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The effects of AR-enhanced English Language Learning Experience on Students' Attitudes, Self-Efficacy and Motivation

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Abstract

This mixed-method pre-test/post-test experimental study aims to investigate the effects of Augmented Reality (AR) supported English as a foreign language course on 42 high school students' attitudes towards the English language course, on learners' beliefs of self-efficacy in English and on their motivation towards the instructional materials used in the class. Following a 10-week teaching period, both the quantitative and the qualitative results showed that the AR-enhanced foreign language education significantly improved students' attitudes towards the English language course and increased their beliefs of self-efficacy in the English language. The results also revealed that the implementation of AR technology had a significant positive impact on the motivation levels of learners towards the instructional materials in the classroom. The AR technology in the class served as an interactive and entertaining tool which transformed a monotonous learning atmosphere into an engaging and effective one. Finally, the findings confirmed that AR-driven listening and speaking activities could lead students to gain a good understanding in English language topics and that teachers could make use of AR not only in classrooms but also for extra-curricular activities.

Keywords Augmented reality · Foreign language learning · Improving classroom teaching · Interactive learning · High-school education

Introduction

Augmented reality (AR) is a technology that enables users to interact with virtual objects in the real world by simultaneously combining digital information with the ones from the physical world through various technologies (e.g. mobile devices) (Milgram et al., 1995). It can be argued that AR technology creates a perfect bridge between the real physical environment and virtual objects (Klopfer & Squire, 2008). A surgeon's viewing the vital functions of a patient through special glasses in 3-dimensional (3D) during an operation without looking at a monitor constantly might be a better example to help visualise such bridging. AR is not only exploited for professional activities but also used for entertainment and leisure (Iatsyshyn et al., 2020). A well-known example can be Pokemon GO used worldwide (Chamary, 2018). This game is a popular AR based mobile app that combines virtual objects with the real world. The popularity of AR technology has increased as its use and accessibility have been easier (Johnson et al., 2010). In the Horizon Report (Freeman et al., 2017), it was foreseen that AR would become one of the most used technologies in K-12 education in the next 2 to 3 years. With novel learning and teaching opportunities offered by AR, teachers are now more aware of its potential in education so the implementation of AR in the classroom is more common than ever before.

The potential power of AR is that it offers the opportunity to explore some situations that are near-impossible or very difficult to experience in the real world by bringing together physical and virtual objects (Johnson et al., 2010); moreover, the teaching of complex abstract concepts can be made easier to comprehend by concretizing abstract concepts (Cai et al., 2019). In general, 3D visualizations of AR technology can be utilized to create immersive learning environments that make authentic and situated learning possible and improve interactive and collaborative learning (Fan et al., 2020). In this context, there are numerous benefits of using AR technology in educational settings (Table 1):

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Table 1 Educational benefits of AR technology

Educational fields	Educational benefits	References
Science education	Improving laboratory skills Building positive attitudes towards science laboratories	Akçayır et al., 2016
Mathematics Education	Improving interactivity Increasing performance Promoting positive attitude	Demitriadou et al., 2020
Physics education	Enhancing self-efficacy Increasing motivation	Cai et al., 2021
English Education	Improving learning and motivation Providing attractive and effective learning Enhancing entertainment	Redondo et al., 2020
Astronomy education	Reducing mental load Improving learning	Liou et al., 2017
Geography education	Increasing academic achievement Decreasing cognitive load levels	Turan et al., 2018
Biology education	Increasing interest and motivation	Erbas & Demirer, 2019
Chemistry education	Improving positive attitude towards learning	Cai et al., 2014

A review of the literature suggests that learners' studying via AR can cause better academic performance, improved their learning pleasure, increased interest, closer interaction with 3D teaching contents, involvement of multiple senses actively in the learning process, collaboration, enjoyable lessons and more student-centered teaching environment (Akçayır & Akçayır, 2017; Dey et al., 2018; Parmaxi & Demetriou, 2020; Safadel & White, 2019). Although many researchers draw attention to various benefits of AR in education, some disadvantages are also reported. While many of these concern technical difficulties and problems that occur during AR experience (Lin et al., 2011) the others are increased workload for teachers and that some teachers find AR applications time-consuming (Kerawalla et al., 2006). In terms of the need for time in using AR-based teaching content, Munoz-Cristobal et al. (2015) emphasize that using AR technology effectively in a classroom requires more than an average class time. In addition, teachers should be well-equipped and trained to use AR as intended, to achieve the desired results and to cope with technical problems that may arise during its use (Billinghurst & Duenser, 2012). Trust et al. (2021) warned that although AR offers several benefits such as deeper learning, boosting spatial and visual skills and increasing engagement, teachers need to be familiar with using AR technology in terms of resolving problems when incorporating AR technology into their practice. Considering the advantages and disadvantages of AR for educational purposes, it can be said that its advantages are reasonably more, and the disadvantages may decrease depending on the technology acceptance levels and the frequency of use.

