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The use of augmented reality in a gamified CLIL lesson and students' achievements and attitudes: a quasi-experimental study

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Abstract

The advancement of technology has provided new avenues for English language teachers to assist students in improving their language learning processes. Augmented reality is an emerging technology that can implement virtual objects into the physical learning environment. This quantitative study aimed to determine the impact of employing augmented reality in a CLIL lesson. The study also looks at EFL learners' attitudes about the use of AR. For this purpose, 76 high school students (38 males and 38 females) have taken part in this study. The results showed that using an AR-based mobile application improved the language achievements of the learners. The learners who used AR have gathered better results in the CLIL lesson. Additionally, the learners had positive attitudes towards the use of augmented reality. They found it satisfying and engaging and were willing to use it in the future again. Based on the study findings, EFL teachers are encouraged to use AR in their classes to teach both content and the language.

Keywords: Metaverse, Augmented reality, CLIL, Gamification, Attitudes

Introduction

Today, mobile technology has become a fundamental part of students' lives. These Generation Z students are so-called *digital natives*. Thus, many students worldwide have handheld devices such as tablets and smartphones. Using mobile technologies, students may overcome time and geographical constraints (He, Ren, Zhu, Cai, & Chen, 2014). They can obtain information without visiting a library or sitting in front of a computer. Mobile devices are also used for entertainment purposes. For instance, learners can play games, watch videos, or listen to podcasts for the sake of their amusement without being constrained by time and location. A vast majority of teenagers (97%) play video games, and three billion hours a week are spent on gameplay (McGonigal, 2011). Conversely, English language teachers are frequently troubled by their students' disinterest in their classroom approaches (Ekiz & Kulmetov, 2016; Demir, 2017). Technology is, so to speak, advancing at an *alarming* rate. If one thing does not change forever, it is the *change*. English as a foreign language (EFL) teachers need to adapt to these changes and capitalize on the developments to help learners better. As games may provide a great

deal of engagement, why do we not gamify our lessons? In addition, Augmented Reality (AR) may be utilized to enhance language learning alongside a gamification technique for teaching English. For this reason, investigating the effect of an AR based mobile application in a gamified Content and Language Integrated (CLIL) class can help us gain insights and employ beneficial pedagogical techniques.

Literature review

In this section, a brief overview of relevant literature has been provided. The underpinning theoretical framework and key terms related to the study have been described.

Gamification

Gamification refers to using game components and game style within a context that is *not* a game (Werbach & Hunter, 2012). Using gamification provides learners with a motivating learning setting (Flores, 2015, Philpott & Sun, 2022). This, in turn, empowers teachers' pedagogy as motivation is necessary for EFL learning (Brown, 1994; Sanacore, 2008). However, how can gamification be employed in a particular EFL teaching context? Gamification can be applied in the classroom in various ways, meaning there are no strict rules that the teachers need to stick. The model of Huang and Soman (2013)that consists of five steps could be beneficial to follow: know about the learners to whom the instruction will be delivered, define and design the lesson by considering instructional goals and particular learning aims, structure the experience, identify the resources, choose and apply gamification element. Applying a gamification element may include using points to assess and display in a leaderboard, adding levels that students can go through by passing each of them, setting a time limit for a specific task to boost excitement, and giving badges as rewards. Any mechanic of the gameplay can be "uniquely" and "independently" integrated into one's own pedagogy by considering the aim of the lesson (Philpott & Sun, 2022, p. 2). Principled review studies reveal that gamification provides positive effects (Hamari, Koivisto & Sarsa, 2014) and helps maintain motivation as a solution to declining student engagement (Alsawaier, 2018) both intrinsically and extrinsically (Buckley & Doyle, 2016). Use of game elements as a novel approach increases student participation and engagement (Thiel & Fröhlich, 2017).

There are many games whose elements can be integrated into EFL teaching and learning. One example is the scavenger hunt. A scavenger hunt in education is an activity that learners search for hidden objects by following a series of locations in and around the school building to achieve particular learning aims. As scavenger hunt originates from a child game, it carries game elements such as rewards, scoring, competition, time limit, set of objectives. Scavenger hunt has been used in various fields of education for purposes such as an orientation activity for freshmen (Lu et al., 2015), improving intercultural communication (Santoso, 2020), teaching academic writing (Lin et al., 2021), a word study activity (Chen & Greenwood, 2021), enhancing confidence and networking (Mazzoli, Moffit, & Mansell, 2021), second language teacher training (Zhang, 2020), and improving learner engagement (Dakroub et al., 2022).

Gamification and emergent technologies are interrelated (Flores, 2015). Teachers can gamify any lesson utilizing emergent technologies. For instance, AR helps EFL teachers to create an immersive learning environment for the learners.

