography. • Study of the secondary school textbooks. • Search for the best design practices. • Investigation of schools' needs. • Collaboration with experts. • Formulation of aims, objectives and research questions.
Stage B: Design and development of the educational AR material	• Design of a mobile learning scenario. • Choice of educational background. • Selection of design principles for digital development environment. • Development of the material utilizing the platform Zapworks.
Stage C: Formative evaluation of the educational AR material	• Evaluation of the scenario by six teachers and three postgraduate students with excellent knowledge of Social Informatics. • Evaluation of the AR material in Marasleio School in Athens by 15 participants, i.e. teachers and postgraduate students and a PhD with specialization in educational technology. • Evaluation of the material in real conditions at two schools in Crete by 49 students and two teachers.

their classrooms took part in the research too. The first teacher is a mechanical engineer, 56 years old, has been teaching for 16 years and holds a master's degree. The second teacher is a philologist of Greek language, 39 years old, holder of a master's degree with 13 years of experience.

The data from the experts in ICT and the teachers were collected via interviews based on Technology Acceptance Model (TAM) (Davis, 1989), while the data from the students were extracted via pilot questionnaires based on TAM (Alfalah et al., 2020; Ghani et al., 2019; Shroff et al., 2011) and MARAM (Mikropoulos et al., 2022). Those that were collected through the interviews were analyzed using the method of thematic analysis, in the light of the constructivist-interpretative paradigm, because it interprets data with the ultimate goal of understanding the meaning they receive from a particular point of view or position. Specifically, after investigating their validity and correctness, their total volume was coded and then followed their categorization into thematic sections. Regarding the questionnaires, the validity of the data was checked and a descriptive quantitative analysis of them was performed through excel, while the open-ended questions were interpreted.

3.2. Research Procedure: Design-Based Research (DBR)

This study was conducted (January 2022-December 2022) relying on the me-

thodology of Design-Based Research (DBR), which aims to make interventions in order to solve a problem, is implemented in real conditions, produces conclusions and "learning theories" and includes iterative cycles of tests and assessments (Lyons et al., 2021). This methodology has been leveraged again to other research, related to augmented reality (AR) in education (Lee et al., 2023; Jia et al., 2023). **Table 1** presents the three main stages and the corresponding actions that were carried out in the current research, which included the identification of the problem and its analysis, followed by the design and the development of the augmented reality educational material and finally the iterative testing and formative evaluation of the material.

3.3. Stage A: Recognition and Analysis of the Problem

The purpose of the first stage was to investigate the problematic of the research, the needs addressing the deficiency, the best evidence from previous interventions, as well as the advantages of AR in relation to its added educational value. So, they were carried out: 1) a review of the bibliography 2) a study of programs and methods used before 3) an examination of the curriculum and textbooks 4) a study of best features and practices of AR applications and 5) a collaboration with experts and 6) an investigation of the schools' needs via the distribution of pilot questionnaires to 14 teachers and 14 students based on bibliography. The above methodological approaches highlighted the need to adopt, in teaching, more student-centered and experiential approaches, in accordance with situated learning with an emphasis on empathy, on cooperative activities and on using digital technology during learning. Additionally, this stage highlighted the necessity of designing and developing the educational augmented reality material, which takes as a case a mystery scenario regarding the social problem of bullying, in order to engage students in a certain context and learn through experience.

3.4. Stage B: Design and Development of the Educational AR Material

The second stage of the research concerns the design of the educational augmented reality material. Its content was based on the findings of the reconnaissance and problem analysis. Specifically, the first design stage of the material concerned the configuration of the its script, which required the analysis of the needs, the literature review, the curriculum, the study of already existing programs and technological tools and finally the delineation of the learning needs and objectives. Indicatively the goals were the cultivation of students' empathy, the highlighting of the advantages of AR applications, the dominance of these in the script and the emphasis on the active use of AR. Also, the material aimed to increase the motivation and cooperation of the students through active involvement, sought the adoption of student-centered approaches and leveraged situated learning to relate the scenario to real life so that students could be able to cope

with everyday problems. Additionally, among the skills it intended to cultivate were the social and digital skills.

After that, it was designed an illustrated scenario, which serves the objectives, utilizes the techniques of Social Pedagogy and contains a strong element of AR. Also, it was developed supporting material (e.g. newspaper, poster, comics, etc.). At the second stage regarding the configuration of the material it was conducted the selection of design principles and learning theories for the development of the material and the selection of technological tools. Specifically, it was based on the theory of "situated learning" (Lave & Wenger, 1991), where learners construct their knowledge through their experiences in the real world. Situated learning belongs to sociocultural theories and prepares the students to discover solutions to problems through their personal experience, so that they will be able to apply them when found in a similar context in everyday life (Renkl, 2001).

At the same time, for the smooth transfer of the students from the real conditions in augmented ones, which is a characteristic of mobile learning, were followed some design principles from the cognitive theory of "multimedia learning". Specifically, "the multimedia principle" was utilized, i.e. the presentation of words and images at the same time (Mayer, 2001), the "principle of coherence" in order to avoid burdening students with "unnecessary information" (Mayer, 2001) and the "signaling principle", which provides a trigger for more thorough processing of the material by the students, to acquire metacognitive skills (Mayer, 2001). Also, it was utilized the "principle of transferring control of learning to the student" (Clark & Mayer, 2008), the "cooperation principle", the "challenge principle", the "imagination principle" (Dunleavy, 2014) the "principle of integration", "the principle of empowerment", "the principle of flexibility" and "the principle of minimalism" (Cuendet et al., 2013) in order to strengthen the interaction of the students, to correlate the material with the analytical program and to adapt the process according to the students' answers avoiding redundancies (Cuendet et al., 2013).

Moreover, for the implementation of the theoretical background it was chosen to be utilized in the design the revised version of Bloom's taxonomy, which imparts dynamism to energy by transforming the nouns into verbs and aims in the acquisition of skills and methods, leading to metacognition within strategic planning, self-knowledge and finally foresees to the application of knowledge in other contexts (Armstrong, 2010). Finally, the development of the first version of the material was created via the zapworks designer platform (https://zap.works/designer/), which was used in order to augment posters, cards, notes and brochures with virtual elements, such as images, videos, links, sounds and padlets. These materials were placed in different strategic areas of the schools in order to contribute to the solution of the mystery via scanning the qr codes by mobile devices such as tablets and smartphones and for enhancing students' knowledge with new information and tasks that develop social and digital skills.