The Use of AR in English Language Teaching

Technology has an important place in creating learning scenarios, especially in foreign language education. Authentic or virtual learning scenarios, consisting of situations that students may encounter in daily life, enable students to gain experience to use a foreign language in daily life (Preston et al., 2015). Specifically, the use of AR technology can be a promising and effective tool to teach a foreign language in early childhood (Fan et al., 2020). In addition, AR applications provide contextual learning environments based on real world scenarios, which might facilitate foreign language learning (Ho et al., 2017; Redondo et al., 2020). In this perspective, students of English as a foreign language who have difficulty in daily life conversations in English can be expected to benefit from the numerous advantages given of AR applications so as to overcome their speaking-related problems.

As a foreign language learning experience is a process with full of ambiguity, especially for the beginners, AR offers a promising way to make the ambiguous verbal concepts of English clearly understandable. Owing to AR, information can be personalized according to student profiles and preferences, the learning environment can be re-designed to provide rich and immediate feedback and thus, a meaningful and contextual learning environment can be created in real life (Godwin-Jones, 2016). In a study conducted by Ho et al. (2017), AR technology was used to associate the English language learning experience with real life. The researchers were able to create an AR based learning environment by adapting appropriate learning strategies for students' different cognitive styles to teach daily conversation in English.

No-one would question that psychological factors such as attitudes, motivation and self-efficacy are important contributors to success in mastering an objective such as learning a foreign language (Gregersen & Mercer, 2022); therefore, the effects of AR on learner psychology should be handled with care. It has been clearly emphasized in many studies that motivation is an important affective variable in

foreign language learning (Dörnyei, 2009; Dörnyei & Ushioda, 2011). Since motivation plays a key role in influencing foreign language learning outcomes, many motivational theories on language learning have been proposed and some of these theories have been widely accepted (Dörnyei & Ushioda, 2011; Liu & Huang, 2011). In this context, the use of AR in foreign language education stands out with its potential to positively affect learner motivation. According to Law and Heintz (2021), the use of AR is popular in language learning because of its capacity of visualizing learning scenarios that enhance student motivation, especially students in primary and secondary school. In their study, Redondo et al. (2020) revealed that AR applications in English learning positively affect students' motivation. Dalim et al. (2020) found that AR provides an effective and enjoyable learning experience to motivate children to deeply learn English as a second language and increase knowledge gain, especially in learning abstract words. Taskiran (2019) assessed the effect of game-based AR learning materials on student motivation while teaching English as a second language and revealed that these learning materials make foreign language learning interesting and enjoyable as well as increase student motivation. In a different study, Mahadzir and Phung (2013) investigated the effects of using AR pop-up books in English language learning and found that AR increased student motivation. Another study conducted by Di Serio et al. (2013) revealed that utilizing AR in the classroom environment positively affected students' motivation in their study of how secondary school students' motivation levels changed due to the use of AR technology in their visual arts class.

The literature suggests that motivation is affected by the student's attitude to learn a foreign language and, as a result, students' attitudes play a critical role in keeping their willingness and effort to learn the foreign language at high levels (Liu & Huang, 2011). At this point, the attitude can be explained as the value the student attaches to learning, how interesting he/she finds the information to learn, and the level of benefit he/she predicts from the information to be learned (Cochran et al., 2010; Ustun & Tracey, 2020, 2021). A study conducted by Bursali and Yilmaz (2019) revealed that AR applications draw 5th grade school students' attention and increase their motivation and attitude. This study showed that students who are involved in AR based reading activities are significantly better in reading comprehension than students who are traditionally involved in reading activities. A similar experimental study carried out by Wu (2021) showed that the use of AR as a learning tool promotes students' attitudes and learning outcomes in language learning. Another study conducted by Akçayır and Akçayır (2017), it was revealed that the lessons taught using AR technology increased students' learning pleasure, motivation, overall interest in the lesson. Another finding of the study

was that students felt more comfortable in taking an active role in classroom tasks. Given that, one might clearly link the potential benefits of AR technologies to the foreign language classroom where active participation is an obligation for improving communication skills in the target language.

