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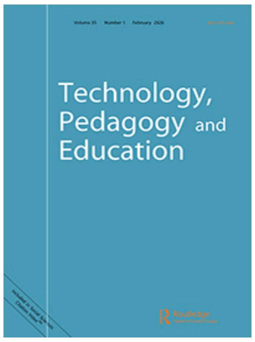

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The changing perceptions of virtual reality technology amongst elementary school teacher candidates

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ABSTRACT

This research aims to reveal the changing perceptions of elementary school teacher candidates who participated in online virtual reality (VR) training. The research consists of a qualitative study of 30 elementary school teacher candidates. Data was collected at the start of the course using a demographic information form and an online opinion form. The teacher candidates in the study participated in four-day online courses and recompleted the same opinion form at the end. The data was analysed by the deductive content analytical method. It was found from the research that elementary school teacher candidates had developed basic technical abilities and a profound awareness of VR technology in their future teacher training. It was also concluded that the training given to the classroom teacher candidates is effective in developing an innovative perspective and raising awareness of how VR can be incorporated in teaching.

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KEYWORDS
Virtual reality; elementary school teacher candidates; innovative technologies; teacher education; online training

Introduction

Virtual reality (VR) has been increasingly integrated into educational processes over the past decade. The affordability of hardware, the emergence of web-based design environments and the availability of free applications have all contributed to a growing interest in this innovative technology in both schools and higher education. Additionally, through the utilisation of platforms such as CospaceEdu and InstaVR, teachers and students are able to create, and engage with, their own virtual reality environments by using affordable, and mobile phone-compatible, VR goggles. Recent studies indicate that the prevalence of VR environments in education has led to a strengthening of instructional processes and the creation of innovative teaching opportunities. According to these findings, the technology allows students to observe events and places that they wouldn't otherwise have access to, understand abstract models, conduct unlimited trials and progress at their own pace, thereby supporting the development of cognitive and affective skills (Chen et al., 2020; Cooper & Thong, 2019; Gandolfi et al., 2021; McGarr, 2021; Merchant et al., 2014; Mikropoulos & Natsis, 2011).

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Teachers play a crucial role in the transformation of education through the integration of VR technology. As suggested by Farrell et al. (2022), successful adoption of pedagogical innovations in the classroom depends on teachers being willing to accept and experiment with new technologies. It is therefore of utmost importance to enhance teacher candidates' (TCs') awareness of the use of VR technology and support them in their training in regard to its integration into their teaching practices. In other words, after TCs have been introduced to VR, it is essential that they be guided and supported by professionals so they can develop the necessary attitudes, skills and specific strategies required for its effective implementation (Ferdig et al., 2018; Tondeur et al., 2017).

Despite existing studies introducing TCs to VR technology (see Bower et al., 2020; Geng et al., 2021; Patterson & Han, 2019), there is limited availability of effective training programmes and support processes, and this situation highlights a significant gap in the literature. Ali and Ferdig (2002) emphasised that teachers face challenges in integrating newer technologies, such as VR, due to their unfamiliarity with the technology, lack of confidence in applying it in the classroom and limited access to workshops or support training. This raises the crucial question of how TCs can be best trained in the use of VR technology.

The current study is aware of this gap in the literature, and so aims to investigate the impact of an online professional development training programme which is designed to introduce TCs to VR technology, as well as provide them with a valuable learning experience. Specifically, the study will address the following research question:

- How does online professional development training influence TCs' perceptions of VR technologies and the integration of VR technologies in education?

To address the main research question, this study will examine the changes in teacher candidates' understanding in three key dimensions by the end of the training programme: (1) the features and power of VR technology, (2) the contribution of VR technology to the learning and teaching process, and (3) the fields or topics into which VR technology can be integrated. Thus, in addition to assessing the changes in teacher candidates by the end of the training programme, the detailed design and process of the training programme will also be elaborated. This will provide valuable insights for guiding future studies.