3.5. Stage C: Formative Evaluation of the Educational Augmented Reality Material

The last stage of the research included the formative evaluation of the educational augmented reality material, which consisted of iterative assessments and was conducted in three phases regarding the evaluation of the scenario, then evaluation of the prototype and finally the evaluation of the improved edition of the material which was implemented at two schools.

3.5.1. Phase A: Evaluation of the Scenario of the Educational Augmented Reality Material

The aim of phase A was to evaluate the satisfaction of the purpose of the material, its contribution to cooperation between students and to the increase of their motivation in learning. Moreover, it was examined the strengths and the weaknesses of the material, its content validity and its appropriateness for the age of the students. For this aim, an illustrated scenario of the augmented reality material was developed, which was presented to three postgraduate students with excellent knowledge of Social Informatics and to six secondary school teachers who answered to semi-structured questions. The results highlighted the advantages of AR in relation to other teaching methods and other technological applications, the completeness and the satisfaction of the script's purpose, its validity and appropriateness for the age group it targeted, its originality and the increase of motivation and cooperation. However, some parts of the material stood out, such as the newspaper and some instructions, which were considered difficult for children to understand. Moreover, the lack of time for the implementation of the script was emphasized, suggestions were made regarding the improvement of the material and also it was highlighted the need to prepare students for the use of technology applications before putting the material into practice. When the script was finalized, the material was developed through the zapworks designer platform.

3.5.2. Phase B: Evaluation of the Prototype in Practice

The aim of Phase B was the evaluation of the material in practice based on the Technology Acceptance Model (TAM) (Davis, 1989). Moreover, there were examined its correspondence to the purpose that was designed, the obstacles during its practical implementation and suggestions for improvement were made. Between the objectives were the investigation of the perceived ease of use of the material, its perceived usefulness, its perceived relative advantage in relation to other technologies, its perceived enjoyment, the facilitating conditions and the intention to be utilized in the future by teachers. The sample consisted of 15 experts in ICT, out of whom seven were teachers of secondary education. They came to the site of the Marasleio School in Athens, used the material in small groups on different dates and answered questions through interviews. The duration of the implementation of the material in practice was 90 minutes for each group. The results of the assessment led to the optimization of the material.

3.5.3. Phase C: Evaluation of the Educational Augmented Reality Material in Real Circumstances

The aim of the last phase of the formative evaluation was the evaluation of the material regarding the satisfaction of its purpose and the TAM model from 49 students and two teachers of secondary education. Among the objectives were its ease of use, its usefulness, its advantages, the enjoyment it offers, the facilitating conditions, the accessibility and its acceptance by teachers and students. The material was used by two public schools during two teaching hours in each subject. In particular, it was applied to second and third class of a junior High School in Anogia village during the Technology course and in second class of a High School in Heraklion, in Crete in the course of Modern Greek Language. At the end of the implementations the students answered to questionnaires and the teachers of the classrooms' were interviewed.

4. The Educational AR Material

The educational augmented reality material is designed for secondary education students. For its development, which is image-based, a teaching scenario was devised, which is about a mystery story that deals with solving the case of an immigrant girl, who has been bullied by her classmates and has disappeared from school. The aim of the students is to collect the clues, save the girl from her bullies and stop antisocial behaviour regarding the whole school community via specific tasks. Their assistant in this journey is a detective who guides them in order to discover new clues and to wonder about the problem of antisocial behaviour.

The scenario of the educational augmented reality material is structured in four individual phases, which include seven activities that take place inside and outside of the classroom enhancing typical and atypical education. To begin with, the students occasioned by augmented cards with videos about antisocial behavior learn about the phenomenon by discussing and answering questions in the padlet. Using the technique of compound stimulus they find the bullied girl's personal diary and they study the newspaper augmented with the visual detective, where they learn about the incident of bullying at their school (**Figure 1**). In this context the following activities continue outside of the classroom where students:

• Explore the area of school and find clues, such as comics, notes, newspapers, letters or posters (**Figure 2**), which are augmented with images, videos, hyperlinks and sounds and provide important information relevant to the signs, the causes and the consequences of antisocial behaviour.

• Create their own posters and conceptual maps using different padlets regarding children's rights via teams' interaction (**Figure 3**). Also, students learn about children's advocate and can become volunteers in an organization called "The Smile of the Child" helping other children or find useful phone numbers in case they are the victims.

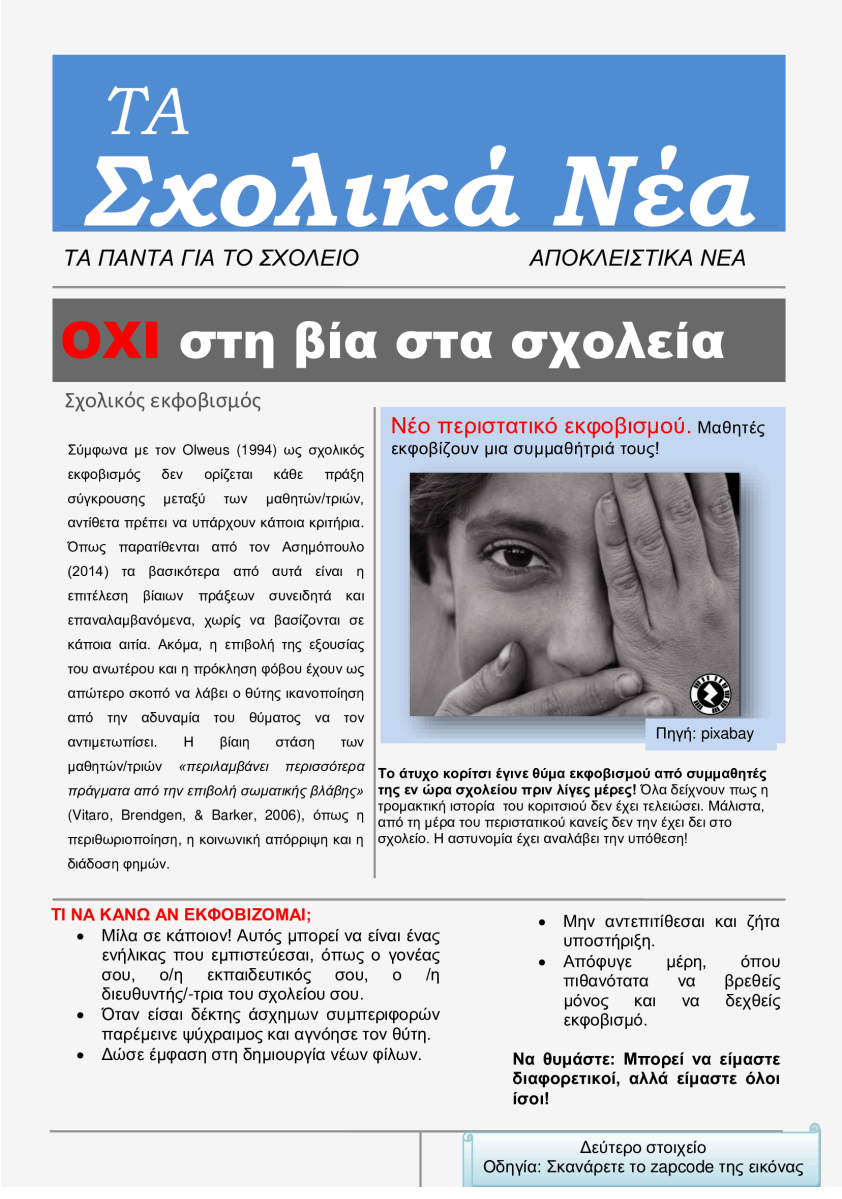
• Express their feelings about the situation via pictures of themselves (still image technique) accompanied with poems, songs or their own words in a padlet or via role playing.