Self-efficacy is another dimension that could be investigated in AR-enhanced classes. Self-efficacy was explained by Bandura (1977) as a person's belief in self-regulation and effort to achieve the goal. Several studies reveal the importance of self-efficacy and its effect on academic achievement. For example, in a study conducted by Zajacova et al. (2005) on 107 freshmen, it was found that self-efficacy had a significant positive effect on students' course scores. In a similar study conducted by Kitikanan and Sasimonton (2017) investigating the effects of self-efficacy on English language learning of 32 fourth-grade university students, it was found that self-efficacy positively contributed to English language learning. Learning environments created using AR technology might help students reach their learning goals as the use of AR could improve students' critical-thinking and problem-solving skills by creating learning situations appropriate to individuals' strengths and learning preferences (Dunleavy et al., 2009). For instance, an empirical study carried out by Cai et al. (2021) uncovered that the integration of AR into physics lessons promotes students' self-efficacy in terms of cultivating a higher level of conceptions and improving their sophisticated thinking skills. Similarly, Cai et al. (2019) integrated AR technology into the mathematics classroom and found that high school students' self-efficacy is enhanced in terms of the understanding of complicated concepts. In this sense, the use of AR in language learning might improve students' self-efficacy to apply their higher-level cognitive skills for challenging tasks such as writing an essay, learning abstract words or speaking without feeling anxiety.

Purpose of the Study

Reviewing the literature on AR in English language education, it can be seen that there is still a need for a comprehensive study which thoroughly examines the effects of AR on foreign language learners' attitudes, motivation and self-efficacy as the majority of studies available in the literature merely focus on the impact of AR in education on a single variable (Sahin & Yilmaz, 2020). In order to fill this gap, this study aims to evaluate the effects of AR-supported foreign language education on learners' attitudes towards the English language course, on learners' beliefs of self-efficacy in English and lastly on their motivation towards the instructional materials used in English language course. Another novel aspect of this study is that it tries to deal with multiple psychological factors triggered by the use of AR in formal, on-going educational environments in a relatively

longer period. More specifically, this study will answer the following research questions:

- To what extent does AR-supported foreign language education influence high school students' attitudes towards the English course?
- Does AR-enhanced foreign language teaching have a significant effect on high school students' beliefs of self-efficacy?
- Does AR-enhanced foreign language teaching have a significant effect on high school students' instructional materials motivation?
- What are high school students' perceptions of AR-supported foreign language education?

Methods

Research Design and Participants

In this study, an experimental design with pre-test and post-test control group was used. The participants were 42 10th graders studying in a public high school in Turkey. The participants were randomly distributed into two groups in approximate numbers so as to form the control and the experimental groups. Finally, there were 20 students in the control group and 22 students in the experimental group. Of the students participating in the study, 14 (33.3%) were male and 28 (66.6%) were female.

In their high school, these students are taught English as a foreign language for four hours a week. Within the scope of the research, while the students in the experimental group were introduced AR-enhanced foreign language education, the students in the control group were introduced non-AR-used foreign language education for 10 weeks.

This research follows a mixed method approach as it employs both qualitative and quantitative data collection instruments. As seen in Fig. 1, after informed consents were obtained and the participants were informed about the research, the students were asked to fill in the attitude towards the English course scale, the self-efficacy in English scale, and the motivation towards the teaching material scale in the pre-test stage. Following the 10-week instruction stage, these three scales were administered again as the post-test and a semi-structured interview form was employed to record students' views on their learning experience.

Instruments

The data collected in this study were obtained from three different scales, which were used as the pre-test and post-test, as well as a semi-structured interview form to collect verbal data regarding students' language learning experience.
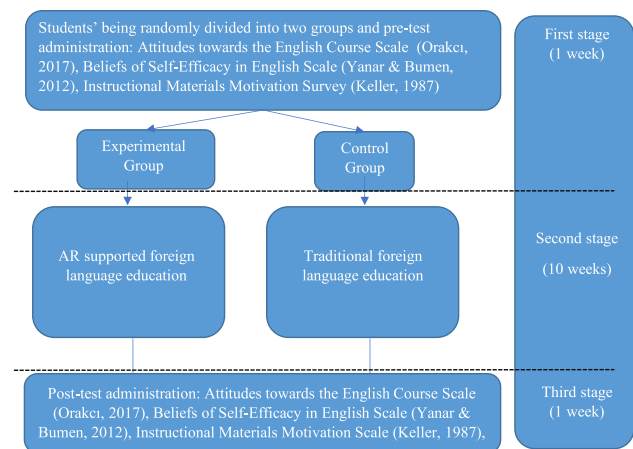

