THE DESIGN OF A TRAINING PROGRAM ON IMMERSIVE TECHNOLOGIES IN TRANSDISCIPLINARY STEAM EDUCATION

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Abstract

This paper presents the theoretical framework, design, and evaluation of an online training program on immersive technologies for education, which was based on the participatory design and STEAM education approaches and targeted in-service teachers and university students from various STEAM fields. Findings based on a survey that was administered at the end of the program showed that the approach was successful in terms of participants' perceived learning and that transdisciplinary collaboration in the context of hands-on design and application tasks were two important features that contributed to participants' satisfaction.

Keywords: training program, immersive technologies, participatory design, STEAM education, in-service teachers, university students.

1 INTRODUCTION

This paper presents the theoretical framework, design, and evaluation of an online training program on immersive technologies for education, which targeted in-service teachers and university students from various STEAM (Science, Technology, Engineering, Arts, and Mathematics) fields. The training program was developed by the Erasmus+ KA203 Project, *ImTech4Ed: Immersive Technologies for Education (agreement* 2020-1-DE01-KA203-005679)[1], which aims at increasing the educational integration of serious games and other immersive technologies at the school level by promoting the interdisciplinary and international collaboration between researchers, in-service teachers and university students in computing, game design, and education.

The project adopts the participatory design (PD) framework [1] and engages practicing teachers and university students in the co-design of technologies, to enable them to both contribute and benefit from the process. Participatory design is a common practice in fields such as informatics and involves product users in the design, to ensure the usability, acceptability, and effectiveness of the final product [1]. Recently it has been adopted in the learning sciences, as an approach that can successfully support teacher professional development for the implementation of technology-driven educational interventions and reforms, because it is expected that it can help teachers gain ownership of new ideas and practices [2], [3], [4]. In teacher professional development contexts, PD involves interdisciplinary teams of teachers, researchers, and other professionals (e.g., disciplinary experts) in the co-design of technology-enhanced curriculum materials and learning environments [3], [4]. The ImTech4Ed project builds upon recent approaches in interdisciplinary game design education, involving the cross-disciplinary collaboration of programmers, designers, and artists [5], and takes the PD approach forward by also including educational science, computer science and game design university students. It is expected that in-service teachers and education students will gain a better understanding of the potential of state-of-the-art technologies for student learning, while game design and computer science students will both contribute their design and technical skills, respectively, as well as benefit from the contributions and perspectives provided by their education counterparts. It is also expected that utilizing educational, technological, and design-oriented perspectives may increase creativity in the design and use of immersive technologies as well as lead to usable technological solutions that are more likely to be integrated in educational practice.

In addition, the project has adopted a STEAM education approach. STEAM education is an extension of the interdisciplinary STEM model through the addition of the arts [6], which include performing and fine arts as well as linguistics and liberal arts. The STEAM approach recognizes that the qualities of

[1]https://imtech4ed.eu/

the arts, including creativity and unconventional thinking, can fuel the scientific community, but also society at large, with interesting and innovative ideas and approaches [7]. A key feature of the STEAM methodology is transdisciplinarity, which focuses on addressing authentic problems through the complex use of conceptual and methodological tools across all disciplines [7]. As a holistic approach, STEAM education is considered more appropriate for the study of complex modern societal problems and is expected to support the development of creativity and other important 21st century skills in students [8].

The training program on immersive technologies was offered online in the spring term of 2022 and included five 2-hour synchronous sessions and optional asynchronous learning activities provided via an e-learning platform that was built to support the training process. Program content was organized in four modules addressing topics relevant to STEAM education, game-based learning, and authorware tools. A brief description of the modules and the five online sessions is presented in Table 1.

Table 1. ImTech4Ed training program structure.

Module	Online Session Content
1. Introduction to STEAM education	1. Theoretical framework and pedagogical models of STEAM education.
2. Game-based STEAM education	2. Theoretical foundations and pedagogical practices of game-based learning. Quality characteristics of learning games.
3. Exploring authorware tools	3. The Augmented Reality educational platform ARTutor.
	4. Immersive learning prototypes, game types and game design.
4. Applying the ImTech4Ed approach in the classroom	5. Design of STEAM education scenarios using concepts and ideas from previous modules.