• Find solutions to the problems via researching bibliography and via brainstorming and posting them in any way they wish, such as an image in a specific padlet.

• Participate in cooperative tasks and fill in quizzes, multiple choice or answer to open-ended questions in the worksheets (**Figure 4**).

• Fill in the mystery map of the story regarding the roles, the context, the clues and the solution of the mystery.

Finally, the scenario is completed inside the computer room by the creation of posters or comics augmented with students' videos or audio messages about anti-social behaviour campaign.


ΤΑ
Σχολικά Νέα
ΤΑ ΠΑΝΤΑ ΓΙΑ ΤΟ ΣΧΟΛΕΙΟ ΑΠΟΚΛΕΙΣΤΙΚΑ ΝΕΑ
ΟΧΙ στη βία στα σχολεία
Σχολικός εκφοβισμός
Σύμφωνα με τον Olweus (1994) ως σχολικός εκφοβισμός δεν ορίζεται κάθε πράξη σύγκρουσης μεταξύ των μαθητών/τριών, αντίθετα πρέπει να υπάρχουν κάποια κριτήρια. Όπως παρατίθενται από τον Ασημόπουλο (2014) τα βασικότερα από αυτά είναι η επιτέλεση βίαιων πράξεων συνειδητά και επαναλαμβανόμενα, χωρίς να βασίζονται σε κάποια αιτία. Ακόμα, η επιβολή της εξουσίας του ανωτέρου και η πρόκληση φόβου έχουν ως απώτερο σκοπό να λάβει ο θύτης ικανοποίηση από την αδυναμία του θύματος να τον αντιμετωπίσει. Η βίαιη στάση των μαθητών/τριών *«περιλαμβάνει περισσότερα πράγματα από την επιβολή σωματικής βλάβης»* (Vitaro, Brendgen, & Barker, 2006), όπως η περιθωριοποίηση, η κοινωνική απόρριψη και η διάδοση φημών.
Νέο περιστατικό εκφοβισμού. Μαθητές εκφοβίζουν μια συμμαθήτριά τους!
Πηγή: pixabay
Το άτυχο κορίτσι έγινε θύμα εκφοβισμού από συμμαθητές της εν ώρα σχολείου πριν λίγες μέρες! Όλα δείχνουν πως η τρομακτική ιστορία του κοριτσιού δεν έχει τελειώσει. Μάλιστα, από τη μέρα του περιστατικού κανείς δεν την έχει δει στο σχολείο. Η αστυνομία έχει αναλάβει την υπόθεση!
ΤΙ ΝΑ ΚΑΝΩ ΑΝ ΕΚΦΟΒΙΖΟΜΑΙ;
- Μίλα σε κάποιον! Αυτός μπορεί να είναι ένας ενήλικας που εμπιστεύεσαι, όπως ο γονέας σου, ο/η εκπαιδευτικός σου, ο /η διευθυντής/-τρια του σχολείου σου.
- Όταν είσαι δέκτης άσχημων συμπεριφορών παρέμεινε ψύχραιμος και αγνόησε τον θύτη.
- Δώσε έμφαση στη δημιουργία νέων φίλων.
- Μην αντεπιτίθεσαι και ζήτα υποστήριξη.
- Απόφυγε μέρη, όπου πιθανότατα να βρεθείς μόνος και να δεχθείς εκφοβισμό.

Να θυμάστε: Μπορεί να είμαστε διαφορετικοί, αλλά είμαστε όλοι ίσοι!
Δεύτερο στοιχείο
Οδηγία: Σκανάρετε το zapcode της εικόνας

Figure 1. The newspaper and the girl's diary.

Figure 2. Poster and comic.