Fig. 1 The experiment process

a. **Attitudes towards the English Course Scale.** In this study, Attitudes towards the English Course Scale (Orakcı, 2017) was used to evaluate students' attitudes towards the English course. Having 2 factors, affective and behavioural, the five-point Likert type scale consists of 16 items in total. High scores obtained in this scale simply indicate positive attitudes. Cronbach's alpha coefficient was recomputed for this study, and value was 0.91.

b. **Beliefs of Self-Efficacy in English Scale.** A second scale used in this study was Yanar and Bumen's (2012) Beliefs of Self-Efficacy in English Scale. Consisting of 34 items, the scale has skill-based sub-dimensions which could be categorized as reading, writing, listening, speaking. High scores obtained in this scale show higher levels of self-efficacy beliefs. A reliability analysis of the scale was carried out to measure Cronbach alpha coefficient and it was found 0.96.

c. **Instructional Materials Motivation Survey (IMMS).** The third and the last quantitative instrument used for this study was an adapted version of IMMS (Instructional Materials Motivation Survey) in Turkish. This survey was originally developed by Keller (1987) and later adapted to Turkish by Kutu and Sozbilir (2011) and it aims to measure students' motivation levels towards the instructional materials used in the English class. Confidence—satisfaction and attention—relevance factors constitute this 24-item, five-point Likert type survey. For this study, the scale's Cronbach's alpha coefficient was 0.85.

d. **Opinion forms. Opinion forms**, the only qualitative element of this mixed-method study, were used to evaluate students' views on AR supported foreign language learning experience. The structured form involved questions similar to the sub-dimensions of the quantitative instruments used (see below for examples) and these

questions were reviewed by language teaching and instructional Technologies experts:

Data Collection

In the study, students in the experimental group were introduced a specifically-designed coursebook (Çimen et al., 2019) which included embedded QR codes for each chapter as well as for some individual activities to support teaching practices in English with hands-on, digital contents. While providing an interactive learning environment, this coursebook was designed to make learning not only more effective but also efficient by drawing learners to the centre of the learning process. Students were able to visit the web interface for accessing the digital contents thanks to the QR codes (see Fig. 2).

This interactive coursebook and its contents were prepared and stored by the Turkish Ministry of Education so as to help the course be more interesting and efficient by

the integration of audio, video and animation. In addition to its native interactive contents (e.g. Fig. 3), some activities of the book were supported with external AR applications implemented by the researchers (e.g. Fig. 4). Assemblr Edu mobile application was used and students' books were manually added a few more QR codes for them to have access. *Assemblr Edu* is an easy-to use mobile platform that enables educators to make more interactive and collaborative learning activities with AR. The mobile platform utilises the camera of the device to trigger certain activities such as bringing a 3D image or playing a YouTube video. Once an activity is created by the educator the app simply exports a QR code for scan-to-see purpose.

Throughout the study, students in the experimental group were asked to bring their tablet computers or smartphones to foreign language classes. First, the teacher led the class and covered the fundamentals of the topic presented in the coursebook and later students were asked to use their tablet computers or smartphones to view and study the Web or

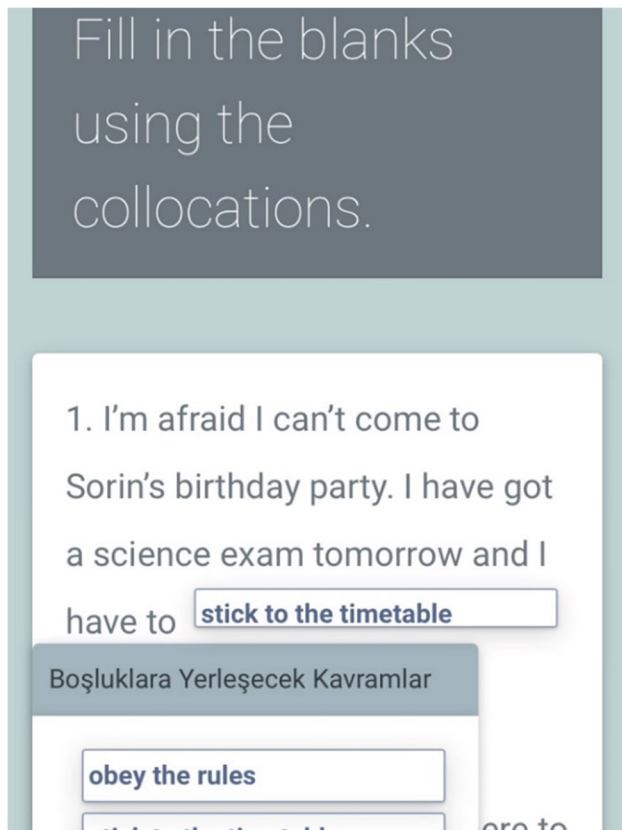**Fig. 2** A sample page showing how the coursebook units with the QR code look

TRAVEL

FUNCTIONS
- Talking about past and present events/experiences
- Booking
- Exchanging ideas and plans
- Asking for approvals and/or confirmations

57

Fig. 3 An interactive fill-in-the-blanks activity accessed on mobile phone

AR-driven contents thanks to the QR codes given in the coursebook.