For each of the four modules, learners were provided with study guides describing the content, learning objectives, learning activities, essential readings, links to useful resources, and references for further study, which complemented the content of the online sessions. The module study guides and all the learning activities and resources were available on the e-learning platform. The synchronous online sessions involved presentations of key concepts, group activities, and whole-class discussions. In the group activities, teams included participants with different backgrounds (e.g., students in education and computing collaborated with in-service teachers) and tasks required the critical application of the ideas that were formerly presented in the online session or/and the design of solutions (e.g., a proposal for a learning game for STEAM education, an outline of a STEAM education scenario, etc.). After a group activity, teams presented their work in whole-class discussion. To evaluate the success and potential of the methodological approach that was adopted in the program, in the last online session participants were asked to provide their views and comments on their experience by completing an online questionnaire.

2 METHODOLOGY

The participants of the training program included educators, mainly teachers working in the project partner secondary schools in Cyprus and Greece, as well as university students who were recruited via a call-for-participation flyer that circulated in the undergraduate and graduate programs of STEAM fields in the project partner universities (in Cyprus, Greece, and Germany). Initially, one hundred in-service teachers and university students from various EU countries expressed interest in the ImTech4Ed training program. Subsequently, seventy-one (71) persons registered and logged-in the project's e-learning platform, and of those, a total of 43 persons (20 practitioners and 23 students) attended at least four sessions, thereby completing the minimum program participation requirements.

An online survey was used to evaluate participants' satisfaction and the effectiveness of the training program. The survey included seven questions on demographics and 13 questions inquiring about participants' satisfaction and their views on various aspects of the program and their contribution to

their learning. Also, teachers were asked to respond to two additional questions regarding their readiness to incorporate emerging technologies in their teaching.

Thirty-eight (88,4%) of the active participants who completed the online training responded to the survey. The majority of the respondents were female (71%), aged 18-40 (44.7% were 18-30 years old and 26.3% were 31-40 years old), held a post-graduate degree (52.6%) and were schoolteachers (52.6%), while the majority of the students (61.1%) majored in computer science. Also, participants were located in Greece (68.4%), Cyprus (26.3%) and Germany (5.3%).

3 RESULTS

3.1 Participants' Satisfaction with the Program and its Learning Outcomes

Overall, as Table 2 shows, learners expressed high levels of satisfaction with most aspects of the program, including the topics and the tools that were introduced as well as the duration of the program and its sessions. Also, 57.9% thought that the program met their expectations to a high or very high degree and 89.5% responded that they would recommend the program to others. Participants rated very positively the program's contribution to their learning (see Table 3): they thought that presentations and activities in the online sessions were interesting, that they addressed ideas and issues relevant to practice, and that their knowledge and skills in the areas addressed by the program were improved.

Table 2. Percentage of participants who were "very" or "extremely satisfied" with program elements.

	Teachers (%)	Students (%)	All (%)
Program duration	75	50	63.2
Session duration	70	50	60.5
Time allocation in session	50	27.8	39.5
Instructional materials	65	38.8	52.6
Technological tools introduced	80	55.5	68.4
Topic 1: STEAM education	70	38.9	55.3
Topic 2: Game-based learning	70	55.5	63.2
Topic 3: Augmented reality tools	80	55.5	68.4
Topic 4: Game prototypes	65	66.7	65.8
Topic 5: Applying ImTech in the classroom	85	50	68.4

Table 3. Percentage of participants who "agreed" or "absolutely agreed" with statements about program learning.

	Teachers (%)	Students (%)	All (%)
Presentations were interesting	95	77.8	86.8
Group activities were interesting	95	88.9	92.1
Topics satisfactorily analysed by moderators	90	61.1	76.3
Ideas could be implemented in practice	90	100	94.7
Practical issues were addressed	75	77.8	76.3
My knowledge and skills improved	90	77.7	84.2
Background on educational ImTech use improved	90	88.9	89.5

In-service teachers tended to express more positive views compared to university students. It is interesting, however, to note that more than half of the students rated very highly the motivational and

learning aspects of the program (see Table 3) and responded that they were very or extremely satisfied with the topics and the technological tools it addressed. It also appears that teachers were more satisfied than students with topics that were relevant to pedagogy, such as STEAM education and classroom applications of the ideas and tools presented (topics 1, 2, 3 and 5 presented in Table 2), which can be interpreted by the fact that many of the students who responded to the survey were not necessarily planning to work in education (they majored in computing and in game design or programming). In addition, although the asynchronous learning activities, most of which included independent study, were optional, all students and teachers reported that they had spent time to study the materials provided on the e-learning platform. About half of them (44.7%), both teachers and students, claimed that they had devoted at least six study hours.