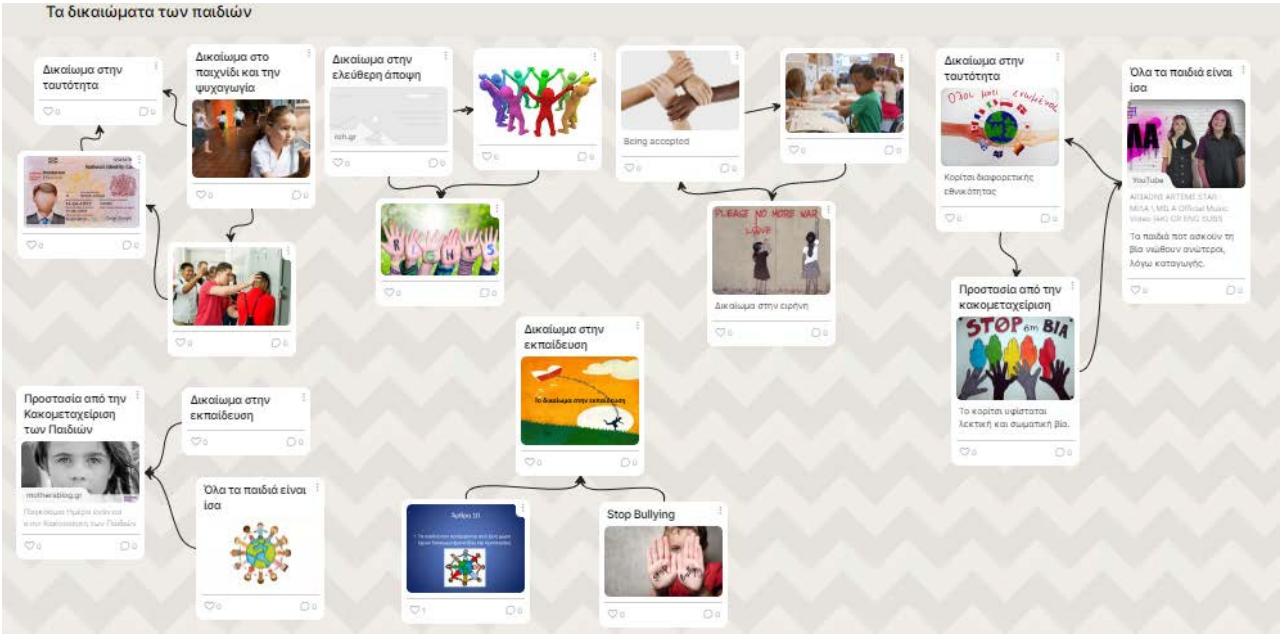
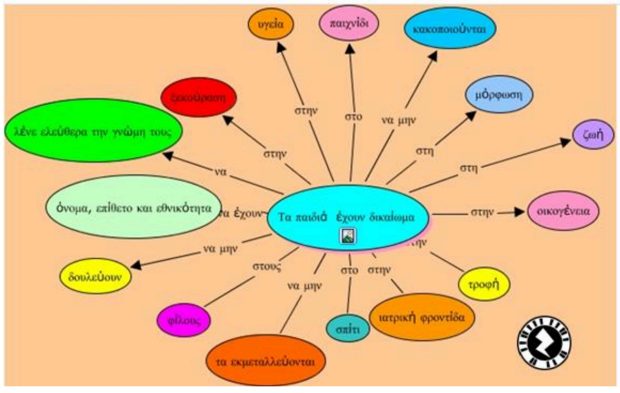


Figure 3. Padlet with conceptual maps about children's rights.

Β) Να αναπαραστήσετε τα συναισθήματα του θύματος με μια παγωμένη εικόνα. Συλλέξτε φωτογραφίες και ανεβάστε τες στο padlet που θα βρείτε ενσωματωμένο στο εικονίδιο. Κάτω από τις φωτογραφίες εκφράστε τα συναισθήματα που βιώσατε κατά την αναπαράσταση της ιστορίας με όποιον τρόπο θέλετε (με λόγια, με τραγούδια, με link από το youtube, με υπερσύνδεσμο ιστοσελίδας που σας αρέσει κ.ά.). Έχετε στη διάθεσή σας 10 λεπτά.

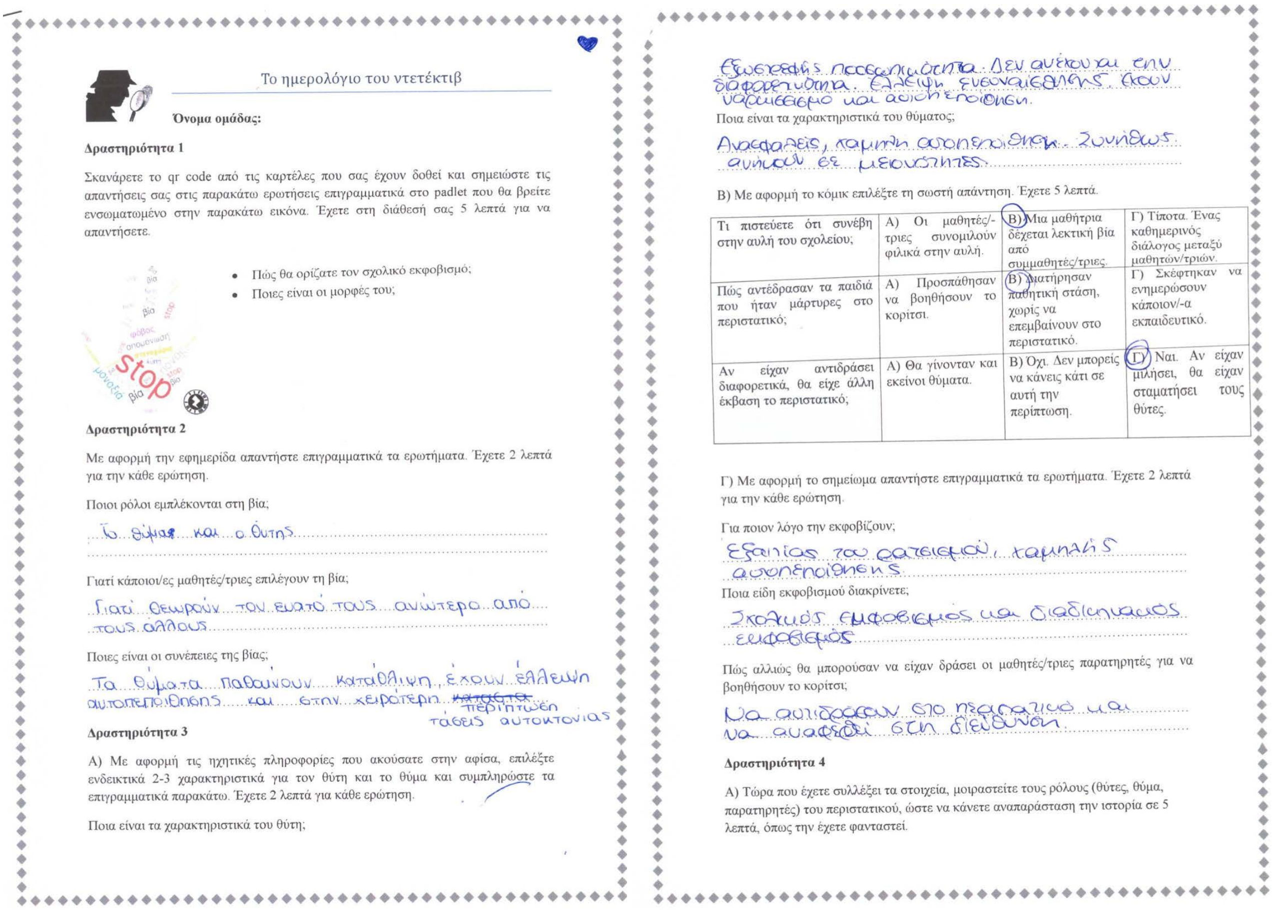
Δραστηριότητα 5

Κατευθυνθείτε προς την αίθουσα των υπολογιστών και αναζητήστε νέα στοιχεία στο email! Στη συνέχεια, αναλάβετε δράση και ενημερωθείτε για τα δικαιώματα του κοριτσιού και τα δικά σας.



