

Selection of the Most Effective Augmented Reality Application for English Education

Araştırma Makalesi/Research Article

 Mehmet Bilge Kağan ÖNAÇAN^{1*},  Vildan ATEŞ²,  Tunç D. MEDENİ³,
 Demet SOYLU⁴,  Sadık KULAKOĞLU⁵

¹Faculty of Applied Sciences, Department of Information Systems and Technology, Okan University, Istanbul, Türkiye

²Faculty of Business, Management Information Systems, Ankara Yıldırım Beyazıt University, Ankara, Türkiye

³Faculty of Business, Management Information Systems, Ankara Yıldırım Beyazıt University, Ankara, Türkiye

⁴Faculty of Humanities and Social Sciences, Management of Information and Documents, Ankara Yıldırım Beyazıt University, Ankara, Türkiye

⁵Turkish Naval Forces, Istanbul, Türkiye

kagan.onacan@okan.edu.tr, vgirginates@gmail.com, tuncmedeni@gmail.com, bunchnoble@gmail.com, sadikkulakoglu@gmail.com

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Abstract— Efforts to take advantage of the opportunities offered by advancing information technologies to make the process of learning and teaching English more effective are increasing every day. One of the information technologies that has begun to be used in different fields of education and whose popularity is increasing day by day is Augmented Reality (AR) technology. This study aims to provide information about the general concept of AR technologies, to identify the application areas and examples of AR technology in education and English education, to identify and classify the difficulties encountered in teaching English, to make recommendations for AR technology applications that can solve the difficulties identified in English teaching, to present the priority rankings and importance levels of the identified difficulties, and to decide on the most effective AR technology application that can solve the identified difficulties. In the scope of the study, the difficulties encountered in teaching English are divided into four different classes: difficulties arising from students, difficulties arising from the education system, difficulties arising from materials, and difficulties arising from teachers. It has been determined that the difficulties arising from students have the most impact on teaching English. Among the nine solution proposals that could solve the problems in teaching English, the "virtual character wandering in the classroom" application has been identified as the most effective solution proposal. Since there are a limited number of studies on the use of AR in English education in the literature, it is expected that this study will fill the gap in the literature and will contribute to academicians and application developers, and be a source of inspiration for future research.

Keywords— augmented reality, information system, english education, focus group interview, analytic hierarchy process.

İngilizce Eğitimi için En Etkili Artırılmış Gerçeklik Uygulamasının Seçimi

Özet— İngilizce öğrenme-öğretme sürecini daha etkili hale getirebilmek için, gelişen bilgi teknolojilerinin sunduğu fırsatlardan yararlanma çabaları her geçen gün artmaktadır. Eğitimin farklı alanlarında kullanılmaya başlanan ve popüleritesi her geçen gün artan bilişim teknolojilerinden biri de Artırılmış Gerçeklik (AG) teknolojisidir. Bu çalışmada; AG teknolojilerinin genel kavramı hakkında bilgi vermek, eğitim ve İngilizce eğitiminde uygulama alanlarını ve uygulama örneklerini ortaya koymak, İngilizce öğretilen konularla karşılaşılan güçlükleri belirlemek ve sınıflandırmak, İngilizce öğretilen konularla karşılaşılan zorlukları çözebilecek AG teknolojisi uygulamalarına yönelik önerilerde bulunmak, belirlenen zorlukların öncelik sıralamalarını ve önem derecelerini sunmak, belirlenen zorluklara çözüm olabilecek en etkili AG teknolojisi uygulamasına karar vermek amaçlanmaktadır. Çalışma kapsamında İngilizce öğretilen konularla karşılaşılan güçlükler; öğrenciden kaynaklanan zorluklar, eğitim sisteminden kaynaklanan zorluklar, materyallerden kaynaklanan zorluklar ve öğretmenlerden kaynaklanan zorluklar olmak üzere dört farklı sınıfa ayrılmıştır. Bunlardan İngilizce öğretmeye en fazla etki edenin, öğrenciden kaynaklanan zorluklar olduğu belirlenmiştir. İngilizce öğretilen konularla karşılaşılan zorluklara dokuz çözüm önerisinden "sınıfta dolaşan sanal karakter" uygulamasının en etkili çözüm önerisi olduğu tespit edilmiştir. Literatürde AG'in İngilizce eğitiminde kullanımına ilişkin sınırlı sayıda çalışma olduğundan, bu çalışmanın literatürdeki boşluğu doldurması beklenmekte ve çalışmanın akademisyenlere ve uygulama geliştiricilere katkı sağlayacağı ve gelecekteki araştırmalar için ilham kaynağı olacağı düşünülmektedir.