Literature review

Virtual reality (VR) enables users to interact with a computer-generated, three-dimensional (3D) environment which is usually accessed through wearable devices that create a strong impression of actually being there (Choi et al., 2015; Frydenberg & Andone, 2019). The psychological sense of presence created by this computer-generated environment enables a user to autonomously navigate around a VR as avatars, as well as interact with simulated objects and other avatars in real-time and at the same pace (Mitchell et al., 2007). Moreover, the use of wearable technologies allows individuals to immerse themselves in interactive and immersive experiences within these virtual environments (Meritt et al., 2015; Schultheis & Rizzo, 2001).

Numerous studies can be found in the literature which utilise VR technology to address learning difficulties and enhance the learning process (see Bailenson et al., 2008; Freina & Ott, 2015; Shu et al., 2018; Stavroulia et al., 2017). The potential of VR technology in these studies can be summarised as enabling students to embody abstract concepts (Chen et al., 2020; Sala, 2013) and provide them with opportunities to experience rare, dangerous and challenging scenarios (Boyles, 2017, Nadolny et al., 2013). It is suggested that by immersing themselves in a VR environment, students are able to experience nearly the same physiological and cognitive responses as they would in the real world (Lamb & Etopio, 2020). Stavroulia et al. (2017) emphasised in their study that VR technology offers unlimited possibilities for repetition in the learning process, thus simulating real-life situations without any negative consequences. Similarly, Lamb et al. (2018) concluded from their research that VR technology provides students with repeatable and low-risk environments, allowing them to explore, benefit from feedback and make mistakes with minimal adverse consequences. All of these features suggest that VR technology can provide an ideal learning environment that greatly surpasses what traditional educational methods can provide (Bailenson et al., 2008). In summary, teaching processes enriched with virtual reality technology in the classroom may be more effective than traditional methods, particularly for subjects that are better learned through hands-on experience, are difficult, costly or dangerous to bring into the classroom, require close observation or are expected to evoke emotional responses in individuals.

Virtual reality and student-teachers

Although the number of studies highlighting the potential of new technologies, such as VR, has increased over time, there remain several barriers which prevent effective integration of these technologies into education for both teachers and TCs. These barriers can be categorised as internal factors, the encompassing of teachers' and TCs' competencies, perceptions, beliefs, willingness, expectations, attitudes and design skills. Other barriers are due to external factors, including direct or indirect experiences, as well as support and training, access to resources, infrastructure, management, government and culture (Ertmer et al., 2012; Instefjord & Munthe, 2017; Laurillard et al., 2018; Martinovic & Zhang, 2012; Vongkulluksn et al., 2018). It is essential that these barriers be addressed for an effective integration process. It is essential to provide TC with supportive processes and activities beyond the curriculum during their teacher education. This ensures that, upon graduation, they perceive themselves as confident, competent and proficient in the context of new technology integration. Numerous studies in the literature emphasise the significance of these supportive processes, particularly in overcoming internal barriers to integration (Bower et al., 2020; Farjon et al., 2019; Instefjord & Munthe, 2017). For instance, Bower et al. (2020) have highlighted the effectiveness of a well-designed preservice teacher education programme in addressing preservice teacher beliefs and conceptions regarding Immersive Virtual Reality (IVR) and subsequently impacting professional practice and student learning. There is no doubt that it is of great importance to expose TCs to firsthand opportunities provided by VR during the teacher education process so that knowledge and skills in various disciplinary fields can be enhanced. A study by Lee and Shea (2020) similarly found that when teachers are introduced to new technologies, such as VR, and provided with the necessary informed support during the teacher education process, their self-efficacy and willingness to use the new technology in future lessons increase.

All these studies underscore the importance of supporting TCs in the effective integration of technology in their teaching. By designing a well-structured online training programme, we aim to introduce TCs to VR, a new technology they have never encountered before, and raise their awareness of its use in education. This programme will provide them with basic knowledge, vision and skills related to the use of VR and provide basic opportunities to develop practice. The impact of the training on the TCs and the changes in their perceptions of VR technology will be evaluated at the end of the process.

Method

A qualitative research approach was used in a case study of a four-day online training programme. The case study demonstrates the change that occurred in the perceptions of TCs regarding VR technology before and after the programme.