Μελετήστε το υλικό που θα βρείτε στην παραπάνω εικόνα (5 λεπτά) και διαλέξτε 3 δικαιώματα που σχετίζονται με τον σχολικό εκφοβισμό. Στη συνέχεια, δημιουργήστε έναν εννοιολογικό χάρτη για τα ανθρώπινα δικαιώματα μέσω του padlet (καμβάς) που θα βρείτε στο παρακάτω εικονίδιο (10 λεπτά).

Οδηγίες: Στην κάθε ανάρτηση σας, θα επισυνάψετε μια φωτογραφία, ένα βίντεο ή έναν υπερσύνδεσμο σχετικό με το δικαίωμα που έχετε επιλέξει, στο θέμα θα αναγράψετε την ονομασία του δικαιώματος και κάτω από την ανάρτηση θα εξηγείτε για ποιον λόγο επιλέξατε το συγκεκριμένο δικαίωμα. Στη συνέχεια ενώστε τα δικαιώματα μεταξύ τους με το κουμπί *«Να γίνει σύνδεση με ανάρτηση»*. Μην ξεχάσετε να αναγράψετε το όνομα της ομάδας σας!



Το ημερολόγιο του ντετέκτιβ

Όνομα ομάδας:

Δραστηριότητα 1

Σκανάρετε το qr code από τις καρτέλες που σας έχουν δοθεί και σημειώστε τις απαντήσεις σας στις παρακάτω ερωτήσεις επιγραμματικά στο padlet που θα βρείτε ενσωματωμένο στην παρακάτω εικόνα. Έχετε στη διάθεσή σας 5 λεπτά για να απαντήσετε.

- Πώς θα ορίζατε τον σχολικό εκφοβισμό;
- Ποιες είναι οι μορφές του;

Δραστηριότητα 2

Με αφορμή την εφημερίδα απαντήστε επιγραμματικά τα ερωτήματα. Έχετε 2 λεπτά για την κάθε ερώτηση.

Ποιοι ρόλοι εμπλέκονται στη βία;

Το θύμα και ο θύτης

Γιατί κάποιοι/ες μαθητές/τριες επιλέγουν τη βία;

Γιατί θεωρούν τον εαυτό τους ανώτερο από τους άλλους

Ποιες είναι οι συνέπειες της βίας;

Τα θύματα παθαίνουν κατάθλιψη, έχουν έλλειψη αυτοπεποίθησης και στην χειρότερη ~~κατάστα~~ περίπτωση τάσεις αυτοκτονίας

Δραστηριότητα 3

Α) Με αφορμή τις ηχητικές πληροφορίες που ακούσατε στην αφίσα, επιλέξτε ενδεικτικά 2-3 χαρακτηριστικά για τον θύτη και το θύμα και συμπληρώστε τα επιγραμματικά παρακάτω. Έχετε 2 λεπτά για κάθε ερώτηση.

Ποια είναι τα χαρακτηριστικά του θύτη;

Εξωστρεφής προσωπικότητα. Δεν ανέχονται την διαφορετικότητα. Έλλειψη ενσυναίσθησης. Έχουν ναρκισσισμό και αυτοπεποίθηση.

Ποια είναι τα χαρακτηριστικά του θύματος;

Ανασφαλείς, χαμηλή αυτοπεποίθηση. Συνήθως ανήκουν σε μειονότητες.

Β) Με αφορμή το κόμικ επιλέξτε τη σωστή απάντηση. Έχετε 5 λεπτά.

Τι πιστεύετε ότι συνέβη στην αυλή του σχολείου;	Α) Οι μαθητές/-τριες συνομιλούν φιλικά στην αυλή.	Β) Μια μαθήτρια δέχεται λεκτική βία από συμμαθητές/τριες.	Γ) Τίποτα. Ένας καθημερινός διάλογος μεταξύ μαθητών/τριών.
Πώς αντέδρασαν τα παιδιά που ήταν μάρτυρες στο περιστατικό;	Α) Προσπάθησαν να βοηθήσουν το κορίτσι.	Β) Διατήρησαν παθητική στάση, χωρίς να επεμβαίνουν στο περιστατικό.	Γ) Σκέφτηκαν να ενημερώσουν κάποιον/-α εκπαιδευτικό.
Αν είχαν αντιδράσει διαφορετικά, θα είχε άλλη έκβαση το περιστατικό;	Α) Θα γίνονταν και εκείνοι θύματα.	Β) Όχι. Δεν μπορείς να κάνεις κάτι σε αυτή την περίπτωση.	Γ) Ναι. Αν είχαν μιλήσει, θα είχαν σταματήσει τους θύτες.

Γ) Με αφορμή το σημείωμα απαντήστε επιγραμματικά τα ερωτήματα. Έχετε 2 λεπτά για την κάθε ερώτηση.

Για ποιον λόγο την εκφοβίζουν;

Εξαιτίας του ρατσισμού, χαμηλής αυτοπεποίθησης

Ποια είδη εκφοβισμού διακρίνετε;

Σχολικός εκφοβισμός και διαδικτυακός εκφοβισμός

Πώς αλλιώς θα μπορούσαν να είχαν δράσει οι μαθητές/τριες παρατηρητές για να βοηθήσουν το κορίτσι;

Να αντιδράσουν στο περιστατικό και να αναφερθεί στη διεύθυνση.

Δραστηριότητα 4

Α) Τώρα που έχετε συλλέξει τα στοιχεία, μοιραστείτε τους ρόλους (θύτες, θύμα, παρατηρητές) του περιστατικού, ώστε να κάνετε αναπαράσταση την ιστορία σε 5 λεπτά, όπως την έχετε φανταστεί.

Figure 4. Selected pages from the students' worksheet.

In order to implement the above, the students were separated into small groups during the process, which has been shown to contribute to creating motivation (Holden & Sykes, 2011) and also encourages cooperative construction of knowledge. In addition, mobile devices were used (e.g. tablets, smartphones) as means of performing the process. Regarding the above, the situated learning, the inquiry-based learning, the game-based learning, the learning by doing and the learning by design were used during the progress of the scenario. Moreover, the material was designed based on revised Bloom's taxonomy, which is achieved by correlating the aims of the activities to specific tasks that lead gradually from term understanding to knowledge acquisition via different stages.