Augmented reality

AR refers to the technology mixing the actual environment with virtual components (Klopfer & Sheldon, 2010, Diegmann et al., 2015, Akçayir and Akçayir, 2017). It provides the learners with the experience of space, often seen through a camera implementing virtual objects and sounds into the actual environment. AR allows learners to experience both virtual and natural environments in an optimum way (Almenara & Osuna, 2016). AR allows learners to examine inaccessible items or get unavailable experiences (Merzlykin et al., 2019; Wojciechowski & Cellary, 2013). For instance, students can investigate a brain to learn its parts, interact with it, and have pre-coded conversations. AR has been used in educational contexts such as art (Di Serio, Ibáñez, & Kloos, 2013; Wei et al., 2015), medicine (Tang, Cheng, & Greenberg, 2019), biology (Erbas & Demirer, 2019), science education (Chang & Hwang, 2018), chemistry (Wan et al., 2018), physics (Matcha & Rambli, 2015), and astronomy (Liou, Yang, Chen, & Tarng (2017). There are mainly three types of AR: marker-based, markerless and markerless, and location-based AR.

Marker-based AR employs static images expected to be recognized by the camera to initiate the action (Godwin-Jones, 2016). QR (Quick Response) codes, a new kind of barcode, can be used as markers to generate learning experiences in a classroom setting (Kapp & Balkun, 2011, as cited in Kuru Gönen & Zeybek, 2021). The learners scan the code via camera and access the experience through the link automatically decoded by the handheld device. The essential ability of AR is to lay content upon the existing one so that the learners experience multiple facets (Radu, 2014). For instance, learners can experience three-dimensional (3D) visual representations and voiced pronunciations of words overlaid onto the real world in a vocabulary class by scanning a marker. In this way, learners' cognitive load is lowered, facilitating the learning process (Mayer & Moreno, 2003). Marker-based AR is the easiest and simplest way to experience AR, as marker-based activation accurately directs the user to the experience. Smart learning environments can be created for the students in and around the school by placing markers. Scholars have implemented marker-based AR in foreign language classrooms, such as helping the students learn vocabulary (Santos et al., 2016) and pronunciation (Solak & Cakir, 2015). Promoting the students to form marker-based AR experiences may also be engaging for students to learn (Godwin-Jones, 2016). Therefore, the teachers can take advantage of AR to help the learners. Markerless-AR scans the real environment and detects appropriate spaces to implement 3D virtual objects (Mystakidis et al., 2022).

In markerless AR, the student usually scans a horizontal surface in the real environment, such as a table, or a vertical surface, such as a wall, to access the AR experience. The AR system analyzes the real space and identifies the pixels to map the space to implement digital objects. Thus, the physical environment's actual characteristics are used instead of a marker. This brings about a limitation: the surface must have some patterns, colors, lines, or textures. A plain surface may ruin the AR experience as the technology usually cannot track the surface. On the other hand, markerless AR has some benefits. For instance, the experience can be interacted with in any place in time. Therefore, the learners have freedom of motion. They can also implement any digital content to express themselves easily. Metaverse Studio, CoSpaces Edu, and Figment AR are some platforms where teachers can find ready-to-use AR experiences. However, these experiences must be adapted to suit the lesson's particular learning objectives and the learners' needs (Karacan & Akoğlu, 2021).

Location-based AR layers digital data into the student's real environment using sensors and tools including Global Positioning System (GPS) and compass (Mystakidis et al., 2022). Unlike marker-based AR, location-based AR does not require a physical object to display the experience. The location of the students is utilized to trigger the experience (Belda-Medina, 2022). Location-based AR is a great source of technology that EFL teachers can use to create gamified AR-based experiences for learners (Lee & Park, 2020; Richardson, 2016).

The literature on the subject emphasizes the advantages of using AR for teaching purposes. The systematic review of 54 studies by Parmaxi and Demetriou (2020) regarding the use of AR in language learning indicates that AR provides increased positive emotions, improved language skills, enhanced interaction and learning opportunities. AR fosters learners' autonomy, creativity, motivation, and attention (Lee, 2012) and thus improves the learning process (Blagg, 2009; Alsowat, 2017; Arunsirot, 2020; Kuru Gönen & Zeybek, 2021). Regarding EFL learning, AR-based activities are engaging and may have a significant effect on learners' language achievements (Küçük, Yılmaz, Baydaş, & Göktaş, 2014; Richardson, 2016; Çevik, Yılmaz, Göktaş, & Gülcü, 2017). AR can be utilized to teach both receptive and productive language skills. Emergent researches show that AR improves students' reading skills (Tobar-Muñoz, 2017; ChanLin, 2018), listening skills (Río Guerra et al., 2020; Suwancharas, 2016), speaking skills (Dalim et al., 2020; Shea, 2014), and writing skills (Wang, 2017; Yılmaz & Göktaş, 2017). In addition, there is a substantial corpus of study reporting that AR improves EFL vocabulary repertoire of learners (Juan et al., 2010; Barreira, Bessa, Adão, Peres, & Magalhães, 2012; Solak & Çakir, 2015; Tandoğan, 2019; Tsai, 2018; Tsai, 2020). Moreover, AR may also provide greater retention rates (Lam, Sadik & Elias, 2021).