Anahtar Kelimeler— artırılmış gerçeklik, bilgi sistemi, İngilizce eğitimi, odak grup görüşmesi, analitik hiyerarşi süreci

1. INTRODUCTION

Today, rapid advances in science and technology affect and change our lifestyles [1]. With the increasing use of computer and internet technologies in daily life in recent years, the education process and educational environments are also affected by this change [2]. Thanks to the development of computer, internet and mobile technologies, many new applications that increase communication and interaction in educational environments have emerged. Especially, the use of AR technologies in education, which has emerged with advancing technology and allows the real world to feel like augmented by adding objects such as pictures, text and sound to real-life images simultaneously, is becoming widespread. Providing the educational process by using AR technologies in English language teaching is one of the AR application areas in education. Since the learning features of the new generation, known as the generation Z, are more information technology-oriented than the previous generations, it is important for the recognition and effective use of AR technologies, which are thought to contribute to a more effective learning process in the English learning environment [3] [4] [5].

In the literature, there are a limited number of academic studies on the use of AR in English learning and to what extent AR technologies can be a solution to the difficulties in English learning. With this study that has the aim of putting forward suggestions for AR technology applications that may solve the difficulties encountered in English learning, it is expected to fill the gap in the literature and it is estimated that it will contribute to academicians, application developers, teachers and the process of identifying educational assistants at the university and guide future research aimed at identifying AR technologies that can solve these challenges by identifying challenges encountered in English learning.

This study provides solutions with AR technology for the difficulties encountered in learning English in the Analytic Hierarchy Process (AHP) method, which is one of the multi-purpose decision-making methods. It is believed that this method has a unique quality in terms of being used for the first time on this subject. That is, the AHP method, which is known and used in many fields before, has been applied to the difficulties encountered in learning English in a different field. Another original characteristic of the study is that the criteria and sub-criteria related to the difficulties faced in English education were specified within the frame of the focus group study.

In the following parts of the study, the general concept of AR and the difference between Virtual Reality (VR), the use of AR in education and English education, the difficulties encountered in English education and the suggested AR applications for the difficulties encountered

in English education are revealed, the method of the study is explained, the findings obtained within the scope of the research are discussed and the study was concluded by presenting an evaluation of the study and making suggestions for future research.

1.1. General Concept of Augmented Reality

In general, it is possible to divide reality applications into two as AR and VR. VR is the imitation of real-life environments through computers. It is a technology that gives its participants the feeling of being real and allows mutual communication in a dynamic environment created by computers [6]. VR environments are usually created with a helmet or glasses worn on the head. In some cases, there may be accessories to support VR glasses. The main goal in VR is to adapt to the environment in the helmet or glasses when the VR helmet is worn and forget the real environment.

AR is a technology that aims to integrate the physical world with virtual objects in real-time and to be in the same frame. This technology can be defined as the enrichment of the real-world environment with virtual objects during the visualization process with various technological devices [7]. In other words, it is the change and augmentation of reality by the computer. AR applications can be evaluated in two different groups as optical-based technologies and video-based technologies, considering the technology used [8]. The main difference between these two technologies is the tool in which the scene formed by the integration of the real and virtual worlds is seen. In optical-based reality systems, the integrated scene is seen in the real world through glasses, while in video-based reality systems, the integrated scene is seen on computers, tablets and mobile devices [9].

Among the main differences between AR and VR, the following can be listed. While VR offers an experience that is isolated from real life, AR is built on top of real life and makes it more interactive. Although the environment experienced in VR is a completely simulated environment that does not exist in reality, the virtual environment that created in AR completes the real environment. While there is a need for glasses that will cover the whole field of vision and control what is heard during VR applications, there is no such need during AR applications. In VR, the system works in a virtual environment, but in AR, the real and virtual images are combined and the system works according to real-time [10].