Study group

The aim of the online training programme was to increase elementary school TCs' awareness of VR technology. Of the 173 TCs who filled out the online application form, 30 candidates were selected based on criteria such as gender, grade level, university and not having previous VR experience. The most important criterion for the selection of participants was that they had not previously received training in VR technology, i.e. the participants' lack of knowledge and experience with this technology was an important selection criterion. In addition, to control for possible effects in group studies, an equal distribution of participants in terms of both gender and year was considered. Based on the idea that the more the study group is enriched with students continuing their education in different contexts, the more representative and generalisable the data obtained can be for Turkey as a whole, the participants were selected from different universities according to the above-mentioned criteria. A total of 30 elementary school TCs from 27 different universities in Turkey participated in the training. Demographic information regarding these candidates can be seen in Table 1.

According to Table 1, 70% of the TCs were female and 30% were male. Of the TCs, 43.33% were 3rd-grade students and 56.67% were 4th-grade students.

Table 1. The demographics of the study group.

Variables		*f*	%
Gender	Female	21	70
	Male	9	30
Grade Level	3rd grade	13	43.33
	4th grade	17	56.67
Total		30	100

Implementation process

The pre-training process was planned based on Roblyer and Doering's (2013) 'Technology Integration Planning' (TIP) model, which aims to provide teachers with comprehensive technology integration. Each step suggested by the model represents the most effective process of using technology to meet the needs of the teaching environment. The stages of the model are as follows: Phase 1. Determining relative advantages; Phase 2: Deciding on objectives; Phase 3: Design of integration strategies; Phase 4: Preparation of the instructional environment; and Phase 5: The evaluation and revision of integration strategies. In the preparation phase, the following steps were carried out according to the TIP model:

Phase 1. Determining relative advantages

The researchers initiated the process by discussing the limitations of technology integration in education, the necessity of using VR in educational contexts, the power and significance of this technology, its strengths and weaknesses, and the specific needs of TCs. After clarifying the integration challenges and the relative advantages of using VR in education, the process moved on to the second phase.

Phase 2. Deciding on objectives

The objectives, skills and methods for evaluating the training were established in this phase. The training aimed to ensure that TCs would: 1) understand what VR technology is, 2) recognise its impact on learning and teaching, 3) comprehend how, and in what contexts/subject/topics it can be used, 4) know the platforms, programmes and tools used in VR design, 5) learn the steps involved in the VR design, 6) identify and use web-based VR development platforms, and 7) acquire basic skills to design and develop VR environment using these platforms. The evaluation of the effectiveness of the training programme was also determined at this stage. In addition to using an opinion form consisting of open-ended questions, the researchers decided to assess the VRs developed by the TCs as part of the evaluation process.

Phase 3: Design of integration strategies

Although the training will be conducted with TCs who voluntarily participate, it is essential to plan strategies to maintain their engagement and motivation at a high level. Therefore, communication, interaction and motivation strategies have been determined. Specifically, these strategies were based on Keller's (2016) ARCS-V motivation model (Attention, Relevance, Confidence, Satisfaction and Volition). Utilising this model, several tactics and strategies were implemented, including informing students about the objectives, providing examples from daily life, relevant fields and experiences, increasing success expectations, encouraging TCs to question, discuss and collaborate, using a reassuring, warm and sincere communication style, implementing icebreaker activities through drama techniques at the beginning of the training, assigning responsibilities, enriching the teaching process with various materials for different learning styles and sharing materials instantly. Additionally, to enhance communication and interaction, WhatsApp groups and email groups were created, allowing TCs to communicate freely among themselves and with educators at any time. In the content organisation, a flow was planned that involved field experts and progressed from basic conceptual skills to technical and design skills, moving from simple to complex.

Phase 4. Preparation of instructional environment

Following the identification of strategies that could be utilised during the training process, the next step involved organising the instructional environment. In this phase, the researchers, in collaboration with other field experts, selected and arranged the learning management system (LMS), equipment, software, content and materials. The Moodle-based LMS from the university where the first author works was utilised for the online training. Before the training, informative emails regarding the use of the LMS were sent.

Subsequently, decisions were made regarding the training process and the duration. Considering the programme's goals and intended outcomes, a four-day online training was planned, with six hours of instruction each day. The training programme and content are detailed in Appendix 1 in the online supplemental materials.

