



Investigating EFL teacher candidates' acceptance and self-perceived self-efficacy of augmented reality

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Abstract

The mixed-methods sequential explanatory design study presented here sought to investigate the acceptance and self-perceived self-efficacy of Augmented Reality technology among English as a Foreign Language teacher candidates. This study's contribution to the field of AR as an instructional technology lies in that research on the using AR technology in language teacher education are particularly limited. To bridge this research gap, one-group pre-test-post-test design was used in this study, in which ten weeks of AR-enhanced English language teacher training treatment was carried out. To answer the research questions, quantitative data were gathered from 50 volunteers by using the Technology Acceptance Model survey and Self-Efficacy Scale. Qualitative data were received via semi-structured interviews carried out with 12 pre-service teachers. Findings revealed that there was a significant increase in EFL teacher candidates' levels of AR technology acceptance whereas no significant difference was identified in their self-perceived self-efficacy. The interviewees proposed interpersonal, intrapersonal, technological, and technical factors to explain their low self-efficacy levels. Based on the findings, the paper offers implications and suggestions for researchers, teacher educators, and policymakers. The solutions to increase the level of acceptance and self-perceived self-efficacy levels to use AR among EFL Teacher Candidates include courses on Emergent Technologies (ICT, MALL, CALL, AR), training via seminars, workshops, input sessions through (inter)nationally funded projects, real-life examples, field-specific samples, and hands-on experiences.

Keywords Augmented reality · Emerging technology · EFL teacher candidates · Acceptance of AR-enhanced materials · Self-perceived self-efficacy

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1 Introduction

Augmented Reality (AR), which is one of the potentially beneficial instructional technology tools, has proliferated due to the obvious growth of mobile devices (Zhang et al., 2020). AR is an immersive technology that superimpose digital images onto the real world (Azuma, 1997; Mohn, 2015). AR was delineated as a fusion of technologies that overlay computer-generated content onto an authentic physical environment (Wang et al., 2018). As projected by Johnson et al. (2016), AR technology has been widely embraced in various fields, but it has made its way into the ELT field in the recent years (Marrahi-Gómez & Belda-Medina, 2022a). While AR technology may not necessarily be situated at the methodological periphery of language education (Nöhrer, 2020, p.2), we cannot claim the same for teachers who still lack basic technological pedagogical knowledge. The inclusion of this technology into language instruction at various educational level has not yet reached its full potential, despite its advantages (Bonner & Reinders, 2018). Furthermore, given that Goldman Sachs (2016) predicted that by 2025, 15 million users working in the education sector will have used AR technology, there is a pressing need to update the pre-service teacher education curriculum to equip future educators with the knowledge and skills to effectively implement such cutting-edge technologies. Since all prospective English as a Foreign Language (EFL) teachers and their potential pupils will be digital natives, they will all need to become “tech savvy” (Prensky, 2001). Nevertheless, it was discovered that some of them lacked the required skill sets (Bennett et al., 2008). To create a learning environment that conducive and motivating (Marrahi-Gómez & Belda-Medina, 2022a, Üstün et al., 2022) for these digital natives, promote language learning in a manner that is more deeply integrated into the context and provides a heightened sense of immersion (Marrahi-Gómez & Belda-Medina, 2022b). Thus, this authentic and immersive learning environment offered by AR (Lee, 2022) can address the challenges that arise in education as a result of epidemics or natural disasters, prospective teachers are to be more competent in using instructional technologies. As a result, both in- and pre-service teachers should receive the necessary training during their undergraduate studies to fulfil this role.

Despite the growing body of literature on utilising AR for language learning, there is still room for further inquiries (Belda-Medina & Marrahi-Gómez, 2023). One major cause of the low number of the inclusion of AR technology into learning is low technological pedagogical content knowledge, which was noted as a downside of AR technology (Akçayır & Akçayır, 2017). In recent studies and reviews, the need for showing instructors the ropes of using “pertinent learning apps and devices” like AR (Khan et al., 2023, p. 12) is also emphasized (Belda-Medina & Marrahi-Gomez, 2023; Marrahi-Gómez & Belda-Medina, 2022b). When creating AR-based language learning materials, it is crucial to assess teachers’ acceptance of AR and their self-perceived self-efficacy level (SPSEL), since they should have the tools and training needed to benefit from it in such a way to accomplish their outcomes and resolve any technical issues which may arise

(Billinghurst & Duenser, 2012). Considering the emphasis on training instructors, the potential of AR technology for motivating learners and fostering language learning (Ebadi & Ashrafabadi, 2022; Koç et al., 2022; Min & Yu, 2023; Üstün et al., 2022; Yilmaz et al., 2022), and the affordances of AR technology regarding learning gains, interaction, and collaboration (Altinpulluk, 2019; Bacca et al., 2014), this study can address the call made by Min and Yu (2023) who pointed out the importance of investigating the teachers' and students' attitude towards AR technology. Against this background, this study could be useful for EFL teacher candidates, which can aid in filling the niches in the literature in this regard as they are to develop AR-enhanced language learning materials for students with any level of English proficiency. The investigation of prospective English teachers' perceptions of and competence in employing AR technology in language instruction can also be another contribution of this study. This research is distinctive in that it focuses on EFL teacher candidates, whereas there have been a few studies in this field (Belda-Medina, 2022; Karacan, 2019) and some in other fields of education including outdoor learning and AR (Huang et al., 2019), astronomy (Chen et al., 2022), using AR for informal learning and promoting a sense of heritage places (Chang et al., 2015) and for facilitating students' understanding of demanding science courses (Yoon et al., 2017).

This study is based on the master's thesis carried out by the first author under the supervision of the second author. The first author made contributions to the research article, including conceptualization, data curation, formal analysis, investigation, methodology, visualization, roles/writing - original draft, and writing - review & editing, while the second author, serving as the thesis supervisor, played a pivotal role in conceptualization, methodology, visualization, writing - review & editing, supervision, and validation.

The following sections outline the theoretical framework, the pertinent literature, research questions, methodology, and the significance of the study, offering readers a concise roadmap for the ensuing exploration of our findings and analysis, and conclude with a discussion of the findings and provide implications and ideas for further research.