Metaverse

Metaverse Studio is a free platform where everyone can create an AR experience. The interface is simple to use and devoid of advertisements. The AR experiences can be created using a drag and drop system with no programming required. The teacher can create an AR learning experience by adding 3D objects, texts in speech bubbles, and voices. Once the experience is created and ready, the teacher can share the QR code with the learners. The platform has a mobile application called Metaverse. Students download it to their mobiles to access the experience by scanning the QR code. Although the platform is no longer under development, the developers have stated that the platform will stay available.

CLIL

Implementing extensive foreign language programs seems inefficient as many weekly class hours are devoted to foreign language education. Thereupon, educators in many parts of the world try to find the optimum way to enhance students' language learning processes. CLIL is a productive, strengthening, and supporting way of learning a foreign language (Lasagabaster & Sierra, 2010). A second or a foreign language rather than students' native tongues is utilized for teaching language and subject matter together.

Such an immersion learning approach may facilitate the learning process by lowering the cognitive load (Blakemore & Frith, 2005). Thus, understanding how CLIL affects brain activities is of significance. Van de Craen, Mondt, Allain & Gao (2007) compares

monolingual, bilingual, and school-bilingual brains to address this question. Their study compares magnetic resonance imaging (MRI) images of the brains of monolinguals, bilinguals, and school bilinguals whose ages are around eight. The brains of the young learners have been scanned when the learners make basic tasks such as calculations. The images that Van de Craen et al. (2007) share show that the bilingual brain is the one that has the lowest workload during the tasks. The monolingual brain has the highest workload, while school bilinguals have an intermediate load. Therefore, simultaneous learning of a foreign language and subject matter can lower the brain load during tasks that may lead to better learning (Van de Craen et al., 2007). Although these effects may be the characteristics of brain plasticity of monolingual, bilingual and school bilingual children, the results may also imply that CLIL tries to utilize this plasticity of bilingual learners and can facilitate the learning process. Therefore, CLIL can improve the cognitive aspects for better learning (Blakemore & Frith, 2005, as cited in Van de Craen et al., 2007).

Global goals

The technologies and industries have developed rapidly, but global issues such as inequity, poverty, access to clean water, and climate change remain consistent. A rapid solution to the problems does not exist. In 2015, leaders worldwide agreed on 17 goals with 169 objectives for global sustainability (Maley & Peachey, 2017). The Sustainable Development Goals (SDGs) cover all the dimensions for sustainable development of the world, and they consist of steps that are achievable. We find teaching SDGs to the students essential. The role of a teacher, especially an EFL teacher with spontaneous ties with the international society, may have the greatest significance in students' learning (Hattie, 2008 as cited in Maley & Peachey, 2017, p. 7). Therefore, we believe that EFL teachers around the world should take charge of making the new generation learn about the global issues and raising their consciousness on the SDGs for a sustainable development of the world. For this reason, the book of British Council has inspired us to implement SDGs into our study (Maley & Peachey, 2017). In the book, there are 22 chapters that point out a variety of SDGs. The book starts with a chapter written by Read (2017). The chapter aims to teach the objectives and names of all 17 SDGs. For the next chapters, a single global issue such as empowering women and ensuring healthy lives is scrutinized by various scholars.

Recent studies in the literature support the view that CLIL is beneficial for teaching both the target language and the subject matter such as Biology (Satayev et al., 2022), Chemistry (Bianco, Andonova, & Buhagiar, 2021), and Maths (Martí Arnándiz et al., 2022). CLIL can also be employed to teach about global issues (Maley & Peachey, 2017). As we believe that SDGs should be taught to the students, we aim to teach SDGs through an AR-based gamified CLIL lesson. The participants of our study would meet with the SDGs for the first time. Thus, we have been inspired by the chapter of Read (2017) to create an introductory AR-based gamified CLIL lesson for the students.

Although there is a growing corpus of research on AR, the number of studies concentrating on EFL learning is still limited. Regarding CLIL research based on AR, only a few studies are conducted (Martinez, Benito, Gonzalez, & Ajuria, 2017; Merzlykin et al., 2019). Thus, the present study aims to determine the effect of using AR in a gamified CLIL lesson on students' achievements at a private Turkish high school. The following research questions have been developed to achieve this goal:

1. Does the use of AR in a gamified CLIL lesson improve EFL students' achievements at a private Turkish high school?
2. What are EFL students' attitudes towards AR who used the AR in a CLIL lesson at a private Turkish high school?