The first two days of the training provided theoretical information on topics such as the definition of VR, the hardware and software used in VR, the significance of VR in education, and related research and case studies. Basic VR applications and platforms, including web-based platforms, were also introduced. These sessions aimed to deepen the TCs' understanding of VR. Additionally, the presentations by the field experts and the examples they provided aimed to help TCs develop concrete understandings of how to incorporate VR into their future classrooms in subjects such as Science, Mathematics, Language Education and Social Studies.

The last two days were planned as design and development workshops in which TCs actively participated. These workshops aimed to support their design and development skills using various web-based VR environments. The selected platforms were Insta VR, VR360 and CoSpaces Edu, which are suitable for block-based programming and offer trial versions. Additionally, to enable the teacher candidates to experience the VR environments they designed, 'VR Shinecon' brand headsets, compatible with mobile devices, were sent to their addresses before the training.

During the design and development workshops, TCs developed products through individual and group work. The LMS's group formation feature was utilised to create random or planned groups. Furthermore, the collaborative design potential of the CoSpaces Edu platform was employed, allowing TCs to explore the same VR environment with their group.

In the design workshop, TCs worked in groups to learn how to define problems, create scenarios and develop storyboards for VR design, aligned with a specific learning objective from the primary education curriculum. They created their designs based on at least two objectives selected from Science and Mathematics, Language Education and Social Studies. Following this, the focus shifted to the development workshops, where each candidate designed web-based VR related to the developed scenarios. At the end of the development sessions, the VRs were shared and discussed by all participants.

Phase 5. The evaluation and revision of integration strategies

At the end of the training, the opinion forms collected and the products developed by the teacher candidates were reviewed and evaluated to determine what worked well in the process and what could be improved. In this study, the responses provided by TCs in the opinion forms will be analysed.

Data collection and analysis

A demographic information form and an opinion form consisting of open-ended questions were used for data collection. The form used open-ended questions to obtain detailed views from TCs on the use of VR technology in the education-teaching process. More specifically, the questions asked candidates 'What they think about VR technology?', 'How they perceive the value and importance of this technology?', 'How teaching processes could become more effective through the use of this technology?' and 'In which areas/acquisitions do they think they could use this technology in the future?'. The opinion form was given to the participants twice, once before the training process started, and once after it was completed. At the end of the training process, the data was analysed with the content analysis method. The open-coding method was first used on the raw data, which meant that the codes that were determined as being related to each other were grouped to create categories and themes. For example, one TC's comment: 'I can design lessons in which my students can actively participate in the process by using VR technologies' was coded into the 'active learning' sub-theme of the 'contribution to the learning process' theme. Similarly, the TC comment 'I can become an exemplary teacher by using the knowledge I learned after this course in my school in the future' was coded into the 'Being a role model for colleagues', which was a sub-theme of 'Contribution to the Teacher' theme. After the coding process, the two researchers worked together to compare the codes and the themes, discussed the points of disagreement, and finalised the data analysis process.

Results

The findings were discussed in three themes (Figure 1), and the findings related to each sub-theme are given below.

The features and potential of VR technology

Table 2 shows the answers of the elementary school TCs in relation to the features of VR technology, and the perceived opportunities provided by the technology before and after the online training.

According to Table 2, before the training process, candidates believed that VR technology offers the opportunity to access places that are inaccessible/hard-to-observe ($n = 7$), as well as providing the opportunity to determine abstract concepts ($n = 5$) and equal opportunities in education ($n = 5$).

However, after the training, it can be seen that the opinions of these candidates about the features of VR technology have changed. For example, there was no mention in the first opinion forms collected that this environment offers the opportunity to address different learning styles, make mistakes freely and allow unlimited repetition. However, by the end of the training, the candidates had clearly become more aware of the potential of VR technology. For example, it can be seen from the high number of responses that candidates