2 Literature review

In this part, the theoretical framework on which our research is based, namely Situated Learning Theory (SLT) and Constructivist Learning Theory (CLT), is presented. Next, the previous research on pre- and in-service teachers views on AR technology is provided to inform the current study.

2.1 Theoretical framework

Situated Learning Theory (SLT) and Constructivist Learning Theory (CLT) are the two main scientific pillars that underpin AR technology, according to Dunleavy and Dede (2014), as AR situates the learner within an authentic physical and

social milieu, concurrently guiding, providing scaffolding, and fostering interactive and metacognitive learning procedures, including “authentic inquiry, active observation, peer coaching, reciprocal teaching, and legitimate peripheral participation, with multiple modes of representation” (p.735). The Sociocultural Theory (SLT) of Brown et al. (1989), which is based on Vygotsky’s Sociocultural Theory (1980), contends that learning and language acquisition take place within a specific framework; and that interactions between students, artefacts, and cultural factors will help students learn more effectively. Based on this paradigm, learning also occurs through the combination of prior knowledge with spontaneous, genuine, and unintentional qualitative learning (Stein, 1998). AR opens the door to a learning environment where users can interact, engage, finish the learning challenge, figure out the issue, and use what they have learned to solve other simulations. According to CLT, learners engage with their environment through a series of processes that help them develop their mental constructs (Richard, 2015). The process of knowledge construction by learners depends as much on the context and environment as it does on their prior experience and sociocultural background. Dunleavy and Dede (2014) noted that learners are given the chance to create their interpretations of AR’s immersive interfaces through learning by doing as they get in contact with real-world people in order to create their context-based comprehension. Additionally, the convergence of SLT and CLT offered by AR technology encourages students to put what they know into practice in an AR-based environment. In this equation, superimposed visuals serve as a scaffold, schemata activator, motivator, and facilitator.

2.2 Teachers’ views on AR technology

Teachers are the gatekeepers when it comes to whether a technological tool is integrated into the courses, so it is crucial to ascertain if they are willing to embrace and include emerging technologies like AR to their lessons (Dalim et al., 2017). Depending on the teacher’s readiness and acceptance of the tools, these technological resources can be utilised for instructional purposes.

Several studies have been done recently to explore how this immersive technology is perceived and implemented. Putiorn et al. (2018) developed an AR tool and examined 38 prospective teachers’ perceptions of its efficacy in the course of astronomy. Teachers found it difficult to use this tool in rural schools in comparison with the urban schools. Delello (2014) scrutinized the views of 31 prospective teachers regarding the utilisation of AR application in an exploratory case study. The shortcomings were noted as lengthy in terms of designing, teachers’ insufficient expertise, and shortage of infrastructure. Uygun et al. (2018) conducted a survey with 220 teacher candidates. The findings revealed that they had a limited understanding of AR, which they found to be “entertaining, inspiring, and encouraging learning“. Additionally, through concurrent mixed-method research design, Sat et al. (2023) revealed teacher candidates’ positive views of various AR tools in terms of intention to use, multimedia, satisfaction, usefulness, self-efficacy, effectiveness, and system quality. Additionally, Alsadoon and Alhussain (2019) explored the perceptions

and acceptance of the faculty members at the Saudi Electronic University regarding AR technology and found out that their perceptions of AR technology is positive through not without some concerns like the lack of technical support.

The employment of AR by language teachers has been the subject of a few investigations. According to Kaenchan (2018), there is evidence that EFL Thai students have a high level of self-efficacy when using AR. This self-efficacy is affected by various elements, including “self-satisfaction, imagination, excitement, peer and teacher assistance, technology and infrastructure training.” In the future, they would be able to benefit from AR technologies if they had the time and resources. Another suggestion was to organise training for both teachers and learners on how to implement AR technology for learning and teaching languages. Karacan (2019) used the Decomposed Theory of Planned Behaviour to examine the determinants affecting the 141 English teacher candidates’ plans to use AR technology and revealed the positive perceptions held by the prospective EFL teachers regarding AR applications. Nöhrer (2020) investigated the opinions and experiences of 118 language teachers from secondary schools in Austria with AR and VR. Although many teachers were familiar with these new technologies, the descriptive study revealed that majority lacked sufficient practical experience and were unaware of how to apply this technology to the teaching of languages. They were positive about the potential of immersive technology. However, a small number of participants voiced their worries about the quick adoption of this technology in language instruction. After administering the TAM survey, Pasalidou and Fachantidis (2021) conducted a correlational study and found that EU and PU were predictors of the primary school teachers’ intent to utilise AR. They deemed AR applications user-friendly and enjoyable. Recently, Belda-Medina (2022) found out that pre-service teachers need practical training in creating AR-based content and putting this into practice although they hold positive perceptions of AR as transformative technology. Lastly, a bibliometric analysis of using AR in language instruction revealed the positive perceptions of teachers in regard to utilization of AR technology for language learning (Min & Yu, 2023).

Furthermore, several studies showed that teachers were familiar with and using AR technology. After five weeks, 85 prospective language teachers were found to lack a practical understanding of developing and implementing AR-based content, according to mixed-method research by Belda-Medina and Calvo-Ferrer (2022). In their correlational study, Karacan and Polat (2022) identified the variables that predicted whether 141 English teacher candidates would employ AR in their future language sessions. It was discovered that PU was the most essential indicator, whereas facilitating circumstances and ease of use had the least significant effects. The preparedness, acceptance, and intention of 181 Malaysian English instructors to use AR in English instruction as well as their intention to do so were examined by Jamrus and Razali (2021). It was revealed that they are well prepared to use AR for English reading, with a readiness level of 63.0% ($n = 114$) and acceptance of employing AR of 60.8% ($n = 110$). In conclusion, A substantial and robust correlation exists between acceptability and preparedness with the desire to use AR to teach reading. By using the TAM survey, Salmee and Abd

Majid (2022) aimed to ascertain 180 English language teachers' perceptions of using AR. The results show that they often adopt AR at high levels. The outcomes of multiple regression analysis show that the student's behavioural intention to utilize AR in ESL classes is directly impacted by their perceived usefulness (PU) and attitude toward its use. Mikropoulos et al. (2022) investigated the variables affecting 137 prospective instructors' intention to utilize mobile-based AR in the future. The regression analysis provided a reasonable level of explanation for the variance in PU, perceived ease of use (PEU), attitude, and intention. Attitude and PU were found to be predictive of teacher candidates' intention to use mobile AR in their future instruction.