Method

Population and study group

The primary objective of this study was to find out the effect of using AR on EFL learners' achievements. For this purpose, we employed a quasi-experimental research design (Fraenkel & Wallen, 2006). The study was conducted with 76 participants (38 males, 38 females). 38 learners in the experimental group had treatment through AR material, and 38 learners in the control group were given the traditional instruction.

Instruments

An achievement test and a scale were used to collect data. The achievement test was developed by two English language teachers and the researchers. The items were formed to measure the lesson's learning objectives, which were given for the present study. Three English language teachers reviewed the test. Therefore, the final version of the achievement test was created (Appendix 1). The test consisted of 10 multiple choice questions that were created by considering the aim of the lesson and the content of the AR experiences. The test was used as both pre- and post-test. We changed the order of the options and the questions to avoid memorization. The maximum score that a student can get in the test was 10, and each correct answer was scored as one point.

The other data collection tool was the Augmented Reality Applications Attitude Scale (ARAAS), developed by Küçük et al. (2014). ARAAS was used after taking the permission of the developers via e-mail. The scale had both Turkish and English versions (see. Appendix 2). The present study used the Turkish version as the participants' native tongue was Turkish. There were 15 items in this five-point (5 = strongly disagree, 1 = strongly agree) Likert type scale with three dimensions. The dimensions were "the use of satisfaction", "the use of anxiety", and "the use of willingness" (Küçük, et al., 2014, p. 389). The first dimension had seven positive statements, the second dimension had six negative statements, and the third dimension had two items. For the present study, the name of the second dimension was changed to engagement because the original naming appeared to be inconsistent with the items. Moreover, having less than three items per dimension was not recommended in the relevant literature. However, suppose there are two items in a dimension. In that case, it could be accepted as an exception (Raubenheimer, 2004, cited in Küçük, et al., 2014). The ARAAS was primarily tested for validity with the participation of secondary school students. Küçük et al. (2014) found the alpha score as 0.862, 0.828, 0.644 per dimension, respectively, and the overall internal consistency with a score of 0.835. Nevertheless, the scale was not tested for reliability on high school students. Thus, we conducted a coefficient alpha test with the participants of this study. The overall internal consistency of the scale was calculated as 0.921 (First dimension's $\alpha = 0.861$, second dimension's 0.789, third dimension's 0.781).

Procedure

Two different lesson plans were created for the control and the experimental group. Both had the same learning objectives but followed different teaching procedures regarding the aim of this study. These lesson plans were created after carefully examining the manuscript of Read (2017). We adapted the first lesson, named as "Discover and Prioritise the Global Goals", by making some changes to be used in the treatment period for the experimental group (Read, 2017, p. 12). First, the original activity was planned as 60 min. We have rearranged the lesson to make it approximately 40 min. This was because a class hour in the school that our study took place was 40 min. The aim of the original lesson was to introduce the learners the objectives and names of the United Nation's Global Goals, and justifying choices. We focused on narrower language learning aims by removing the latter aim and related parts of the lesson plan to cut down the lesson to 40 min. In our lesson plan, the students were expected to be able to name and talk about the Global Goals by the end of the lesson. Next, weadapted the experimental group's lesson using scavenger hunt elements to gamify the AR experiences for the CLIL lesson. We determined 10 locations and placed QR codes that would enable them to access various AR experiences. To create AR experiences, Metaverse Studio was used. The researchers created 10 AR experiences by considering the aim of the lesson by using Metaverse Studio. Then, the links to every single experience were embedded into QR codes. On the other hand, the control group's lesson was a traditional CLIL lesson with no AR use and no specific effort to implement game elements. The procedure followed three steps: pre-treatment, treatment, and post-treatment.

Pre-treatment process

Necessary permissions from the parents and the school authority were taken. The researchers provided the learners with the study's objective and informed them that the tests would not determine their grades. The achievement pre-test papers were handed out as pre-test to both control and experimental group students. The test consisted of 10 multiple choice items and took approximately 15 min to complete.

Treatment process

For the experimental group, a gamified CLIL approach with AR was employed. In the previous lesson, the teacher asked students to download Metaverse App and bring their mobile phones to the classroom as they would need it for the lesson. Ten QR codes that direct students to the AR learning experience were placed in different areas in the school and the yard. The experimental lesson took 40 min. At the beginning of the lesson, the teacher asked students whether they had heard about the Sustainable Development Goals, and explained that SDGs are the objectives set to ensure a better and more sustainable future for everyone. Next, the teacher explained that they would have a scavenger hunt activity in which they would race as groups of three. Then, the teacher handed out the papers that contained the places of the QR codes and on which they would write their answers. The students would get 10 points for each correct answer and the students who completed all the 10 steps would get 100 points. The teacher then asked students to start. The introduction part of the lesson took nearly six minutes. One example of the step which led students to the QR code was "Go to the high school canteen, locate

the portrait of the girl with an umbrella, scan the QR code and write the answer". Figure 1 provides an overview of the experimental group's learning process through AR. In each step, learners interacted with AR-basedlearning experiences containing 3D objects. All 3D objects had a speech bubble on the top of them that provided a written and vocalized input to the learners. The learners needed to choose from pre-determined options or write their replies. The experiences taught about United Nations' Sustainable Development Goals and related vocabulary and grammar units.The speech bubbles on the top of the 3D objects instructed the students by explaining the aim of the global goals. Each experience focused on a specific SDG.,