Data Analysis

A Kolmogorov–Smirnov test was performed whether the participants' scores obtained from the scales have a normal distribution. The data were normally distributed ($p > 0.05$); as a result, the data analysis was carried on with parametric tests. The quantitative pre-test and post-test data collected with the help of three instruments, Attitudes towards the English Course Scale, Beliefs of Self-Efficacy in English Scale, and Instructional Materials Motivation Survey were compared by performing ANCOVA. On the other hand, content analysis method was employed to interpret the qualitative data. After the data were encoded by a researcher, were re-encoded by a second researcher (coder) for reliability. The intercoder reliability percentage was 94% = (the number of codes which the coders agreed on divided by the number of total coded items) (Miles & Huberman, 1994). For the difference of 6%, the coders discussed and came to an agreement. When the qualitative data were examined, it appeared that this difference might be because of some answers given

by one of the participants could be belonging to more than one sub-theme.

Results

Attitudes towards Foreign Language Learning

To address one of the first aims of this study, an answer was sought to the question of whether there was a significant difference between the scores of the students in the experimental and control groups in their attitudes towards the English course.

The pre-test scores of the students in the experimental and control groups obtained from the attitudes scale were tested by using post-test as a covariate. Before computing ANCOVA, the assumptions of homogeneity of the variances and regression were checked and found satisfied ($F = 2,471$; $p > 0.05$). The experimental group's corrected post-test mean score was found as ($\bar{x} = 64.43$) and the corrected post-test mean score of the control group was ($\bar{x} = 54.27$). The results of the covariance analysis showing experimental and control group students' attitudes towards the English course are presented in Table 2.

After an examination of both groups' pre-test scores, the difference between the post-test mean was found significant [$F_{(1,39)}$: 14.725; $p < 0.05$] and the experimental group's adjusted mean post-test scores ($\bar{x} = 64.43$) were significantly higher than the control group's adjusted post-test scores ($\bar{x} = 54.27$). As seen in Table 2, the covariate variable was the study groups' pre-test scores and the grouping main effect was significant with a medium effect size [$F_{(1,39)}$: 14.725; $p = 0.000 < 0.05$; Cohen's f = 0.27] (Cohen, 1988).

Self-Efficacy in Foreign Language Learning

The effects of AR enhanced language learning experience on students' beliefs of self-efficacy in foreign language learning was another issue in this research study. In order to examine the experimental and the control group differences in terms of their beliefs of self-efficacy scores, Covariance analysis was carried out. Before computing ANCOVA, the assumptions of homogeneity of the variances and regression were checked and found satisfied ($F = 0.549$; $p > 0.05$). The experimental group's corrected post-test mean score was found as ($\bar{x} = 123.77$) and the corrected post-test mean score of the control group was ($\bar{x} = 92.44$). The results of the covariance analysis regarding the beliefs of self-efficacy post-test scores of the students in experimental and control groups are demonstrated in Table 3.