In light of this, pre-service and in-service educators both endorsed benefitting from this immersive technology in language instruction. However, they argued that because they lacked the necessary training and experience, taking advantage of this immersive technology would be challenging. This summary demonstrates the paucity of studies conducted in the field and the need for additional studies on EFL teacher candidates' acceptance of and SPSEL of AR technology. Thus, this study strived to scrutinise the followings:

1. What is EFL teacher candidates' acceptance level of AR-embedded language learning materials after their experience with AR for ten weeks?
2. After completing the AR-enhanced language learning materials to teach English, what was the self-perceived self-efficacy level of EFL teacher candidates in using AR technology?

3 Methodology

The present study adopted mixed method research design in order to determine EFL teacher candidates' acceptance and self-efficacy level of AR technology. This section presents the demographic data for the participants, the data collection procedures, and data analysis.

3.1 Participants

The current research was conducted with the voluntary contribution of 50 EFL teacher candidates, who were chosen through convenience sampling from a private university in Ankara, Türkiye. Their mean age was 22.90 and mostly ranged between 20 and 25. The female student teachers made up the majority ($N=40$, 80%) while there were ten males (20%). Regarding their technological affinity, all of them ($N=50$, 100%) had to take the three required courses in their B.A. program: Computer I, Computer II, and Instructional Technologies and Material Design. Majority ($N=29$, 58%) said they were familiar with AR technology, while 42% of participants

($N=21$) said they had never heard of it before. This suggests that for most participants, this was their first exposure to AR. Twelve of the participants from the sample described above also contributed to the semi-structured interviews.

3.2 Data collection procedures

This study, which is a component of a master's thesis, uses a mixed-method sequential explanatory design in which the collection and analysis of quantitative data comes first, followed by the analysis of qualitative data, and the qualitative data helps to explain the quantitative findings (Creswell et al., 2003). Data collection was carried out through three main phases. Figure 1 summarizes the overall procedure of the study.

As shown in Fig. 1, a one-group pre-test-post-test design was employed to measure the acceptance and SPSEL of AR technology among prospective EFL teachers. After obtaining ethical approval from the Applied Ethics Research Centre from the university with which the researchers are affiliated, a pre-survey was administered. To give the participants practical experience, an online input session was then conducted. The step-by-step process of the input session is displayed in Fig. 2.

To start, the definition and types of AR technology were discussed. The fundamentals of the use of *Blippar* were described through detailed instructions that were accompanied by screenshots. *Blippar* was selected for this study as it is free to use for educational purposes and has a less complicated interface compared to

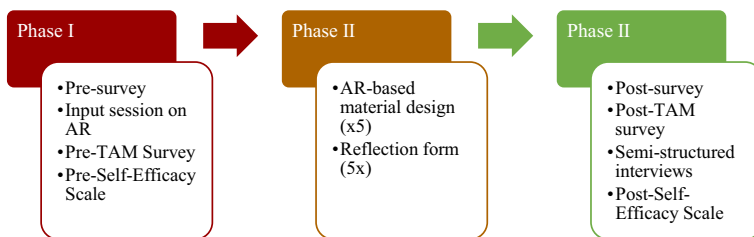


Fig. 1 Data collection phases

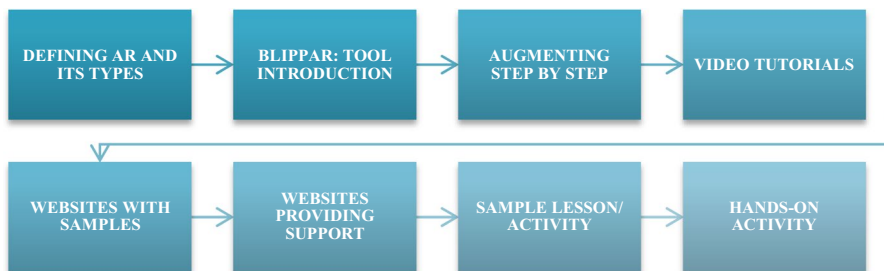


Fig. 2 Online input session steps on AR technology

some other AR applications. The websites that offer samples and support for using the website and the application were then showcased after the video tutorials. After sharing the sample activities, the session concluded with a hands-on activity session where participants tested the mobile application and asked questions. The participants had the opportunity to ask questions during the task design process via email or WhatsApp groups.

Following the completion of the consent forms, a Google Forms survey was used to gather demographic information about the participants' technology experience, attitude toward technology, and prior AR exposure. The TAM survey and Self-Efficacy Scale were conducted online before and after the participants' ten-week-long process of designing five AR-based tasks, in order to collect information on their acceptance and SPSELS. During the implementation of AR-based tasks, participants designed their own AR-enhanced English language teaching materials (Please, see App. A for a sample participant AR activity). After ten-week AR implementation, TAM post survey and Self-Efficacy Scale had been completed, semi-structured interviews were conducted to fully explore the prospective EFL teachers' experiences with this immersive technology. In the post survey, all the respondents reported their self-perceived level of using AR technology in preparing materials for language learning purposes. Out of 50, four participants from each self-reported AR competency level—basic, intermediate, and advanced— (total of 12 participants) willingly participated in the interviews. These participants represented the research group according to their self-efficacy scale findings and the materials they designed. The interviews were conducted in English via Zoom and participants' consent was taken for audio-recording the interviews. To avoid any ethical issues, pseudonyms were used to address the interviewees.