Today these two technologies, VR and AR, are preparing to put the Metaverse, which is considered one of the technologies with the greatest potential, to the service of humanity [11]. Designed as a simulation of the natural world, Metaverse aims to be the most advanced form of human-computer interaction, enabling individuals to move, communicate, and exist in digitally and digitally-enhanced physical environments through two-way interactions between virtual and physical worlds [12]. In

the future, the metaverse will fully model the world in a virtual environment, allowing us to live in this modeled world using a digitally chosen avatar and will be built upon VR and AR Technologies [13]. In this study, VR applications are excluded from the scope and only AR applications are focused on. Therefore, in the following parts, AR is explained in detail.

AR applications were first used in the military field history [14]. Transparent screens placed on fighter pilots' helmets and used at eye level are designed. These screens instantly show the flight data that pilots must see. Thanks to the transparent structure of the equipment, it is aimed for pilots to see the real image and the data screen image at the same time. In the following periods, AR applications started to be widely used in education as well as in areas such as engineering, health, sports, tourism, advertising [15] and the manufacturing industry [16] [17].

This technology, which started with the application area in fighter pilots, shows itself in many areas today [18]. AR technology is intensely used in games, in applications that serve as a compass and in GPS, in providing information about historical artifacts, in learning the product prices in markets, in design studies for determining the interior design of a place, in obtain, share and store information about its construction and it also has many more application areas. In the use of AR technology for mobile devices; a mobile phone with a camera and the hardware to run the necessary applications is sufficient. By downloading the appropriate applications, AR can be experienced only with a mobile phone. In order to experience fully AR on mobile phones, it is of great benefit if the phone has a digital compass, navigation and accelerometer.

1.2. Use of Augmented Reality in Education

According to the model developed by Dale [19] in order to assist students, teachers and educators in the learning-teaching process by making use of the relationships between experiences and the formation of concepts, people remember; 10% of what they read, 20% of what they heard, 30% of what they saw, 50% of what they saw and heard, 70% of what they said and wrote, and 90% of what they did. In this respect, AR applications in the field of education support the development of students' imagination and creativity and provide an enjoyable learning style at the learning level by increasing students' perceptions of the real world and their interaction with the real world. Using 3D visual objects in AR applications attracts the attention of students, increases their participation in learning and lessons and motivates them. It also supports them to gain different perspectives on issues [20]. In addition to these, AR applications have advantages such as making lessons interesting in education, increasing the quality of education, facilitating learning because it is based on visuality and providing easy access to materials that are difficult to obtain. AR applications are effective learning materials in education, highly interactive, contribute to the learning process and are easy to use [21].

There are various studies in the literature on the applications of AR technologies in the field of education. Freitas and Campos [22] designed and implemented an education system using AR in three different primary school classes in their research. As a result of the study, it was observed that the learning experiences of students with poor learning skills improved. Cuendet et al. [23] focused on the usability of AR technology in the classroom and it was shown that AR technology can be realized not only in the laboratory environment but also in the classroom environment. Within the scope of the study, AR applications were tested in the classroom environment by making arrangements in the classrooms of a high school-level school providing vocational education in Switzerland. It has been revealed that AR technology can be used in the classroom without interfering with the teaching of other lessons. In another study conducted by Abdüsselam and Karal [24], 11th-grade Physics course students were divided into the experimental group that carried out their activities with AR technologies while the subject of magnetism was taught, and the control group, which continued its effectiveness with classical methods, and the success of the experimental group was controlled. It was observed that it increased compared to the group. In the study conducted by Di Serio et al. [25] in Spain, it was found that the attention, interest, trust and satisfaction of the students at the secondary school level increased when using the AR technology.

In a study conducted by Demirer and Erbaş [16] and fully supported by the manufacturer company, Google Glass was used for the purposes of gaining experience, especially in practice-based courses, making virtual field trips, preparing evaluation images on field trips, or giving lectures simultaneously with faculty members at different universities. It has been concluded that it can be used in higher education institutions. Rezende et al. [26] designed a mobile education tool for children using the Jigsaw methodology. AR technology, which aims to improve the teaching experience, was used in the designed educational tool. In the study, 3D book content was presented and a fun environment was created. As a result, it was observed that the interest and motivation of the students increased. In the study of Albayrak and Altıntaş [17], 50 students were given lesson preparation notes supported with AR for the connection with the database for the visual programming course, and the other students were given lesson preparation notes prepared in plain text. It was found that the difference between the two groups differed significantly. In Durak and Yılmaz's [27] study, it was aimed to evaluate the effect of AR applications from the perspective of students, and as a result of the analysis of the opinions of 43 participants, who were 7th and 8th-grade students in the Technology and Design course, it was revealed that the most frequently stated codes regarding AR are "providing a fun learning environment" and "making the learning process remarkable and effective" and it was revealed that they think that it's use in the next lessons will contribute to the success of the lesson. In addition, in the study, the course that students think will be most useful for using AR applications is identified as