After an examination of both groups' pre-test scores, the difference between the post-test mean was found significant [$F_{(1,39)}$: 26.885; $p < 0.05$], which would indicate that the
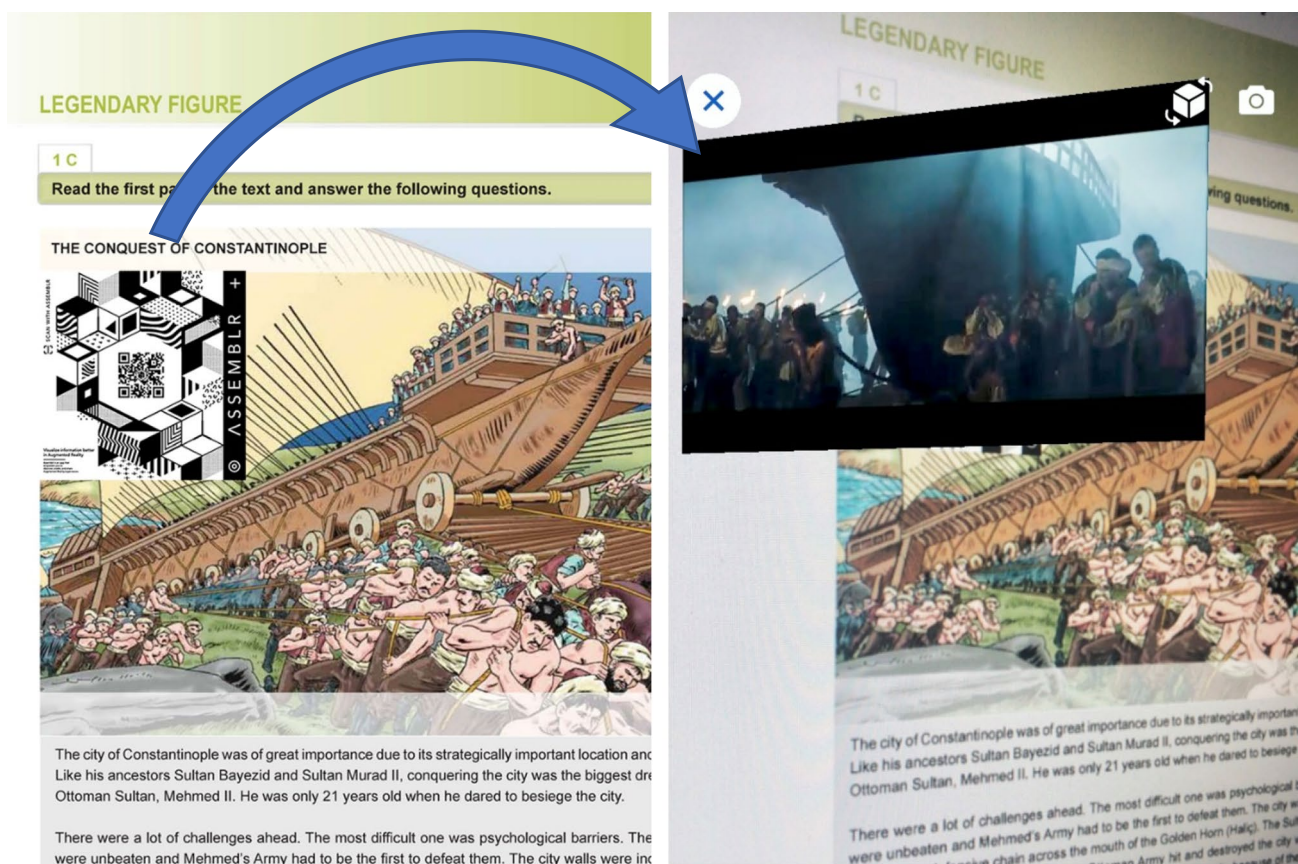
Fig. 4 QR and AR use to support a reading activity with video in Unit 3

Table 2 Covariance analysis of students' attitudes

Source	Sum of squares	df	Mean square	F	p
Pre-test	218.480	1	218.480	2.973	.093
Group	1082.071	1	1082.071	14.725	.000
Error	2865.925	39	73.485		
Total	152693.000	42			

Table 3 Covariance analysis of students' beliefs of self-efficacy

Source	Sum of squares	df	Mean square	F	p
Pre-test	2827.184	1	2827.184	7.391	.010
Group	10283.481	1	10283.481	26.885	.000
Error	14917.630	39	382.503		
Total	525718.000	42			

corrected post-test scores of the students in the control group ($\bar{x}$= 92.44) were significantly lower than the corrected post-test scores of the students in the experimental group ($\bar{x}$= 123.77). As seen in Table 3, the covariate variable was the study groups' pre-test scores and the grouping main effect was significant with a medium effect size [$F_{(1,39)}$: 26.885; $p = 0.000 < 0.05$; Cohen's f = 0.41] (Cohen, 1988).

Motivation Towards the Instructional Materials

To move on to the third issue investigated in this research study, the pre-test scores of the students in the experimental and control groups obtained from the IMMS were examined by performing covariance analysis to test whether there was a significant difference between the post-test scores. Before computing ANCOVA, the assumptions of homogeneity of the variances and regression were checked and found satisfied (F = 3.500; $p > 0.05$). While the corrected post-test mean scores of the students in the experimental group were ($\bar{x}$= 107.59), the control group's score was ($\bar{x}$= 98.21). The results of the covariance analysis showing experimental and control group students' instructional materials motivation are presented in Table 4.