There were three sections and 20 questions in the interview protocol which was adapted from the protocol designed by Kaenchan (2018). The first section examined participants' experiences with using AR technology by asking them ten queries about their acceptance of and views of this technology, as well as their SPSEL with it. In order to learn more about the prospective EFL teachers' experience with AR technology, the following section consisted of questions about the design of AR-embedded activities. Four questions were included in the third section to elicit their opinions on the potential uses of AR technology in educational fields as well as their intent to benefit from AR. The interview was concluded with asking the interviewees if they had any additional inquiries, feedback, or recommendations regarding the study.

3.3 Data analysis

Two instruments, TAM3 survey and Self-Efficacy Scale were employed to gather quantitative data, while the qualitative data were gathered through interviews and open-ended items. A pilot study was carried out with a small sample of participants in order to confirm the validity and reliability of the instruments, and expert opinion was obtained. According to these, the instruments were revised prior to the actual

study. In the current study, relevant analytical procedures were carried out on quantitative and qualitative data. Figure 3 presents the overall procedures of the data analysis.

The TAM3 survey, which was originally generated by Venkatesh and Bala (2008) but modified for the current research from Kaenchan's (2018) thesis research, contained 24 statements based on four-point Likert scale (See Fig. 4 below). Cronbach's alpha values were 0.847 and 0.901 respectively for the pre- and post-TAM survey, indicating that the survey was highly reliable. The Self-Efficacy Scale was originally based on the study by Compeau and Higgins (1995) and modified for the current research from Kaenchan's (2018) thesis research, had ten items and was coded on a four-point Likert scale. The Self-Efficacy scale included ten statements and aimed to measure pre-service EFL teachers' self-perceived levels of self-efficacy. Cronbach's Alpha coefficients were 0.882 and 0.822, respectively for the pre- and post-self-efficacy scale, showing that the instrument was reliable. After checking the distribution of the data through Kolmogorov-Smirnov's test, the appropriate statistical tests were run to investigate if there was a significant change in their acceptance and SPSEL of this emerging technology after a ten-week-long experience.

As proposed by Strauss and Corbin (1990), open, axial, and selective coding procedures were used along with constant comparison method to analyse the qualitative data based on the post-survey and interview. Initially, every discovery was consistently

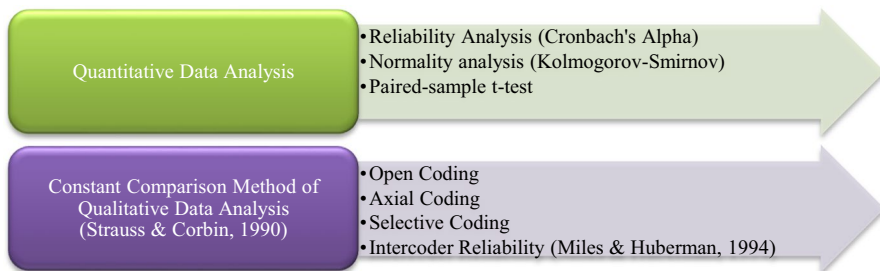


Fig. 3 Data analysis

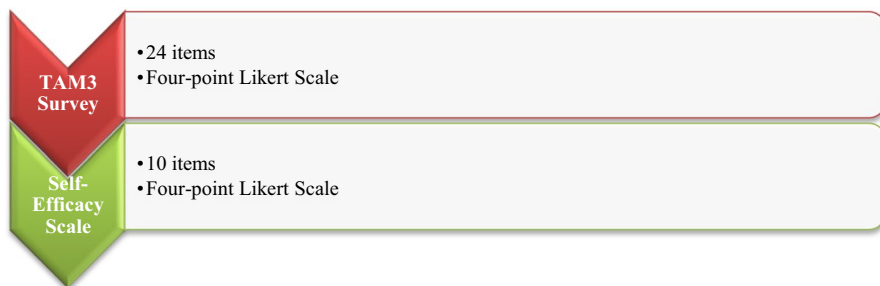


Fig. 4 Data collection instruments

compared to generate pertinent categories up until the moment that “no new information or themes are observed in the data” (Guest et al., 2006). During axial coding, codes from previous stage were merged to form the categories. In the subsequent stage of selective coding, the researcher determined the major categories by connecting these categories to one another. The frequencies of the codes were calculated. In relation to the second research question, to reveal the factors affecting prospective EFL teachers’ SPSEL in employing this immersive technology, the three factors, namely Intrapersonal, interpersonal, technological, and technical factors, proposed by Kaenchan (2018) were utilized to code the qualitative data. Additionally, the first author and a colleague with a B.A. in ELT and a Ph.D. in Computer Education and Instructional Technologies independently coded the data. To verify the validity of the data analysis, intercoder reliability was computed. The result was 0.086, which is regarded as sufficient for agreement amongst several coders (Miles & Huberman, 1994).

4 Results

This section provides the results based on both quantitative and qualitative data for two research questions respectively. The first part presents the EFL teacher candidates’ acceptance of AR technology while the second part their perceived level of self-efficacy in creating AR-based language learning materials.

4.1 The EFL teacher candidates’ acceptance of AR technology

The acceptance of AR technology by prospective EFL teachers was explored through the TAM survey. Table 1 presents the descriptive statistics in the pre-TAM survey ($N=50$, $M=71.08$, $SD=9.043$) and post-TAM survey ($N=50$, $M=75.12$, $SD=10.217$).

A paired sample t-test was performed because the data had a normal distribution, and the results showed a statistically significant difference between the pre- and post-TAM surveys, $t(49)=3.38$, $p=.001$ (See Table 2). This implied that the 10 weeks

Table 1 Descriptive statistics for TAM3 survey

	n	Pre TAM3 survey		Post TAM3 survey	
		Mean	SD	Mean	SD
Exp. 1	50	71,08	9,043	75,12	10,217
Kolmogorov-Smirnov Test			df	Statistics	Assumption Sig. (2-tailed)
Pre-TAM3 survey			50	0.054	0.200
Post-TAM3 survey			50	0.072	0.200

Table 2 Paired sample t-test for TAM3 survey

	Mean	SD	t	df	Sig. (2-tailed)
Post TAM-Pre TAM	4,04	1.192	3.38	49	0.001

of exposure to AR technology by the EFL teacher candidates resulted in a statistical significance in their acceptance level of AR technology in language instruction.