As Fig. 1 illustrates, the learners used their mobiles to access the AR learning experiences to learn and collect the answers. The teacher and the researcher followed students through all the steps ensuring that the students would not copy the answers from each other. If a student could not locate a QR code, they were allowed to move on to the next one, yet leaving the opportunity of getting 10 point behind. The students took approximately 30 min to complete all the steps in the scavenger hunt. After completing ten steps, they delivered their papers to their teachers.

The control group's learning objectives were the same. However, they were instructed by traditional materials. The teacher followed the regular class routine, provided them with the input about Sustainable Development Goals, taught them the related vocabulary and grammar units. The teacher employed a communicative method to instruct the learners, but only printed pictures were visuals.

Post-treatment process

A newly acquired information should be "consolidated" within a few days to become unfluctating (e.g. by sleeping) (Dudai, 2004, as cited in Tetzlaff et al., 2012, p. 716). Thus, the researchers decided to use a 10-day period between the treatment process and the

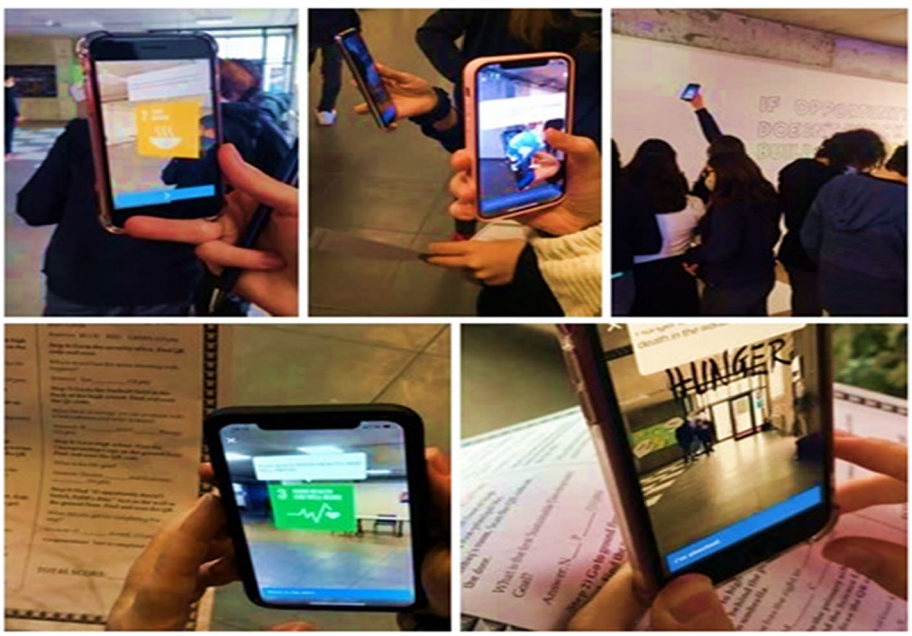

Fig. 1 The experimental group studying with mobile-based AR

post-test so that the post-test scores would reflect learners' retention. 10 days after the treatment process, both the control and the experimental groups took the achievement post-test. Then, ARAAS papers were handed out to the experimental group, and they were completed and delivered. Once the data collection period ended, the control group learners also experienced the AR lesson.

Data analysis

After all the data were gathered, they were analyzed in SPSS version 26 for Windows. Shapiro–Wilk normality test was run through SPSS to determine whether using parametric or non-parametric analyses. As the all data were not normally distributed, a Wilcoxon Signed Rank Test and a Mann Whitney U test were employed to find out whether the use of AR in a gamified CLIL lesson improve students' achievements. For all the tests, the significance threshold was set to 0.05. As for the attitude scale, the data collected through ARAAS in the post-treatment period were examined in SPSS using descriptive analysis.

Findings

Firstly, a Shapiro Wilk normality test was applied to the pre-test and post-test data to determine if the data are distributed normally. Test results indicated that pre-test data were distributed normally for both groups ($p = 0.190$ for the control group, and $p = 0.266$ for the experimental group), but the post-test data were not normally distributed ($p = 0.021$ for the control group and $p = 0.002$ for the experimental group. Therefore, we decided to use a non-parametric test as the conditions for a parametric test did not meet. The first research question of this study was "Does the use of AR in a gamified CLIL lesson improve EFL students' achievements at a private Turkish high school A Wilcoxon Signed Rank test was employed to compare the control and experimental groups' pre- and post-test scores to answer the research question. Table 1 was formed to illustrate the findings.