3.2 Participants' Views About the Design of the Program

At least 90% of the teachers and 83.3% of the students rated positively the learning platform relative to its structure, navigation, tools, and text descriptions. In addition, most teachers and students thought that the educational materials that were provided via the e-learning platform and the online sessions contributed to their professional development, considering particularly important the suggested activities, the texts that were prepared for the purposes of the program, and the videos (see Table 4).

Participants' responses to the open-ended questions of the survey, which asked them to indicate the most positive and the most negative aspects of the program, are particularly interesting. Based on Table 5, which summarizes the most common views about the program positive aspects, participants rated highly the collaborative and practical aspect of the learning activities, which provided learners with the opportunity to exchange ideas with others and to work on tasks that required the application of theoretical ideas on practical issues. Teachers and students appeared to enjoy equally the presentation of technological tools and applications and, albeit to a lesser extent, the introduction to relevant theoretical ideas and concepts. Collaboration was particularly important for students, half of whom rated it as one of the most positive aspects of the program. Also, several students and teachers commented that being able to interact with professionals or with people having different backgrounds was particularly positive for them, as the following excerpts from two teachers and two students show:

Teacher A: "The collaboration and listening to other colleagues' ideas, as well as to the university students who are game based researchers."

Teacher B: "… and it had group activities (that) gave us the chance to collaborate with different professionals."

Student A: "Collaboration of educators and students."

Student B: "Get to know how people from other disciplines think and to learn new things (about teaching, especially since I am not a teacher)."

Table 4. Percentage of learners responding that program aspects were "important" or "very important" for their professional development.

	Teachers (%)	Students (%)	All (%)
Educational texts	75	72.3	73.7
Videos	75	77.8	76.3
Suggested activities	80	83.3	81.6
Suggested bibliography	45	61.1	52.6
Online session recordings	65	55.5	60.5

Eleven participants thought that there were no negative aspects in the program. Comments on the negative aspects were harder to group into categories because many of them addressed a unique feature of the program. Some comments concentrated on the time that was allocated for the group activities, which was considered insufficient (n=6) given that tasks required exploration of resources

and negotiation of ideas while at the same time group members were not acquainted with each other and had to communicate in English. Also, some participants (n=5) thought that less time should be devoted to theoretical issues while others (n=5) found some topics complex and would benefit from longer presentations and further analysis. The last two groups of comments may relate to the fact that the program involved participants with diverse characteristics and background knowledge relative to program topics.

Table 5. A summary of participants' views regarding the most positive aspects of the program.

	Teachers (n)	Students (n)	All (n)
Technological tools presented	7	5	12
Hands-on/practical activities	11	2	13
Collaboration/break into groups activities	6	9	15
Ideas/concepts presented	5	4	9
Learning resources	3	2	5

4 CONCLUSIONS

This paper presents the design and evaluation of an online training program on immersive technologies for education, which addressed a diverse group of participants, including in-service teachers as well as educational science, computer science and game design university students. The program was based on the frameworks of transdisciplinary STEAM education and participatory design, and learners were asked to work collaboratively on tasks that utilized their diverse backgrounds and areas of expertise. Although participant diversity in background knowledge, interest and learning needs can present challenges to the implementation and success of a learning program, participants' responses to the evaluation survey showed that, overall, they considered the program effective and appreciated its design.

Not only in-service teachers but also university students rated very favourably the contribution of the program to their professional development and learning. Also, they appeared motivated to engage with its content and activities, despite that most of the students majored in computing and game design and were not necessarily planning a career in education after graduation. In addition, many teachers and university students appreciated both the opportunities for transdisciplinary collaboration that were offered by the program and the learning tasks in which they engaged, because the latter required the application of theoretical knowledge and technological tools to real-life problems and situations. Both these elements (transdisciplinary collaboration and "hands-on" design tasks) are essential ingredients of the program's theoretical framework, and it is very encouraging that many participants mentioned these two elements when they were asked to describe the most positive aspects of the program.

Finally, another interesting finding is that both university students and teachers were comfortable with the online delivery of the program. This factor, which is probably related to the distance learning experiences that all participants had acquired during the Covid-19 pandemic, is important for the organization of similar initiatives in the future, because programs that connect people online are easier to implement, may benefit larger numbers of learners, and provide opportunities for transnational participation.

In conclusion, the online training program was successful, showing that bringing together teachers and university students can lead to fruitful transdisciplinary collaborations and that there is indeed a need for this approach.

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