4.1.1 Qualitative findings regarding acceptance of AR technology

To investigate the EFL teacher candidates' acceptance level of this immersive technology, certain open-ended queries were directed through two instruments. In the course of the interviews, the prospective EFL teachers' views on using AR tools in English classes had changed (See Table 3). Before the implementation, there was one neutral opinion and eleven negative ones. After the event, all reviews were positive.

Virtually all the respondents asserted that there was no possibility for employing AR technology to teach English before they had any experience with it. After their experience, they decided to benefit from this cutting-edge technology in their forthcoming lessons. The usage of AR-based activities in English classes was seen by the majority as "a new language learning strategy" after the implementation process since it allowed teachers to prepare a range of activities for teaching English. Before the implementation stage, two interviewees acknowledged not being familiar with this technology. As they gained experience, they came to the conclusion that AR technology could be used to teach English. Even though some teacher candidates were aware of this emerging technology, they remarked that they were initially cautious to use it because they had never used it in a classroom before.

Overall, almost all prospective teachers admitted that they did not know about this emerging technology before using it for this study. After its introduction, all interviewers acknowledged their acceptance of AR technology, and the participants displayed a favourable inclination for its use in English language sessions.

4.2 The EFL prospective teachers' SPSEL in employing AR technology

In order to collect data on prospective EFL teachers' perceived level of self-efficacy in creating AR-based language learning materials, the self-efficacy scale was utilised. Table 4 presents the descriptive statistics for the pre-self-efficacy scale ($N=50$, $M=29.92$, $SD=6.163$) and the post-self-efficacy scale ($N=50$, $M=30.30$, $SD=5.643$). The paired sample t-test was performed because the data shows a normal distribution.

According to Table 5, no significant difference between the pre- and post-self-efficacy-scales was identified, $t(49)=0.430$, $p=.669$. This result demonstrated that their ten-week exposure to AR technology did not significantly alter their SPSEL in employing *Blippar*, an AR application. Nevertheless, qualitative data revealed an increase and positive attitudes toward the utilisation of this immersive technology, which will be discussed in the following section. Depending on the duration of time, if the exposure had been for a year or two, there would be different results as the initial weeks are generally spent giving training to participants.

Table 3 The change in the acceptance level of AR prior to and following the implementation

Views	Before	After	Quotes
Positive	0	12	"Of course, I think AR makes lessons fun. Today's learning process is becoming much more turned to bring in the elements of interaction and creativity by providing visual representations. AR helps students acquire, process, and remember information. Thereby it helps them test out their knowledge in practice. Therefore, I have positive views about it." [Jane, Interview]
Neutral	1	0	"Before that, I didn't have any idea about augmented reality. We have been exposed to augmented reality with games, instagram or snapchat filters. But, I did not know its name. after that, I know its name, augmented reality, it is not only used for games or instagram filters. It can be also used for educational purposes, architecture industry." [Mary, Interview]
Negative	11	0	"At first, I did not want to work on Blippar because it was very difficult for me. But now I like it and it is enjoyable for me." [Evelyn, Interview] "First, I thought it would be very difficult. Now, there was no change in my mind. It is difficult but as we did it in pairs, we helped each other, and it was easier." [Hannah, Interview]

Table 4 Descriptive statistics and normality for self-efficacy scale

Exp. 1	n	Pre-self-efficacy scale		Post- self-efficacy scale	
		Mean	SD	Mean	SD
Kolmogorov-Smirnov Test	50	29,92	6,163	30,30	5,643
			df	Statistics	Assumption Sig. (2-tailed)
Pre- Self-Efficacy Scale			50	0.115	0.097
Post- Self-Efficacy Scale			50	0.118	0.078

Table 5 Paired sample t-test for SPSEL in AR technology

	Mean	SD	t	df	Sig. (2-tailed)
Post-self-efficacy scale	0.380	6.25	0.430	49	0.669
Pre-self-efficacy scale					

4.2.1 Factors affecting EFL teacher candidates' SPSEL in employing AR technology

Four people from each of the three competency levels of employing AR technology—basic, intermediate, and advanced—participated in the interviews. The interviewees mentioned various aspects that had either positive or negative impact on their SPSEL in employing this innovation. These aspects were put under three main categories, namely intrapersonal, interpersonal, technological, and technical factors, as proposed by Kaenchan (2018) (see Fig. 5).

The emerging themes from the qualitative study are also shown in Table 6 along with their categories and their frequency distributions. The category of interpersonal dimensions included peer assistance (PA) and peer pressure (PP) ($f=11$ and $f=1$, respectively). Almost all respondents ($N=11$) said they would work in pairs because they could assist one another during the design of AR-based activities. Two interviewees who typically dislike working in teams or pairs. Nevertheless, they were optimistic about creating AR-embedded materials with their pairs because they could find images and assist one another when they were having trouble. An interviewee further stated that she was subject to PP as a result of her partner's disinterest in her cooperation and suggestions. For this reason, she would rather finish the AR-integrated material on her own.