As shown in Table 1, the experimental group had significant improvements ($z = -5.265$, $p < 0.05$) in achievement between the pre-test (Mdn = 6.00, M = 5.53) and the post-test (Mdn = 8.00, M = 7.95) Therefore, we can state that the use of AR in a gamified CLIL lesson improved students' achievement. On the other hand, the traditionally instructed control group also improved their achievements significantly ($z = -4.377$,

Table 1 Wilcoxon signed rank test for the achievement test

Post-test–pre-test	*N*	Mean rank	Sum of ranks	*Z*	*p*
Control					
Negative ranks	4	11.00	44.00	−4.377	< 0.001*
Positive ranks	29	17.83	517.00		
Ties	5				
Total	38				
Experimental					
Negative ranks	1	5.00	5.00	−5.265	< 0.001*
Positive ranks	36	19.39	698.00		
Ties	1				
Total	38				

*$p < 0.05$

Table 2 Comparison of achievement mean gains between control and experimental group

	N	Mean rank	Sum of ranks	*U*	Asymp. Sig. (2-tailed)
Control	38	27.54	1046.50	305.500	< 0.001*
Experimental	38	49.46	1879.50		
Total	76				

*$p < 0.05$

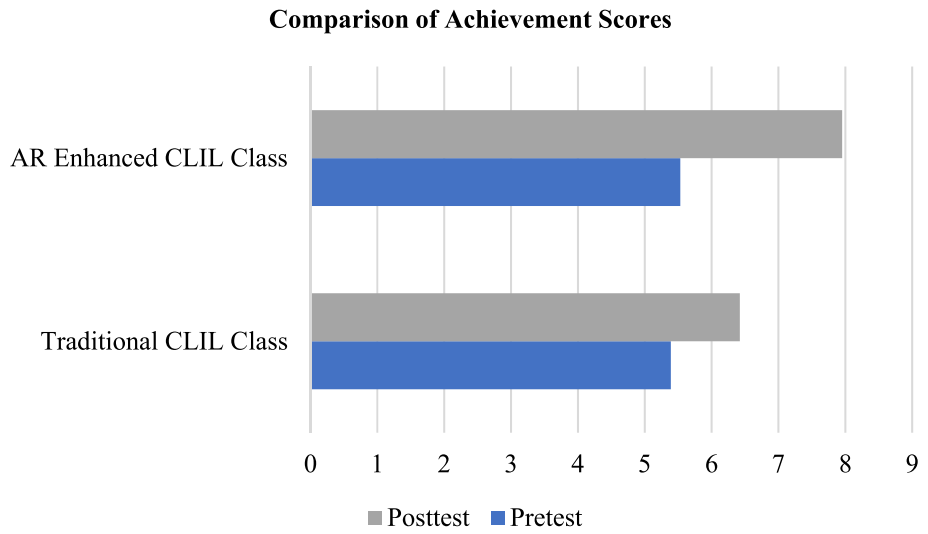

Fig. 2 Comparison of achievement mean gains

$p < 0.05$) as expected between pre-test (Mdn = 5.50, M = 5.39) and post-test (Mdn = 6.00, M = 6.42). However, the experimental group's mean gain was higher (2.421) than the control group's mean gain (1.026). Thus, a Mann Whitney U test was conducted on the achievement mean gains between two groups to see whether this difference is significant as the data were not normally distributed. Table 2 was formed to show the findings.

As shown in Table 2, the result of the Mann Whitney U test indicated that there is a significant difference between the two groups' achievement mean gain (u = 305.500; z = − 4.457, r = − 0.51, $p < 0.05$).

As illustrated in Fig. 2, the results showed that the experimental group had a significantly ($p < 0.05$) higher achievement mean gain (Mdn = 2.50, M = 2.42) than that of the control group (Mdn = 1.00, M = 1.03). Therefore, it can be stated that there is a significant difference in achievements between the use of AR in a gamified CLIL lesson and a traditional CLIL lesson. The group instructed with gamified AR activity (M = 2.42) improved more than twice as much as the control group (M = 1.03).

The second research question was "What are the attitudes of EFL students towards AR who used the AR in a CLIL lesson at a private Turkish high school?". In order to answer this research question, we analyzed the data that was collected through ARAAS developed by Küçük et al. (2014) (Table 3).

The results indicated that students were satisfied ($\bar{x} = 4.37$), engaged ($\bar{x} = 4.27$), and willing ($\bar{x} = 4.19$) to the use of AR in a CLIL lesson. Overall, they had a positive attitude towards the use of AR ($\bar{x} = 4.16$).