“science”, while the difficulties experienced when using AR applications include the lack of smartphone ownership/access. Kırıkkaya and Şentürk [28], who investigated the effect of using AR applications on students' academic success and their views on these applications in the unit of Solar System and Beyond in the Science course, revealed that AR applications positively affect academic achievement in line with the analysis of the findings they obtained within the scope of the research.

On the other hand, Topraklıkoğlu [29] discussed the AR activities designed and developed with three-dimensional modeling software in the teaching of the subject of "views of objects from different sides" in the seventh-grade mathematics lesson in middle school. The researcher aimed to reveal whether the AR activities had an effect on the development of students' spatial abilities, geometry design and change of their attitudes towards AR applications and also tried to reveal students' views on AR activities. As a result of the interviews conducted in the study group consisting of 53 students and the analysis of the data, there was no statistically significant difference in the students' attitudes towards geometry with AR activities, but they revealed that the students' mathematics lesson with AR activities was productive and fun, also their interest and motivation increased with AR. Çetin [30] designed an AR application that includes the "Projection and Appearance Extraction" units in the Information Technical Drawing course given to the 10th-grade students of the Information Technologies Department of Vocational and Technical Anatolian High Schools. They found that this AR application did not have a significant effect on students' achievement, spatial skills and attitudes, but it increased students' excitement, curiosity and motivation for the lesson.

Kurtoğlu [31] investigated the effects of the learning material, which includes the subjects of the unit "Computer Systems" developed with AR technology, on the learning environment in the teaching of information technologies and software lessons. As a result of the research, it was seen that the learning material prepared using AR technology significantly increased the motivation of the students. By participating more actively in the lesson, the students found the lesson more understandable and fun. Özbek and Ak [32] investigated in their studies whether the AR application used in teaching punctuation marks in primary school 4th-grade Turkish lessons had an effect on the students' success in using punctuation marks and their motivation. Timur et al. [33] investigated the effect of AR applications on the academic achievement of sixth-grade students on the subject of "Cell" in the Science course curriculum. In their study, they found a statistically significant difference between the pre-test and the post-test as a result of the analysis of the data they obtained from the Cell Success Test they applied to a sample group of 76 class students determined by random sampling technique. It was observed that the scores obtained in the study increased in favor of the post-test due to the important role of the AR applications, and it was concluded that the AR applications positively affected the success of the student.

Finally, in another study, it is aimed to design a simulation type Mobile-AG teaching software that can be used in the teaching of the data sub-learning area, which includes basic statistical concepts at high school level, by using the Design and Development Research (DDR) method and to examine its effect on the sample determined in the study. It was seen that the application developed in the study was at a usable level according to the software evaluation scales and positively affected the academic achievements and attitudes of the students towards technology [34].

1.3. Use of Augmented Reality in English Education

Among the studies in the literature regarding the applications of AR technologies in the field of English education, Çınar and Akgün [35] targeted the unit "At The Fair" in the 6th grade English course content and enriched the content on this subject visually and aurally. In order to display the text, visuals and AR-supported hybrid textbook section within the scope of their research, it is included to evaluate this section with expert opinions. In another study; Çakır, Solak and Tan [36] examined the application of AR technology developed to enrich and activate education and training environments in the classroom and the effect of this technology on students' academic achievements and motivations. For this purpose, a quasi-experimental study was conducted at the university level. In the study, in which 60 university students participated, English words were presented to the experimental group in an environment developed with AR technology, while the control group was taught with traditional methods. As a result of the study, it was observed that the success of the experimental group of students who taught the lesson with AR technology was statistically significantly higher than the control group of students who taught the lesson with traditional methods. Küçük et al. [37] investigated students' perceptions in the process of learning English with AR. The study was carried out with students from five different secondary schools. As a result of the study, it was revealed that secondary school students were satisfied with learning English with the help of AR technologies, their anxiety levels were low and they wanted such applications to be used in their lessons. Ramya [38] used Computer Assisted Language Learning (CALL) for teaching and learning English in her study. One of the developing technologies in CALL is AR technology. In his study, he examined the advantages of adopting AR in English language teaching. As a result, he found that AR technology provides a better understanding and higher motivation among students while learning English. Vate-U-Lan [39] created a 3D pop-up book for 3rd-grade students in the curriculum, he prepared with AR technology in English education. In the book prepared within the scope of the research, the dialogues were processed audibly and visually and it was observed that participation in the lesson was higher. With this study, it was revealed that AR technology increases students' desire to learn.