Fig. 5 Factors affecting EFL Teacher candidates' SPSEL in employing AR technology

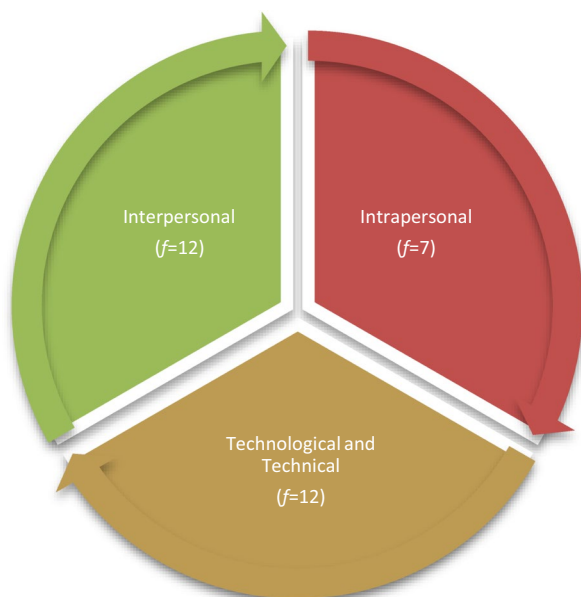


Table 6 Interpersonal factors

Codes	<i>f</i>	Quotes
PA	11	“In pairs definitely because the more people, the creativity flows and the more ideas come out of people.” [Cade, Interview]
PP	1	“I prefer doing on my own, because when I create something in my mind, I want to...I want to create it. But sometimes my pair don't like that idea or don't understand my idea and change something that I don't like. ... But, when I do with my pair, it takes time because making decisions especially.” [Mary, Interview]

To continue with the first intrapersonal factor, intrapersonal factors were low computer self-efficacy (CSE) ($f=4$) and low computer anxiety (CA) ($f=3$) (See Table 7). Majority ($N=9$) indicated that they did not experience any anxiety while employing *Blippar* because they found it to be user-friendly and enjoyable as indicated by Erinore “No, I don't feel any anxiety or frustration about using AR because I think it's really like easy to use and create something.” Therefore, they were confident in their ability to create AR-based activities, as Hannah stated: “No, of course, it is very enjoyable, and I used it very comfortably. There was no situation where I felt nervous.” However, three interviewees claimed that creating AR-embedded materials led them to feel anxious because the systems appeared complex to them. The other interviewee thought she was not very adept at using computers and technology. As a result, she experienced frustration as she prepared language learning activities using AR technology. Another interviewee initially experienced anxiety due to her lack of experience with this technology. She said that by practicing, she was able to overcome her anxiety. The basic users of AR

Table 7 Intrapersonal factors

Codes	<i>f</i>	Quotes
Low CSE	4	“...because like I said, I'm not very good with technology and I'm very new to this and I'm not .I mean, I won't say I'm bad at it, but I'm not very good at it as well. ...” [Emily, Interview]
CA	3	“...At the beginning, I felt nervous because understanding how it works was challenging for me. Now, I feel less nervous.” [Evelyn, Interview]

technology cited low CSE, the second intrapersonal factor, as the reason why they found it difficult to use technology for learning. They remarked that they found it challenging to create AR-based activities for teaching English because they were unfamiliar with the technology.

As presented in Table 8, technical and technological factors include the complicated AR technology interface (CI) ($f=5$), technological infrastructure (TI) ($f=4$), and AR training (ART) ($f=3$). The CI of the tool, particularly adding movement and locating relevant images for 3D models to incorporate into their material, was cited by the teacher candidates. Four interviewees mentioned how managing the activity design and implementation procedures might be more challenging due to the lack of TI. Three interviewees mentioned that the input session to introduce participants how to employ the AR application, *Blippar*, guided them through the process of designing activities. These suggested that for the outcome of the material design process to be successful, a pre-implementation orientation session on using AR technology is essential.

In conclusion, there were a variety of factors that affected the EFL teacher candidates' SPSEL in utilizing AR in both positive and negative ways. These comprised intrapersonal, interpersonal, and technological and technical dimensions.

5 Discussion

The findings of the current study highlighted one more time the significance of equipping EFL teacher candidates with the relevant pedagogical knowledge and skillset considering the estimated number of users of AR technology in the educational fields (Goldman Sachs, 2016).

5.1 The EFL teacher candidates' acceptance of AR technology

The first research query in the present scrutiny aimed to determine if EFL teacher candidates would use AR technology. This part is dedicated to discussing the findings drawn from the TAM survey data.

Table 8 Technological and technical factors

Codes	<i>f</i>	Quotes
CI	5	"So as I said, I've watched some videos about this adding movement thing. There was the old Blippar website video. So it looked really easy to me like it today. I think today's Blippar is more complicated than the oldest one. I think they can make the website easier to understand for everyone." [Erinore, Interview]
TI	4	"I think the only way to not to be able to use it effectively is to use it wrong because my honest opinion is that the only limitation of AR is hardware stuff for example our phones, or different glasses. I think they only need to improve the hardware part not the software part." [Cade, Interview]
ART	3	"I think the disadvantages are ... lack of training..." [Jane, Interview]

The primary objective of assessing teachers' level of technology acceptance was to ascertain whether teachers can embrace and incorporate such immersive innovations into their lessons since teachers are the ones who decide whether any technical tool is integrated into the courses (Dalim et al., 2017). The findings revealed that the EFL teacher candidates' acceptance of this innovative technology differed significantly after their 10-week exposure to it. This result implies that prospective EFL teachers are supportive of AR technologies, which is consistent with previous findings (Belda-Medina, 2022; Jamrus & Razali, 2021; Min & Yu, 2023; Salmee & Abd Majid, 2022; Sat et al., 2023), but not confirmed by Nöhrer (2020). This outcome can be explained through several reasons. This shift in view is because the majority have either never used this cutting-edge technology before or are reluctant to do so even if some prospective EFL teachers are familiar with it. As a result, they did not at first recognize the advantages of using AR in language instruction. As they had the opportunity to design various activities for language teaching and learning, their ten-week-long experience with AR changed their perspectives about its implementation in ELT. Hence, some even deemed AR as "*a new language learning strategy*". Another indicator of user acceptance is their future intention to benefit from this innovation. The analysis of the post-survey and the interviews showed that the majority were open to using AR technology in their classes. The prospective EFL teachers are interested in using AR technology for a variety of reasons. First and foremost, it is inspiring, entertaining, and engaging, which supports the earlier findings (Karacan, 2019; Pasalidou & Fachantidis, 2021; Uygur et al., 2018). They were also adept at coming up with original activities for various scenes or keeping activities going throughout the scenes, which was another important factor. A few EFL teacher candidates added that they planned to use AR technology because they thought its use would become more common in education in the future, which does not support the finding by Nöhrer (2020), who found that a few teachers felt hesitant about the quick adoption of this technology.