Table 3 Attitudes of experimental group towards the use of AR

Attitude	N	$\bar{x}$	SD
Satisfaction	38	4.06	0.62
Engagement	38	4.27	0.68
Willingness	38	4.19	0.71
Overall	38	4.16	0.60

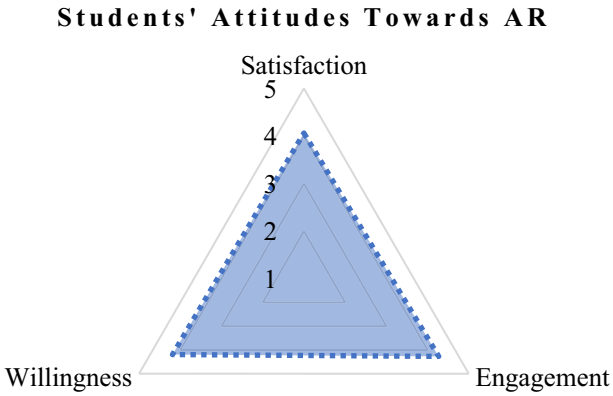

Fig. 3 Students mean scores based on scale dimensions

As shown in Fig. 3, the learners had positive attitudes in general. The learners' satisfaction, engagement, and willingness rates are distributed in a relatively balanced manner. The reported attitudes of the learners and the results of the achievement tests are discussed in the following section.

Discussion

This study investigated the effect of using AR in a CLIL class on high school students' achievements. The results showed that using AR helped learners significantly improve their achievements. The class treated with AR improved at least two times more than the traditional class. The 10-day period between the treatment and the post-test may indicate AR provides greater retention rates. The results matched with the studies of Tan and Liu (2004), Liu, Tan and Chu (2010), Ibanez et al. (2011), Mahadzir and Phung (2013), Barreira et al. (2012), Pérez-López and Contero (2013), Silva et al. (2013), Hsieh et al. (2014), Sırakaya (2015), Solak and Çakir (2015), Chen and Wang (2015), Richardson (2016), Dibrova (2016), Akçayır and Akçayır (2016), Çevik et al. (2017), Martinez et al. (2017), who found out that AR improves language learning.

The study's findings have revealed that learners have positive attitudes towards AR. The findings matched with the studies of Liu, Tan, and Chu (2007), Mahadzir and Phung (2013), Martinez et al. (2017), Bursali and Yilmaz (2019), who found out that AR has positive impacts on students. Another finding is that AR is satisfying for the learners, and students enjoy being taught through AR applications. AR makes learning more amusing (Liu et al., 2007; Nunez et al., 2008; Vate-U-Lan, 2012; Barreira et al., 2012; Küçük et al., 2014; Atasoy et al., 2017).

In our study, the students have reported that AR provides them with better noticing on the content and can make them attend the class more eagerly. They also reported that the use of visuals in AR experience could increase their curiosity if it is demonstrated in a book. Similarly, Wojciechowski and Cellary (2013) state that AR can help make learning more enjoyable. The visuals can also make the understanding easier (Kaufmann & Schmalstieg, 2003). Therefore, the coursebook publishers and authors are encouraged to develop and implement AR experiences by considering the learning objectives. Additionally, the AR learning experience can be presented as an extensive task for students to study at home as they think they enjoy studying at home via AR applications. As for engagement, the learners have found the AR-enhanced CLIL class quite engaging. Therefore, we can state that AR enhances students' engagement with the lesson as relevant studies in the literature may also suggest (Bujak et al., 2013; Wojciechowski & Cellary, 2013).

Generation Z learners have found AR experiences easy to use, functional, and clear. The learners have reported that such a method has attracted their attention. Aziz et al. (2012) has previously stated that AR can gather learners' attention. The learners want to have AR applications on their coursebooks for future classes. The present study has been conducted only in a CLIL class. However, the learners are willing to experience AR-enhanced classes in other academic courses.

Limitations

Unfortunately, there were some limitations to this study. First, the Metaverse app had some bugs in specific Android devices, which disturbed the experience of a few students. Another small number of students did not have mobile devices, or their batteries were dead. Thus, some students completed the AR experiences with their peers. The study focused on participants from one school. More participants from various schools could yield more robust results.

Conclusion

The primary purpose of this study was to determine the effect of using AR in a CLIL lesson on learners' linguistic achievements. The study also looked at the attitudes of learners who utilize AR. The findings revealed that using AR in a gamified CLIL lesson increased EFL students' achievements at a private Turkish high school. The learners expressed positive attitudes toward the use of AR. AR was fulfilling and engaging for the students. They demonstrated a willingness to be taught via augmented reality in the future.