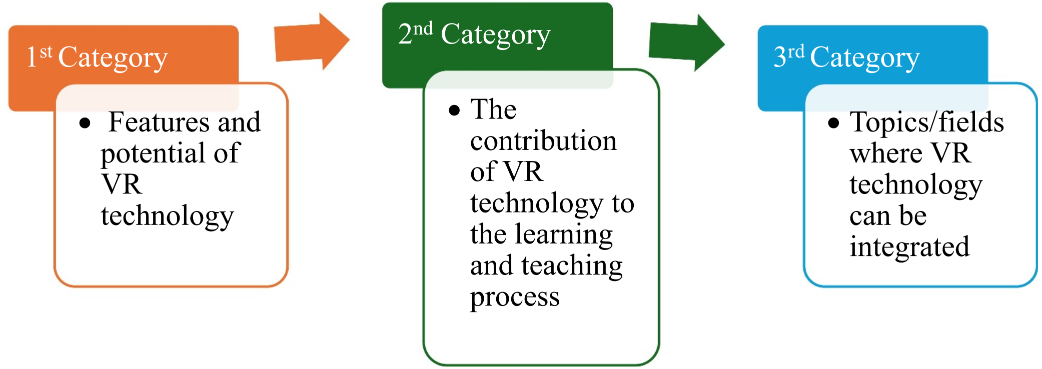


Figure 1. The three main research categories of TC perceptions.

Table 2. Results regarding the features and power of VR technology.

	Before training (f)	After training (f)
Determination of abstract concepts	5	19
Enriching of teaching	2	18
Access to inaccessible/hard-to-observe places	7	11
Ability to develop creativity	1	8
Ability to appeal to different learning styles	0	8
Learning in a safe environment	2	7
Freedom to make mistakes	0	6
Access to low-cost information	2	5
Ability to save time	0	5
Providing equal opportunities in education	5	4
Ability to present difficult-to-learn content	0	4
Unlimited repetition	0	3

had especially noticed the ability of the technology to develop creativity ($n = 8$) and appeal to different learning styles ($n = 8$). Many TCs had also become aware of the ability of the technology to determine abstract concepts ($n = 19$) and enrich teaching ($n = 18$).

Contribution of VR technology to the learning and teaching process

When the views of the TCs before and after the training are considered, it can be seen how perceptions regarding the contribution of VR technology to the learning and teaching process have changed. The extent of this change can be seen in Table 3.

It can be seen from Table 3 that before online training, the TCs were mostly focused on the contribution of VR technology to the learning process (n = 15) and to the teacher (n = 17). Candidates initially only believed that effective and efficient (n = 7), attractive (n = 4), and enjoyable and fun learning (n = 2) could be achieved with VR technology. In terms of how candidates viewed the possible benefits of the technology to themselves, they suggested that the use of this technology could help them to meet the needs of the information age (n = 7) and become an innovative teacher (n = 3). There was virtually no mention of the contribution of VR technology to skill development and teaching methods.

However, TCs' views on the educational value of VR technology varied considerably after the training, and the factors of intensity in terms of contribution to the learning process (n = 82), contribution to the teacher (n = 52) and contribution to skill development (n = 33) particularly stand out. For example, after examining the various basic VR tools and applications about what can be done with VR technology, candidates were able to learn effective-efficient (n = 20), enjoyable (n = 17), permanent (n = 13) and attractive (n = 8) aspects of the VR technology. Furthermore, there was greater emphasis of being able to provide a learning environment where they can learn by doing and experiencing (n = 11).

Another noteworthy aspect of Table 3 are the different forms of potential of VR technology which TCs mentioned for the first time after the training: 'active learning' (n = 12), interactive learning (n = 4) and motivational learning were also perceived as being offered by VR technology (n = 4). Moreover, with these technologies, students' self-confidence in the process (n = 7), technology usage skills (n = 6), high-level thinking (n = 3) and design skills (n = 2) were seen to have

Table 3. Perceptions of the contribution of VR technology to the learning and teaching process.