Furthermore, some EFL teacher candidates were unsure, and some were opposed to using this technology, which can be confirmed by Nöhrer's study (2020). There are a number of reasons why they were initially hesitant to use AR technologies in the future. They noted that this innovation might not be available at their institutions because of its geographical location, and rural schools might not have the necessary hardware and facilities to implement this immersive technology, which confirms the findings by Putiorn et al. (2018). A further consideration in this regard is the environment of the school in which they will be employed, as managers' viewpoints on the adoption of AR technology in English language classrooms may have an impact on their willingness to do so. Since AR-enhanced activities require some time for both planning and implementation, the load of the language curriculum may also have an impact on students' desire to use them, as also posited by Kaenchan (2018). They may not want to deal with the hassle of getting permission to carry out tasks that require students to use smartphones during class hours because students are forbidden from doing so, which is another possible explanation for their resistance. They also asserted that realia was superior to AR as an

instrument for English language instruction, and they preferred utilising realia to AR-based visuals.

In general, following the introduction of AR technology in English lessons, the majority of participants displayed a favourable attitude towards its use, although a few did not foresee any forthcoming advantages from this technology.

5.2 The pre-service EFL teachers' SPSEL in employing AR

This study also set out to explore pre-service EFL teachers' SPSEL in utilizing AR by gathering data through the self-efficacy scale before and after their experience in preparing AR-embedded materials for ten weeks.

There was no significant difference observed between the SPSEL after the ten-week preparation of AR-based language learning materials. This suggests that the effort put into creating these materials did not have a significant impact on the participants' SPSEL in utilizing this immersive technology. This outcome aligns with Kaenchan's (2018) study, which found that self-efficacy levels among EFL Thai students remained consistent across various instances, including computer tutorials, teacher presentations, and student showcases. The prospective EFL teachers provided reasons for their SPSEL with AR technology, which can be categorized into three dimensions: intrapersonal, interpersonal, and technological and technical. When examining the intrapersonal aspects, it was evident that their low self-efficacy in using this technology was influenced by CA. Rather than attributing their unease to the software, they linked their anxiety to the lack of essential hardware and the challenges associated with obtaining this equipment, aligning with Delello's (2014) research findings. As Alsadoon and Alhussain (2019) noted, the absence of technical assistance renders some hesitation and creates a sense of reluctance in potential teachers when it comes to incorporating AR technology into their professional environments. The complex AR technology interface is another factor that makes them anxious. Regarding the second reason, some participants admitted they were just not computer and technology savvy. Due to these, they had low self-efficacy in creating AR-based activities. Regarding interpersonal factors, the prospective EFL teachers stated that some would prefer to work in pairs while some others would prefer to work alone. Pair work may have been chosen because it allows participants to generate various activities, receive assistance from their peers, and assist others where they need it while preparing AR-based activities. In terms of the justification for the choice of individual work, they want to do the assignments independently. PP is another factor, as some groups do not even typically cooperate and hence dominate others in terms of decision-making during activity design. Lack of training on how to teach English to different types of learners through AR technology might also lower users' self-efficacy in using the technology, which falls under the third category of technological and technical aspects. Participants' low self-efficacy suggests that, for the outcome of the material design to be effective, an input session on utilising AR technology must be held before

the implementation. This finding aligns with prior research by Kaenchan (2018) and Karacan (2019), which has previously documented the importance of offering training to both pre-service and in-service teachers regarding the use of AR applications for teaching and material preparation. Another possible explanation can be that the prospective EFL teachers took only three courses on technology. However, as these courses are not field-specific, it cannot be claimed that the course content is specifically designed for equipping EFL teacher candidates with the knowledge and skillset on how to design technology-integrated language learning materials. The fact that they were digital natives does not guarantee that their SPSEL in designing technology-enhanced language learning materials would be supposedly high. As Putiorn et al. (2018) posited, lacking the necessary technological hardware can also make it more difficult to manage the activity design and implementation processes, which may lower users' levels of SPSEL in employing AR. Their fact that there was no significant increase in their SPSEL may also be linked to the complexity involved in utilizing this immersive technology, as indicated by Akçayır and Akçayır (2017). The EFL teacher candidates highlighted the challenges they encountered in integrating motion and suitable imagery for 3D models into their materials, confirming the findings of Delello (2014). This result also validates the assertions made by Belda-Medina and Calvo-Ferrer (2022) that instructors' lack of practical expertise and experience are significant contributors to their low self-efficacy regarding AR technology.

In conclusion, the pre-service EFL teachers' SPSEL in utilising AR did not show statistically significant difference. This finding can be explained by intrapersonal, interpersonal, technological, and technical factors, which are also in line with the pertinent literature.

5.3 Implications

This study's contribution to the field of AR as an instructional technology lies in that research on using AR technology in language teacher education are particularly limited, so this study can fill this niche in the literature. Exploring EFL teacher candidates' acceptance is important because they are the agents in determining whether to integrate AR technology into English courses or not. The prospective EFL teachers' SPSEL is an important predictor of their future intent to benefit from AR technology; therefore, the findings can contribute to further studies in this area.

As for implications for practice, based on these findings of the current research, several interrelated and dynamic procedures are suggested to increase the levels of acceptance and SPSEL to use AR among EFL Teacher Candidates. Figure 6 below illustrates a guide that can be used in applying these main procedures. First, prospective English language teachers' SPSEL in employing immersive technology can aid teacher educators in (re)designing curriculum and directing curriculum designers to include courses that address the inclusion of immersive and emergent technologies into ELT. Some courses can be included in language teacher education programs to give prospective language teachers experience with AR-enhanced environments and