As a consequence of this research, coursebook authors and publishers are urged to adopt augmented reality technology to provide learners with engaging activities. Teachers are also advised to employ augmented reality (AR) in their lessons to teach both subject and language. Creating AR experiences is commonly thought to be complicated. However, specific drag-and-drop AR creation tools, such as the one used in this study, do not require any programming knowledge.. The lesson's objectives and the content need to be of importance. The lesson should be carefully designed to provide learners with learning opportunities.

The research on the use of AR in EFL learning and teaching is still limited. The AR technology can be implemented into EFL in a variety of contexts. We have designed a gamified AR-based CLIL lesson to instruct the students. The AR-based lesson contained elements of a scavenger hunt activity. A future study on student engagement may be useful to conduct

by comparing an ordinary AR-based lesson with a gamified AR-based lesson. Today's AR is mainly based on mobile phones, tablets, and mobile applications. Another study can be conducted on developing a mobile-based AR application with pre-designed AR experiences in the class. Alternatively, a new platform for learners and teachers to create and share AR experiences on specific topics related to language (e.g., relative clause) can be beneficial.

Appendıces

Appendix 1. Achievement test

1. Which one is the framework for solving the biggest problems in the world?

a) Education goals

b) Sustainable development goals

c) Solution goals

d) World transformation goals

2. Complete the sentence. Hunger is a problem...

a) of only African countries

b) of the lack of knowledge about healthy nutrition

c) of food production

d) of fair distribution

3. How many people worldwide have no access to clean water?

a) a quarter

b) one third

c) about half

d) two third

4. What can an illiterate person do without any difficulties?

a) read non-fiction literary works

b) discuss about his/her weaknesses

c) publish the article that he/she has written for a journal

d) write simple essays

5. Which statement is true? The more equality,

a) the greater the gap between rich and poor

b) the less violent a society is

c) the lower the economic growth

d) they have same rights as each other

6. Indigenous peoples have a variety of natural traditional remedies. When western companies appropriate these, it is called ....

a) biorobbery

b) biodiversity

c) biopiracy

d) biofabrication

7.Complete the dialogue with the expression that BEST suits.

Lecturer: The ever-increasing energy demand has led innovators to build engines with higher fuel efficiency.

Student: Then, why is the statistics show that there is only a little reduction in the consumption of gasoline?

Lecturer: [...]

Student: The decisions-makers need to do some regulations about it.

a) Because of the gasoline cars that require more energy than electric cars.

b) We will use electric cars, which run with renewable energy from solar systems

c) Due to the rebound effect that people drive more and buy cars with bigger engines.

d) Because these engines have malfunction which prevents them from running in long term.

8. What goal does SDG 8 define for the year 2025?

a. All forms of child labour must be ended.

b. There must be no more child soldiers.

c. Every country in the world must have the UN Convention on the Rights of the Child enshrined in its constitution.

d. Inaccessibility outside working hours is beneficial.

9. What is the aim of Education for Sustainable Development?

a) International understanding

b) Responsible thinking and acting

c) Saving the Earth

d) Building more private schools

10. Where do most fatal road accidents occur in the EU?

a) On the motorway

b) On rural roads

c) Within build-up areas

d) On urban roads

Appendix 2. ARAAS

AUGMENTED REALITY APPLICATIONS ATTITUDE SCALE

Dear students, below there are items to determine your attitude towards the use of AR technology in education. It is expected from you to answer these questions frankly and sincerely. Please do not leave any questions empty. Thank you for your interest and contributions.

1. Gender: Female ☐ Male ☐

2. Class : .....

3. Read the statements below and choose the best option that suits you the most.

(1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree)

(AR: Augmented Reality, 3D: 3 dimensional, * Negative attitude statements towards AR applications)

		1	2	3	4	5
1.	I enjoy the lessons instructed with AR applications.					
2.	I get bored while I am using AR applications.*					
3.	It is difficult to use AR applications. *					
4.	I can concentrate better on the lesson when AR applications are used.					
5.	I study harder for the lesson thanks to AR applications.					
6.	AR applications make my learning difficult because they confuse my mind.*					
7.	I come to the class more eagerly when AR applications are used.					
8.	There is no need to use AR applications in the classes.*					
9.	3D objects in AR applications give sense of reality in the environment.					
10.	AR applications do not attract my attention.*					
11.	Demonstration of 3D objects, videos, and animations on the book in AR applications increases my curiosity.					
12.	I want AR applications to take place in course books in the future.					
13.	I want AR applications to be used in other lessons, as well.					
14.	Using AR applications in the classes causes waste of time.*					
15.	I enjoy studying lesson at home with AR applications.					

Abbreviations

AR	Augmented reality
CLIL	Content and language integrated learning
EFL	English as a foreign language
GPS	Global positioning system
ARAAS	Augmented Reality Applications Attitude Scale
SDGs	Sustainable development goals
QR	Quick response
3D	Three-dimensional

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Declarations

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