Theme	Sub-theme	Before training (*f*)	After training (*f*)
Contribution to the Learning Process	Effective and efficient learning	7	20
	Enjoyable and fun learning	2	17
	Permanent learning	2	13
	Active learning	0	12
	Attractive learning	4	8
	Motivational learning	0	4
	Interactive learning	0	4
	Meaningful learning	0	4
	Total	15	82
Contribution to the Teaching Method	Supporting learning by doing	2	11
	Supporting gamification/scenario-based learning	1	5
	Supporting individual learning	0	5
	Supporting exploratory teaching	2	4
	Supporting collaborative learning	0	1
	Total	5	26
Contribution to Skill Development	Increasing success	4	8
	Increasing self-confidence	0	7
	Supporting students' social/cognitive development	2	6
	Developing technical ability	0	6
	Developing higher-order thinking skills	0	3
	Developing design skills	0	2
	Developing inquiry skills	0	1
	Total	6	33
Contribution to the teacher	Meeting the needs of the information age	7	21
	Being a more effective and efficient teacher	0	10
	Ability to support professional development	1	8
	Being an innovative teacher	3	8
	Being a role model to colleagues	0	4
	To be able to spread innovation in schools	0	3
	Total	11	54

improved. Regarding contribution to themselves, candidates felt that they could be more effective and productive by using VR technology (n = 10), that they can support their professional development with VR (n = 8), they can be an innovative teacher (n = 8) and be a role model in the effective use of technology in their schools (n = 4).

Fields/topics where VR technology can be integrated

Another area examined in the research is in which field, course, and topics could VR technology be integrated in the teaching process? The views on this issue that were gathered from TCs before the training began are given in Figure 2.

In Figure 2, the size of the text corresponds to how often these fields or topics were suggested by TCs as areas where VR technology could be used. It can be seen that the most commonly suggested area by elementary school TCs were mathematics and science lessons. Human anatomy and the solar system were popular choices for possible science lessons. Although they are less popular choices (as can be inferred from their size), topics such as museum education, culture education, natural disasters, which lie in the field of

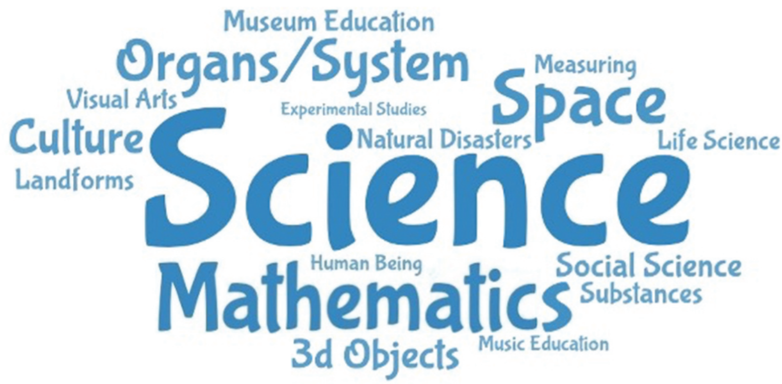


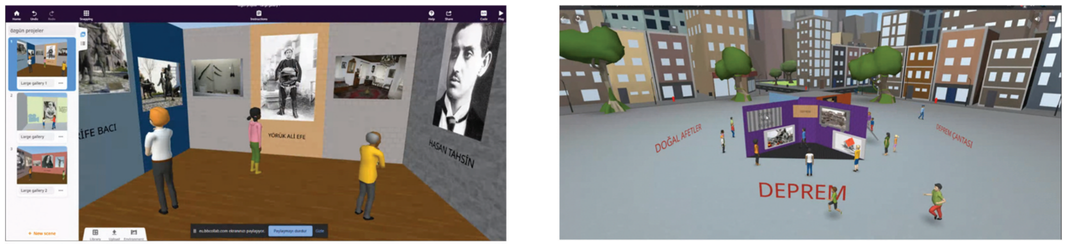
Figure 2. Ideas from TCs on fields/topics where VR technology could be used gathered prior to training.

Figure 3. Ideas from TCs on fields/topics where VR technology could be used gathered after training.

social studies and life studies, are also significant. The same question was asked again after the training and the results are given in Figure 3.

It can be seen from Figure 3 that, as was the case before training, science and mathematics courses were the most popular choices. However, it can also be seen that the variety of courses and topics has increased considerably. For example, courses such as Turkish, English, Citizenship, Music, Physical Education, which did not appear previously, were now suggested by candidates. Other newly included topics are fractions, geometric shapes, units of measurement, safe life, living things and life, environmental education, first aid and light sources. Some screenshots from TC projects are provided in Figure 4.