Furthermore, the students develop their digital skills (Tumbas et al., 2019: p. 9659) with competencies related to domains such as security, knowledge of information systems and data, creation of digital content, problem solving and communication and collaboration skills. These are observed in the design of the material through navigation, search and discussion of information and digital content from the internet, such as the rights of children, the smile of the child and the website of the child's advocate. The right management of the data and the development of critical thinking were enhanced through the questions in the padlets and on the worksheets, the interaction of students was promoted through

technology by discussing and having digital reactions and comments. Digital identity management was reinforced through naming the groups of students and following the rules of safe browsing, since everything is controlled by the teacher. Additionally, the development of digital content, such as the expression of opinions with different media (e.g. words, poems, songs, etc.), conceptual maps and images was promoted. Lastly, the creation of augmented material and the creative use of digital technologies for problem solving were achieved through the story of rescuing the girl from the bullies attempting to lead to the elimination of school bullying from the entire school. Social skills, such as communication, cooperation, empathy, engagement, self-control and problem solving are cultivated through group activities (e.g. conceptual map, brainstorming, role playing), dialogue, joint creations, respect for diversity of opinions, collective responsibility, etc. Finally, teamwork on activities for a common purpose through collaboration and positive experiences lead to the cultivation of the "socio-pedagogical ethos" and to the instillation of socio-pedagogical values, respect for otherness, democracy and equality.

5. Results

5.1. The Formative Evaluation of the Prototype from Experts in ICT in Education and Secondary School Teachers

As we have seen before, some of the objectives were the evaluation of the material regarding TAM, the purpose it serves, the increase of motivation and the obstacles that arose, but also suggestions for improvement by experts in ICT in education and secondary school teachers. Table 2 presents the data that were extracted from the qualitative analysis, which are classified in three thematic categories: 1) Technology Acceptance Model 2) Evaluation of the purpose of the material 3) Obstacles and Improvement proposals.

Table 2. Results B' Phase: Formative evaluation of the prototype from experts in ICT in education and secondary school teachers.

Thematic Categories	Codes
Technology Acceptance Model (TAM)	Perceived ease of use
	Perceived usefulness
	Perceived relative advantages in relation to other technologies
	Perceived Enjoyment
	Facilitation Conditions
	Intention
Evaluation of the purpose of the material	Completeness of purpose
	Empathy
	Attitude changes
	Increase of motivation and cooperation
Obstacles and Improvement proposals	Implementation obstacles
	Improvement proposals

5.1.1. Results of the Evaluation of the Material Based on TAM

Concerning the results of the evaluation of the material based on Technology Acceptance Model (TAM) they were divided into six subcategories as shown in Table 2. Regarding the perceived ease of use the material was considered user friendly as long as there are the appropriate tools and strong internet connection. Regarding the perceived usefulness it was considered useful in a large percentage, because it involves the students in learning, brings them into contact with diversity and creates identification for them through the script and prevents situations. Some indicative answers were the following:

"*Very usable*! *As long as there is technological equipment per student or per group of students*." (*Educator* 8)

"*Of course*, *I find it useful*…*It increases the involvement and the participation of students*…*they essentially take an active role*." (*Educator* 3)

The perceived relative advantages in relation to other technologies, are its experientiality, the interactivity and interaction it offers, its connection with space and events, the multimodality of the media it utilizes (e.g. image, video, sound) and the active role that sets the students. As for the levels of fun while learning, it has been found to increase them importantly, because it shows video and audio, while encouraging children to cooperate and seek the new knowledge on their own. It also stimulates their curiosity and makes use of multimedia and play-based learning to make students feel entertained. As it was referred:

"*With augmented reality*, *there's a variety*, *essentially*, *of media that you can use*…*a padlet*…*a video*, *an audio*, *a website*, *you can put anything you want*, *while with other digital media the variety is a bit limited*." (*Educator* 1)

"*It definitely increases them* (the levels of fun)…*through cooperation they have fun*." (*Educator* 3)

Some of the material's factors that created facilitating conditions were the multimedia, the mobile learning, the use of mobile devices, the hyperlinks, the worksheets, the visual aids and the qr codes. Moreover, the teachers' attitude is positive, because the material deals with one issue, which there is a need to be addressed and prevented in Greek schools in a way which attracts children's attention and makes them identify with the story and to be sensitized. Regarding the aforementioned some indicative answers are as following:

"…*so mobile learning is a facilitating element*…*and padlet and zappar can be handled* (by the students) *because they are already familiar with mobile devices*." (*Educator* 3)

"*My attitude is positive. I think it can help for its intended purpose was created and I think that we could use it as teacher's method*." (*Educator* 3)

5.1.2. Evaluation of the Purpose of the Material

The evaluation of the purpose of the material was divided into four subcategories 1) Completeness of purpose, 2) Empathy, 3) Attitude changes and 4) Increase of motivation and cooperation.

Regarding the relevance of the material to the purpose it serves it was judged that the material adequately informs about antisocial behaviour, through the

augmented reality and the experiential activities, which provide a lot of information to users, sensitizes them and attempted to change their mindset or enhance the already negative attitude towards antisocial behaviour. Some indicative answers are:

"*It informed me to a very great extent and indeed gave me information which I didn't know.* (*Educator* 5)

Yeah, I was against it (*antisocial behaviour*) *anyway, so it made it even stronger for me*." (*Educator* 4)

In terms of increasing motivation and cooperation, everyone agreed that the material increases children's motivation, because it presents a variety of supervisory means, sets them students in an active role and there is a strong image element. Also, the existence of technology alone is very attractive to students. Participants said the aforementioned:

"*Definitely for engagement too. For children engaging with enthusiasm, because they are interested in it* (these apps)…*also for learning.*" (*Educator* 2)

5.1.3. Technical Obstacles and Improvement Proposals

Some of the barriers to successful implementation of the material are the weak internet connection, the lack of mobile devices (e.g. smartphones, tablets) from schools due to the financial cost, the short teaching hours and the difficulty of application focusing in the zapcode. In addition, other obstacles are the teaching noise, the overcrowded classes, the classroom climate, the compulsory subject to be taught, leaving no free time for educational actions, the difficulty of cooperation between teachers, as well as their training in terms of technology, but also their mentality in terms of accepting something new. Some suggestions for improvement were the enlargement and separation of the zapcodes, so that are easily scanned and not confused with other images, as well as increasing time application of the material. Also, it was deemed necessary to have further instructions as to the order of zapcode scanning, as well as the existence of workstations for its processing material. Also, changes were proposed in some speeches, the introduction of quizzes on the sheet work, the further involvement of the arts and the need to take initiatives from them students to plan their own actions. Indicatively, the participants said:

"*It's a matter of logistical infrastructure and what means each school has regarding technology. First is this and second is that the teachers should have been trained in this part. In other words, education and the means.*" (*Educator* 12)

"*I would suggest more instruction…an introduction, if not they have learned in the beginning about the padlet and the scan…*" (*Educator* 11)

5.2. Formative Evaluation of the Material by Students and Teachers of Secondary Education

The aim of the last phase was the evaluation of the satisfaction of the material's purpose and its evaluation regarding TAM model. Among the objectives were its ease of use, its usefulness, its advantages, the enjoyment it offers, the facilitating

conditions, the accessibility and its acceptance by teachers and students.