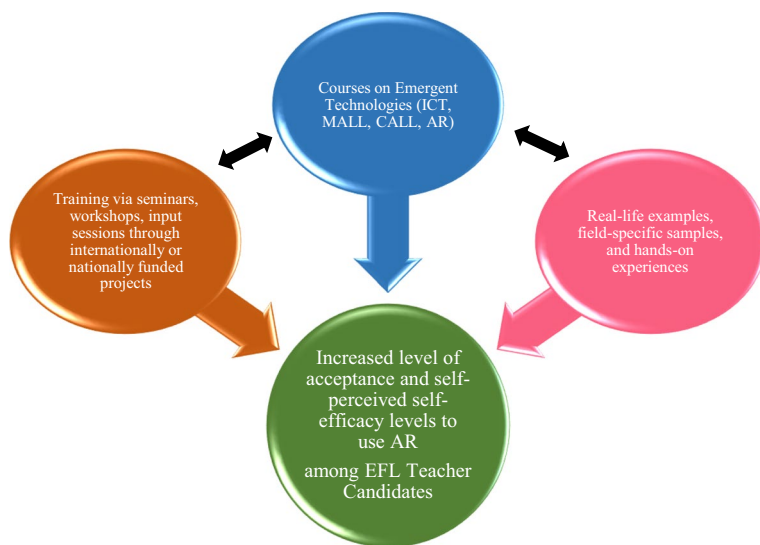


Fig. 6 Guide emerged from the findings of this study for the main procedures to be used to increase the levels of acceptance and SPSE to use AR among EFL Teacher Candidates

the creation of AR-embedded materials. English Language Teacher Education programs can consider incorporating specialized courses like “ICT Integration in ELT,” “CALL,” and “MALL,” as recommended by prospective EFL teachers. In addition to formal courses, practical workshops, input sessions, and webinars can be organized to give prospective EFL teachers hands-on exposure to AR technology and to enhance their understanding of cutting-edge technologies. This training can also be provided with the help of internationally (Erasmus+ i.e.) or nationally funded (TÜBİTAK, i.e.) projects. The input session conducted as part of this study can be utilized as well. These programs can increase EFL teacher candidates’ confidence in their ability to use AR tools in the future. Thus, English teachers in training can be ready to use such cutting-edge technologies effectively in EFL curricula.

This part offered some implications for teacher education to improve EFL teacher candidates’ SPSEL in making use of emergent technologies like AR. Although nowadays teacher candidates are digital natives, they are not necessarily competent in designing technology-integrated materials unless they have been guided in this regard. Therefore, we as teacher educators can assist teacher candidates to be competent in designing such materials through the means such as training and courses on emergent technologies.

6 Conclusion

By analysing EFL teacher candidates' acceptance and SPSEL in employing AR technology to produce materials for language instruction, the current research contributes to the expanding literature on using AR technology for educational purposes. It was discovered that prospective EFL teachers now accept AR technology substantially more than they did before the activity design phase. However, there was no statistically significant change in their SPSELS when it came to using AR technology for crafting AR-enhanced materials following the activity design phase. Their low self-efficacy could be due to an array of factors, including intrapersonal ones like CA and low CSE, interpersonal ones like PP and PA, and technological and technical ones like ART, TI, CI, and the duration factor.

Notwithstanding these constraints, the results offer the following research directions. First, the sample size might not be sufficient to make generalisations about the characteristics of the population. Second, due to non-probability sampling, namely convenience sampling, the findings might not accurately reflect the population. To give a more thorough investigation of the phenomenon, additional empirical research using random sampling and higher sample sizes can be incorporated into further research studies. Third, the results were restricted to data coming from the EFL teacher candidates enrolled in a private university with a B.A. in ELT. Hence, there is a need to undertake a nationwide research project involving prospective EFL teachers across different types of universities (i.e., foundation, public, and private) offering ELT teacher education in Türkiye. Furthermore, considering that the AR-based activity in this research spanned a ten-week design period, a longitudinal follow-up study could be carried out to monitor the evolution of their SPSEL in utilizing AR over an extended timeframe.

Another research can focus on the acceptance and SPSEL of making use of AR among in-service EFL teachers. Additionally, a paucity of scholarly inquiry exists regarding the application of AR for the assessment of language proficiency, underscoring the need for additional investigation of this domain. Lastly, within the scope of this study, we could only analyse the prospective EFL teacher candidates' SPSEL because they could not have the opportunity to put their AR-based materials into use at the dawn of the pandemic in 2020, apart from one student who made use of her material during her private lessons via Zoom. Further research can assess their SPSEL in employing AR after they implement their AR-based materials in a real classroom environment.

Appendix: Sample activity

Skills Integrated	Grammar, reading, spelling
Students' Level of Proficiency:	A1
Students' Age:	9-10
Class Size:	15 students
Duration of the activity: (not less than 15 min.)	15 minutes
Lesson Topic / Theme:	Prepositions of place
Lesson Focus (Teaching Point):	Putting the correct preposition for the places
Pre-requisite Knowledge:	We assume that students have already learned these prepositions. This is an exercise for them.
Objectives:	At the end of this activity, students will be able to; -use the correct preposition for places -talk about places by using prepositions of place -write these prepositions correctly
Test Code: (Blippar)	1458562
Procedure: There is a map in the scene. The girl in the map moves place to place. When the girl stops at a place, students will click on the writing (next to the place) and will answer the question. If they answer it correctly, they will click on "next" and go to the next place. If they answer it wrong, they will click on "go back" and go back to the same question until they find the correct answer.	
Reference(s) for your picture:	https://www.shutterstock.com/tr/image-vector/cartoon-map-river-250467817 https://tr.pinterest.com/pin/544372673706649953/ https://www.shutterstock.com/tr/image-illustration/abstract-gray-background-508982365 https://www.shutterstock.com/tr/image-vector/green-check-mark-icon-tick-symbol-522874111 https://www.vectorstock.com/royalty-free-vector/cross-mark-and-check-mark-vector-12286409

Trigger Picture:



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Data availability Raw data supporting the conclusion will be provided by the author upon reasonable request.

Declarations

Ethics approval This research (071-(ODTÜ)-2020) was approved by decision number 28,620,816/071 by the Applied Ethics Research Centre of Middle East Technical University on 20.02.2020.

Consent to participate Participants were volunteers who filled an informed consent form. They had the right to withdraw from the study at any point. Finally, pseudonyms were used to anonymise the data.

Conflict of interest The authors state that the study was conducted without any conflicts of interest in business or financial relationships.

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