For instance, Figure 4a illustrates a virtual museum designed to provide information about important people in history and culture. In this VR museum, users can explore people freely, and when they click on any photo or name, they can access texts and videos related to them. Additionally, the questioning room they created includes multiple-choice questions about the people in the VR museum. In Figure 4b, the TCs designed an open educational environment focusing on natural disasters. This VR environment covers topics such as the types of natural disasters, their consequences, necessary actions during and



(a) (b)

Figure 4. Screenshots from TC projects: (a) important people in history and culture – the VR developed related to culture, (b) natural disasters and first aid – the VR developed related to social science.

after such events, and essential items in an emergency kit. According to the scenario, participants who engage with all the content in the learning environment will earn a 'Disaster Awareness Citizen' certificate upon completion. The VR environment is enriched with videos, photos and audio narrations to enhance the content.

Discussion and conclusions

TCs today are being trained in the provision of education to the Z generation, who are born into a world of visual and auditory stimuli. While teaching students who have grown up with such a range of new technologies, it is clearly necessary for teachers to use these technologies during their teaching processes by following appropriate pedagogy and providing stimulating content. According to the 'Technology Integration Planning' (TIP) model developed by Roblyer and Doering (2013), it is necessary to identify and determine learning and teacher needs, plan the integration and inclusion process, and organise post-instruction analysis and revision. The TIP model, which is based on a problem-solving model, helps the teacher to plan and select appropriate strategies for integration of the technology.

In this study, which is based on the Roblyer and Doering (2013) model, a four-day online training programme was organised for the TCs in order to provide a basic level of awareness and skills about VR technology. During the organisation of this training, various strategies, particularly Keller's (2016) ARCS-V motivation model, were employed to facilitate the participation, motivation and engagement of TCs. At the end of the process, in order to evaluate whether online education has achieved its purpose or not, candidate perceptions regarding the use of VR technology were examined. It is assumed in this study that this training supported the stage of 'identifying learning and teaching needs'. The key point in reaching this conclusion is that, as stated by Roblyer and Doering (2013) in their model, VR technology was introduced to the candidates through online training and to help realise the relative advantages of this technology and to acquire technical, pedagogical and contextual knowledge-skills. At the end of the training, TCs were seen to have expressed, as compared to their answers in the pre-training, more profound, meaningful and detailed views regarding the contribution of VR technologies to the learning environment, the teacher and the learning-teaching process. Although this study has limited scope, the results obtained are similar to the results of other research that aims to raise awareness among teachers about the use of VR technology. For example, Geng et al. (2021) conducted a study to introduce the pedagogical potential of interactive Spherical Video-Based Virtual Reality (ISVVR) to teachers. In this study, geography teachers were introduced to VR technology for teaching and learning purposes, found it pedagogically useful, and candidates showed positive intentions to use the technology in the classroom.

According to the results, it can be seen that the online training not only introduced candidates to the VR technology, but it also raised awareness of features and relative advantages. After the training, candidates frequently stated that VR technology embodies abstract concepts, enriches the teaching and provides access to inaccessible/hard-to-observe places. Moreover, candidates emphasised the contributions of VR technology to the learning process, teaching method, skill development and to the teacher. These findings can be interpreted as being an increase in the awareness of TCs in the various potential of VR technology at the end of the online training. These advantages and the insights into VR technologies are in line with the research results found in the literature (see Chen et al., 2020; Ferdig et al., 2018; Merchant et al., 2014; Saritas, 2015). It is thought that the awareness gained by the teachers in the study will be an important factor in the integration of technology within education in the future. This is because it is known that in the process of acceptance of new technology, the knowledge of individuals and the understanding of the benefits of technology for teaching are extremely important in the acceptance of this technology and attitudes towards its use (Chen & Tseng, 2012; Kang & Shin, 2015; Shin & Kang, 2015). The results also show that online training has a strong impact on TCs' acceptance of VR technology.

A further result of this research which demonstrates the transformation in the perceptions of candidates towards VR technology are the changes in the number of the courses and topics suggested by candidates where VR technology can be used. TCs who had a limited idea of which courses/topics could benefit from the integration of VR technology at the beginning of the process gained a wider perspective by the end. These results show that the examples from different disciplines provided during the training process regarding the use of VR technology in different disciplines have an impact on the awareness of candidates and the development of their perceptions. This insight is of use to researchers and practitioners when organising training sessions for the introduction of new technology.