Post-test corrected mean scores of the experimental and the control group were significantly different [$F_{(1,39)}$: 30.201; $p < 0.05$]. Students of the experimental group ($\bar{x}$= 107.59) experienced significantly higher levels of motivation towards the instructional materials compared to

Table 4 Covariance analysis of students' motivation towards instructional materials

Source	Sum of squares	df	Mean square	F	p
Pre-test	5048.370	1	5048.370	166.335	.000
Group	916.612	1	916.612	30.201	.000
Error	1183.671	39	30.351		
Total	454067.000	42			

those in the control group ($\bar{x}= 98.21$). As seen in Table 4, the covariate variable was the study groups' pre-test scores and the grouping main effect was significant with a medium effect size [$F_{(1,39)}$: 30.201; $p = 0.000 < 0.05$; Cohen's f = 0.44] (Cohen, 1988).

Students' Opinions on the Use of AR in Foreign Language Learning

Participants' responses regarding the use of AR applications in foreign language learning were analysed and the content analysis yielded some positive and negative sub-themes. The positive opinions of the students are listed in Table 5.

When Table 5 is examined, it could be argued that AR enhanced foreign language education might lead to a better comprehension of the lesson, increase the interest towards the course as well as the participation, help improve language skills (e.g. pronunciation and listening skills), make the lesson a smooth and enjoyable experience, provide the opportunity to study and revise whenever and wherever, and lastly, help student become more self-confident. Some of the students' responses are as follows:

Table 5 Students' positive opinions regarding the use of AR applications in english language education

Sub-themes	f
Makes me understand the topic better	18
Makes me more interested in the lesson	17
Helps me improve my pronunciation skills	15
Increases participation in class	14
Improves listening skills	13
Makes the lesson fun	13
Increases my motivation towards the course	12
Provides an opportunity to revise as needed	12
Provides an opportunity to study the topics where and when I want	11
Gives me confidence that I will be successful in this class	8
Makes the course a smooth experience	7
Reinforces what is learned in the lesson through practice	5

S1: *"It (the QR code) makes it easier for me to check the answers to the questions I do not know and I can learn from there. I have the opportunity to double-check the topics I don't understand".*

S2: *"It (the QR code) helps us understand the subject better. It improves our listening skills".*

S3: *"The speeches (e.g. dialogue activities presented via AR) are very fluent and they contribute to our speaking".*

As mentioned earlier, students commented on some of the aspects of the AR experience that they had some problems or concerns with. These are categorized as the negative opinions and presented in the Table 6.

The fact that only 5 points raised by the students when asked about their negative opinions on the use of AR shows that the majority of the students did not face any problematic issues at any stage of their AR learning experience. The minority of them indicated that they encountered issues such as low voice quality of some listening parts and technical problems in connecting to the internet from their smartphone. Some responses are as follows:

S4: *"They (some others in the classroom) can copy answers from there (web interface) without reading and practicing, and this could affect us negatively."*

S5: *"…difficulty in understanding… only because they speak too fast in the listening parts"*

S6: *"Sometimes the words are not understood clearly, which causes us to mispronounce"*

Discussion

The results revealed that foreign language education supported by AR applications has a positive effect on high school students' attitudes towards English language classes, beliefs of self-efficacy in English, and lastly instructional materials motivation. The qualitative data uncovered several additional benefits of AR enhanced foreign language learning experience in parallel with the quantitative data. Although a few students have mentioned the technology-related problems in the use of AR, the majority of the participants highly appreciated the use of AR as it offered

Table 6 Students' negative opinions about the use of AR applications in foreign language education

Sub-Themes	f
Pronunciation of some words are not clear enough	2
Internet connection is not always available on our smartphones, so applications cannot be opened	2
Provides quick access to the answers to the exercises in the book (which could be misused – e.g. cheating)	1

an effective learning environment by introducing various advantages, such as providing the opportunity to revise the subject as needed and making the learning experience interactive and fun. As shown by a recent meta-analysis (Garzon & Acevedo, 2019), the use of educational AR applications contributes to the achievement of the learning outcomes at a higher level than the traditional multimedia supported teaching applications do.

In this study, it was found that the use of educational AR makes a significant positive contribution to the high school students' attitudes towards the English course. The main reason why students developed such a positive attitude towards learning English could be, no doubt, the AR itself. Similar to what was found in this study, Chen et al. (2020) found that AR-based English language teaching was innovative and effective; furthermore, it was especially revealed that all the students developed a positive attitude towards AR-based English language learning.