5.2.1. Results of the Formative Evaluation of the Material Based on TAM by Secondary School Students

With reference to the aforementioned objectives, the relevant results were extracted in Table 3, which shows the descriptive statistics among the overall means (M) and standard deviations (SD) scores of the nine variables for secondary school students. Overall mean scores of the variables show that they range from 3.22 for perceived usefulness to 3.88 for perceived ease of use, which is relatively positive.

In more detail, in terms of students' views about the educational augmented reality material, the results showed that the material informs them (M = 4.32, SD = 0.987) in a high percent, however their awareness was moderate (M = 3.18, SD = 1.211), so it satisfied its purpose in a quite good percent (M = 3.87, SD = 1.434). It was generally considered easy to use by the students (M = 3.88, SD = 1.201). Then, regarding the perceived usefulness of the material, the students stated that it is useful (M=3.79, SD = 1.353) and cultivates some skills in high extent (e.g. understanding of the content, interaction with other students and teachers), while others in a lower extent (e.g. productivity at school), so the overall score was M = 3.22, SD = 1.500. In general, the students' attitude towards the material was positive (M = 3.54, SD = 1.432) and they stated many advantages of AR in the open ended question, such as the increase of motivation and cooperation, the involvement in learning and interaction. Some indicative answers are: "*Initially, this stuff is like a game and a lot more enjoyable than a video on YouTube which no child might see*" (Student 3), "*With augmented reality there is immediacy, unlike other technologies*"(Student 15), "*The interaction*" (Student 28), "*It helps me to understand it* (*the knowledge*) *better*" (Student 40). So, they intent to use it again in the future (M = 3.75, SD = 1.267), but the overall mean score was M = 3.31, SD = 1.363 due to problems in its practical implementation. They had fun (M = 3.69, SD = 1.342) but regarding facilitating conditions (M = 3.29, SD = 1.444) and accessibility (M = 3.24, SD = 1.250) they referred to technical difficulties, such as small number of devices, or weak internet connection.

5.2.2. Results of the Formative Evaluation of the Material Based on TAM by Secondary School Teachers

Table 4 presents the data that were extracted from qualitative analysis of the teachers who implemented the material in their classroom and observed the process, which are classified into two thematic categories: 1) Evaluation of purpose 2) TAM.

1) Results of the evaluation of the purpose of the material

The secondary school teachers agreed that the material offers completeness of information and satisfies its purpose to a large extent. However, in the piece of empathy it was considered medium, because the children were already concerned before, although the experiential piece contributed to the process. As it was indicatively quoted:

Table 3. Results C' Phase: Formative evaluation of the material based on TAM by secondary school students.

Categories	Variables	Number of phrases	M	SD
Evaluation of purpose	Evaluation of purpose	3	3.87	1.434
Technology Acceptance Model (TAM)	Perceived ease of use	5	3.88	1.201
	Perceived usefulness	6	3.22	1.500
	Attitude			
	Perceived relative advantages in relation to other technologies	5	3.54	1.432
	(Open-ended question)	1	-	-
	Intention	3	3.31	1.363
	Perceived Enjoyment	2	3.69	1.342
	Facilitating Conditions	3	3.29	1.444
	Accessibility	1	3.24	1.250

Table 4. Results C' Phase: Formative evaluation of the material by secondary school teachers.

Thematic categories	Codes
Evaluation of purpose	Evaluation of purpose
Technology Acceptance Model (TAM)	Perceived ease of use
	Perceived usefulness
	Perceived relative advantages in relation to other technologies
	Intention
	Perceived Enjoyment
	Facilitating Conditions
	Accessibility

"*Yes, it informed them in a very special way, an interactive way I would say. Original way.*" (*Educator* 1)

2) Results of the evaluation of the material based on Technology Acceptance Model (TAM)

Regarding the evaluation of the material based on Technology Acceptance Model TAM the results were divided into seven subcategories which are presented in **Table 4**. The analysis showed that the teachers consider it as an easy-to-use material, but it was undermined by technical difficulties. An indicative answer was:

"*The material is easy to use, but it presupposes that the school has good internet…and that the Tablets provided are updated.*" (*Educator* 1)

Teachers observed strong cooperation, participation, motivation and responsiveness of all students, even with the ones with learning disabilities (e.g. dyslexia, dispelling) and with possible autism. They responded more effectively than any other method they have used in the past. Moreover, the material increased

the motivation for learning and for cooperation. As a result of this, the teachers consider the material very useful. In addition, the teachers' attitude towards the material is positive and they believe that it will be good to implement it in other schools as well, if the technical problems are addressed. At the same time, they noticed that the students also liked the material, it increased motivation them in relation to passive teaching methods, however they were some technical difficulties. They indicatively quoted:

"*…I think it's good, because we can offer children a wealth of information… and in different media…I believe piqued their interest…It first gave them the opportunity to express themselves without ours the intervention…it was too much better than other tools…because it contained short and comprehensible texts, they also responded better children with learning disabilities.*" (*Educator* 2)

Among the advantages that make AR special are the increasing of students' interest, the autonomy of learning, the strengthening of interaction and teamwork and the cultivation of empathy. Moreover, AR conveys rich and useful information in a concise manner, combined with the personal search of the student, who otherwise wouldn't go through the process of searching. Another benefit is that teachers avoid the printing of many photocopies and the use of projectors. They showed high intention of re using the material. The intention of the teachers in the use of the material was positive and the permission to apply the material to the entire school community on the day against it school bullying was asked. They observed that students' had fun. Teachers responded that levels of fun while learning increased significantly through play, theater and teamwork. Regarding the aforementioned:

"*I consider it very positive* (*as a mean*), *that is, I think it is very good…*" (*Educator 2)*

"*…it can give you a lot of information in a very short and to say the least economical way, because you don't print something to give… And plus it also mobilizes the student's interest above into hear or see or read the information.*" (*Educator* 1)

"*It increased the levels of fun while learning…*" (*Educator* 1)

There is need for knowledge and tools. The factors that facilitate the utilization of the material in the classroom according to with teachers are good internet connection, updated mobile devices, the training of teachers and the familiarization of students. There were difficulties and accessibility issues, such as weak internet connection or lack of mobile devices, but they managed. As obstacles for the utilization of the material at school were the weak internet signal, the old mobile devices, the absence of logistical infrastructure, the short teaching hours and the noise of the classroom. In particular they stated:

"*…it's good to start to see the use of all these during the lesson and not let's just say that we have to be a projector or an interactive whiteboard.*" (*Educator* 2)

"*Poor internet connection and problems with Tablets. I was afraid the students wouldn't be familiar, but luckily they found it very easy.*" (*Educator* 1)

6. Discussion

In this research was designed, developed and evaluated an innovative educational augmented reality material in order to examine the increase of motivation for learning via AR, the promotion of cooperation and the enhancement of social and digital skills among students of secondary education. This material was evaluated in three phases from ICT experts, teachers and students of secondary education via interviews and questionnaires based on TAM. In general, the material satisfies its purpose and was rated relatively positive regarding the TAM parameters. These results are encouraging for future work in relevance with the development of AR applications for enhancing skills, taking into account the fact that the sample highlighted its advantages in the learning experience into the classroom, its innovative character and intends to use it again.

At the same time, according to the results, a great number of advantages of AR were highlighted, such as the stimulation of interest, the cultivation of imagination, the contribution to understanding and the enhancement of interaction. These findings are consistent with previous research's observations (Ho et al., 2011; Liu et al., 2009; Küçük et al., 2014). Moreover, AR increases motivation, attention and cooperation, but in terms of learning it cultivated some skills (e.g. team participation, increasing of motivation, communication and digital skills, interaction, deeper understanding of the material, imagination and creativity, language skills, democratic skills of dialogue and respect, ability to solve problems and taking personal and collective responsibility to a higher degree) in a higher degree and others in a lower degree (e.g. productivity, school performance). There is agreement with other research regarding the reinforcement of motivation for learning and cooperation (Chang et al., 2014; Perry, 2015). Although there is no similar research, from studies that have been conducted in the past about the teaching of a subject, it has been shown that the use of AR assists to the effectiveness of information taught about an issue, cultivates thinking (Koutromanos et al., 2020) and can change students' attitude (Kriglstein et al., 2020; Xue et al., 2021). The educational augmented reality material was considered easy to use and useful; however it was observed that due to lack of familiarity and time, students should be prepared in advance, while teachers should be trained too. The results are consistent with similar research that has used mobile AR for the teaching of a subject (Koutromanos et al., 2020; Ivanov & Ramos, 2020; Kriglstein et al., 2020). Students and teachers have a positive attitude towards the material, despite the technical difficulties that occurred through its practical implementation. Similar results were found in other research in relevance with other educational AR implementations (Cai et al., 2014). The most important obstacles to the utilization of the material in educational practice were the difficulty connecting to the internet, the lack of mobile devices (e.g. smart-

phones, tablets) at schools due to financial costs, the short teaching hours, the teaching noise, the crowded classrooms, the negative classroom climate, the volume of compulsory teaching material and the difficulty of cooperation between teachers of different specialties and finally the lack of training of teachers in terms of technology, but also their mentality in terms of accepting the new burden the implementation of the material. There is agreement with other research (Efstathiou et al., 2018; Koutromanos et al., 2020) regarding the observed obstacles. Nevertheless, students and teachers would use the material in the future. The intention was similar in other research about AR applications (Ivanov & Ramos, 2020). As suggestions for improving the material were the increase of the time of the activities, the easy to read zapcodes, the involvement of the arts and the complexity of the technological background. The above findings are consistent with other research (Efstathiou et al., 2018; Delello, 2014).

Moreover, students' digital skills were developed. These are seen in material's design (e.g. managing digital identity through team naming, developing digital content, and creatively leveraging digital technologies to solve problems). The above are consistent with the digital competencies (see DigComp 2.2, The Digital Competence framework for citizens). Furthermore, social skills, such as communication, cooperation, empathy, engagement, self-control, problem solving, dialogue, joint creations, respect for diversity of opinions and collective responsibility are cultivated through group activities (e.g. conceptual map, brainstorming). These findings are in accordance with research regarding social skills (Mylonakou-Keke, 2013, 2021; Winman, 2020; Hidalgo & Úcar, 2020; Olweus, 2005; Alevizos et al., 2015; Kholdarova, 2021; Little et al., 2017; Rashedi et al., 2022).

This research enriches the existing literature on applications of AR in education, which are applied in real conditions and adds new data regarding its utilization for socio-pedagogical purpose. However, there are some limitations. One of the limitations of the research is the convenient sampling and for this reason the results cannot be generalized. In addition, technical problems such as weak internet connection created difficulties in the smooth transition of the scenario, as there was movement in space. Also, the small number of mobile devices distributed to students made the process difficult. Moreover, it was seen that strictly two teaching hours defined by the Institute of Educational Policy, are not enough for the full development of the material. Therefore, future research should take into account these limitations.

7. Conclusion and Future Work

The present research enhances current knowledge on the educational use of AR in classrooms and presents new data regarding its utilization for enhancing social and digital skills, as it is one of the first efforts to develop such material. Moreover, the results of the quantitative and qualitative analysis showed that the most variables were confirmed and the findings were encouraging regarding the

satisfaction of the objectives and the material's acceptance. Alongside, the educational value of AR was demonstrated in practice, when properly utilized. Overall, this innovative educational AR material could become a bulwark for future research regarding the AR and the enhancement of skills in secondary education, and also could be expanded by adding more variables according to the needs of the future society.

Future research should consider the application of the material to larger samples and in more schools. Still, there is scope for improving the material in terms of its ease of use, solving technical problems and the way of presenting it. Upgrading the technological background could be an important element in a subsequent redesign. It is also suggested to study the parameters that could be improved on the design of the material. Furthermore, the skills and knowledge required by the teachers and the students in order to design their own augmented learning materials or tasks should be examined. Finally, it should be taken into consideration the effectiveness of the methodology in interdisciplinary research of socio-pedagogical content.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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