Striking results were obtained in the study in terms of the contribution of VR technology to teachers. Before the training, TCs stated that they particularly wanted to use this technology to catch up with the needs of the information age. However, after the training, these candidates wanted to use VR technology in order to become innovative teachers and role models to colleagues, as well as to introduce innovation in their school. This result can be interpreted as the online training increasing self-confidence, and self-efficacy, as well as their perception of the role and the duty they will undertake in schools. In other words, it can be argued that the educational process has an impact on shaping the professional identities of TCs. Consideration of such in-service training and professional development programmes should therefore go beyond focusing only on the content to be given, and the skills to be gained, to also consider how the programmes can affect teachers both emotionally and professionally. According to Miranda and Russell (2012), the technological awareness of teachers is an important key for integration. After all, a door of opportunity is of no use if the teachers are not provided with the key to open it. It is suggested that more training, practice and research are used to introduce future teachers to new technologies, such as VR, and support how they can be effectively integrated into the teaching process (Badilla Quintana et al., 2017; Gandolfi, 2018; Merchant et al., 2014). This need is also emphasised by many researchers. For example, according to Lee and Shea (2020), since many teachers are not very familiar with new technologies such as AR and VR, it is important to that professional development opportunities be provided on how they can be effectively integrated into teaching and learning activities. Similarly, Bower et al. (2020) emphasised the need for extensive professional learning and support in teacher education for candidates to become designers using IVR technology, and to develop the necessary programming and pedagogical skills. Moreover, teachers need guidelines and/or instructional design principles that can guide them to effectively design, develop and apply this technology (Curcio et al., 2016). There is therefore the need for educational processes that prioritise active participation in the teacher training process, while providing collaboration and supporting an awareness of being a part of a learning society.

However, VR technology should not be thought of as a magic wand that can instantly solve all educational problems. What is important is to get to know this technology fully, along with all of its strengths and weaknesses, and to be able to think and design how it can be used to solve any learning or teaching problem. For this, as emphasised by Eutsler and Long (2021), it is clear that there is a need for more research on the integration of VR technology that fully considers all of the dimensions of technology, design and pedagogy, as well as how they intersect. Moreover, the use of VR technology in education is quite new. For this reason, it is necessary to think carefully before using technology in terms of the effect of innovation and excitement. In particular, while integrating this new technology into the education process, we should consider other existing integration problems (external resources such as deficiencies in the curriculum, hardware and software support, the perspective of the administrators) and consider the emotional, psychological and physical health problems that technology may bring (Merchant et al., 2014; Molnar, 2018; Yap, 2016). If this is not done, then the focus will be on a technology that may do more harm than good to the teaching process, and any investment made could be in vain.

In conclusion, the results of the research have shown that following the effective theoretical knowledge presented by domain experts, similarly effective processes for the integration of new technologies can be implemented that allow learning through design, the development of individually tailored environments and experiences, reflection, collaboration, the production of authentic experiences and effective support in the process. The aim is for candidates to become familiar with the technology, realise its potential, acquire basic design and development skills, and gain a vision of why and how such skills might be used in future classrooms. The results show that this goal was successfully achieved.

Limitations and recommendations

This research has some limitations. First, only 30 TCs were able to participate in the online training and the training lasted only four days. More TCs could not be included in the process due to the cost of the VR glasses sent to the TCs. In the future, more long-term training could be organised with more participants. In addition, this online training is limited to elementary school TCs. Similar future training could be designed with other field teachers/TCs in the future. In addition, research data can be enriched by adding quantitative dimensions to examine the changes in the ways candidates intend to use the technology. Dimensions such as the motivation of candidates, as well as the attitudes and beliefs that change in the process, can also be added to this quantitative data. In light of the necessity for support in the integration of new technologies in teacher education, it is believed that enhancing process evaluation efforts is essential for the effective and efficient implementation of online training programmes. In this context, there is a need for more research examining how instructional design models, such as the ARCS-V motivation model utilised in this study, can be applied and their effects evaluated.

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