The use of AR in education is an innovative add-on that attracts students' interest, creates an opportunity for interaction and cooperation, and increases motivation (Huang et al., 2016; Liu & Tsai, 2013). In this study, it was concluded that supporting foreign language education with AR applications could play a key role in fostering high school students' motivation towards the instructional materials used in foreign language education. It could be argued that the higher motivation levels found in this study might be because the use of AR technology in educational settings could enable the students to actively interact with the course contents in an enjoyable way which is almost very close to the real-world experience. Because of the eye-catching nature of AR applications that create a fun environment (Akçayır & Akçayır, 2017) students are getting more involved in the learning. Considering that motivation is one of the key affective factors in language education (Dörnyei & Ushioda, 2011), AR applications could be utilized as an effective teaching method in different ways. It is worth mentioning that students' acceptance of using an innovative technology such as AR in the teaching environment is also related to the students' attitude towards the technology used (Chang et al., 2011; Ustun et al., 2021; Ustun et al., 2020). As Cheng (2017) states, there is generally a strong correlation between the users' motivation and attitude levels. A similar result was found in this study as, thanks to the use of AR, students' motivation and attitudes towards foreign language learning were found to be significantly higher. This aligns with another study conducted by Chen et al. (2020), that motivation and attitudes towards learning a foreign language increased after the AR introduction.

As Lifrieri (2005) asserted, the combination of high motivation and positive attitudes are almost two of the prerequisites for an optimal learning condition. In this context, it would be safe to say that AR enhanced language learning could create an enjoyable learning environment, which in return could allow students to improve their foreign language skills.

Another finding of the study was that AR supported foreign language education had a significant effect on high school students' self-efficacy regarding foreign language. It might be argued that the AR technology could make it easier for learners to remember the contents they see on the AR interface, and as AR offers tangible, collaborative and fun and learning, it enables students to actively participate in the learning process. There are many other studies suggesting that integrating AR technology into the educational environment significantly improves students' self-efficacy towards the subject, increasing both the effectiveness and the quality of education (Cai et al., 2021; Garzon & Acevedo, 2019). Especially when self-efficacy is considered as an effective predictor of student motivation and learning efficiency, its effect on students' academic achievement is inevitable (Bandura, 2006; Yusuf, 2011). All in all, considering its effects on attitudes, motivation and self-efficacy and its flexibility to be matched with other technologies (e.g. QR codes, 3D glasses, mobile applications, 360-degree videos), the use of AR in language classrooms could serve as a unique tool not only to create a peaceful classroom atmosphere but also to compensate for the real-time communication needs in a modern language classroom.

This study, on the other hand, has practical implications for language educators. Coursebook activities could be enriched with AR or QR applications which in return can affect learners' attitudes, motivation and self-efficacy levels positively and, the whole language learning experience could turn into an engaging and confidence-building one. AR could serve as a medium to introduce real-time communication materials for different settings so as to meet the demands of communicative language teaching. AR-enhanced activities not only hold the potential for improving foreign language learners' comprehension, pronunciation and listening skills but also provide the learners with the opportunity to study whenever and wherever they would like to. Therefore, especially listening and speaking activities could be supported by AR technology and teachers could make use of AR for extra-curricular activities. Having said that, further research could explore the key aspects of AR that are responsible for students' overall improvement and how the AR could be implemented to foster other skill areas such as reading and writing in a foreign language.

AR technology is one of the promising and innovative learning tools and AR-supported instructional materials potentially provide an authentic and entertaining learning environment in which students can be motivated to continue studying. In this sense, it would be safe to say that teachers, by utilizing the attractive nature of AR-based textbooks, now have an effective alternative to eliminate some of the

unappealing contents of conventional coursebooks. Besides, instructional designers should be astute to anticipate what emerging learning trends would be in the future; therefore, they might take various capabilities of AR into account while designing hands-on activities to offer more interactive and more engaging learning materials.

Conclusion

This study demonstrates the advantages of AR-supported language teaching by focusing mainly on its effects on students' attitudes towards English class, on students' instructional material motivation and lastly on self-efficacy. Quantitative results showed that AR-enhanced foreign language teaching significantly improved students' attitudes towards English lessons and increased their beliefs of self-efficacy in English. The results also revealed that AR technology had a significant positive effect on the instructional materials motivation levels of language learners.

Most of the participants stated that the use of AR brought many advantages in language education, while only a few students spoke of some technical difficulties especially in accessing to the AR contents. Although different studies show that various pedagogical and technological problems have arisen as a result of the adaptation of AR technology to the educational environment (Billinghurst & Duenser, 2012; Fjeld & Voegtli, 2002), it is well-observed in this study and in the literature that these problems often tend to decrease over time and their advantages and positive effects stand out more clearly. For this reason, as teachers experience the positive effects of AR use on students' cognition and affect, and as long as and the devices supporting AR applications are more affordable and accessible, it can be anticipated that, in the near and medium term, we are likely to see more AR-based applications in various stages of education.

Declarations

Conflicts of Interest/Competing Interests The authors declare that they have no conflict of interest.

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