Rayene [40] investigated the effect of AR as a teaching tool on students' learning with her experiment on third-year English students. The results obtained as a result of the

study show that the use of AR technology gets positive feedback from students and teachers. Koç, Altun and Yüksel [41] investigated whether the use of AR-based materials could contribute to high school students in the process of producing English texts and their perceptions of AR-based materials. The findings showed that the use of AR-based materials had a moderate effect on students' selected writing skills, and students' perceptions of the AR-based writing experience were positive. Pugoy et al. [42] present the development of learning material enhanced with AR technology to help improve nursing education in English in their work. Most of the participants in the study group, which consisted of 39 nursing students in total, stated that the talking comic was useful, easy to use and learn, and they were happy to use it. Tsai [43] aimed to compare the effect of traditional teaching methods and AR methods on the English word learning performance of primary school students and as a result of the study, it was revealed that the English word learning performance and motivation of the students who are taught with the learning materials created by using AR technologies are superior to those who are taught using traditional teaching methods. Wang and Khambari [44] investigated how the AR-based gamified learning environment affects students' learning motivation and collaborative learning in English lessons, and the results of the research revealed that the learning motivation of the students was improved by the change of the teacher's role and the use of virtual content of the AR technology. In addition, they stated in their studies that the AR-based gamified learning environment can effectively improve collaborative learning by strengthening the desire for discussion and providing a comfortable learning environment with more opportunities. In the research that has provided a basis for this work [45], focus group method was applied to a group that consisted of six English teachers, and consequently, problems in front of English teaching were brought up and suggestions with respect to use and benefits of AR for English-teaching were provided. The related problems identified and interlinked were categorized into four main titles.

1.4. Difficulties Encountered in English Education

Among the reasons for not being successful enough in English education and the difficulties encountered are many reasons. Some of these reasons are traditional language teaching habits, errors in foreign language education planning, inadequacies in the methods, materials, deficiencies and mistakes in assessment-evaluation and activities [46], academic and administrative deficiencies of senior managers [47], reasons associated with the profiles of current teachers [48], the motivation problem experienced by foreign language learners [49], problems with the training process of foreign language teachers, trying to determine the competencies of foreign language teachers through multiple-choice exams that are not suitable for the nature of the field, problems related to physical conditions such as crowded classrooms and lack of equipment, not adopting a common teaching method and philosophy related to foreign language teaching, not controlling the foreign language teaching process and

quality problems of educational materials [50]. Şahin [51] categorizes the reasons for the failure in English education under three main headings: 1. student, 2. system, and 3. teacher.

2. METHOD

The main purpose of using technology in education is to provide more effective education by solving the problems encountered in education. This study aims to suggest solutions to the difficulties encountered in teaching English with AR technology and to determine the perception of the effects of these suggestions on solving the difficulties. The main question of this research determined as "What could be the most effective AR applications that can be used in English education in order to solve the difficulties encountered in English education?" and the first sub-research question is "What are the difficulties encountered in English education?", the second sub-research question is "What are the AR applications that can be used in English education?". In order to find the answer to the sub-research questions, a focus group interview was held in November 2018 with a group of 32 English teachers and a moderator and a reporter (they are informatics experts). English teachers had MS degrees from different universities in Turkey and had an average of nine years of experience. In the continuation of the study, for answering the research question, the AHP application, one of the multi-criteria decision-making methods, was carried out to determine the most effective AR application that can be a solution to the difficulties in teaching English. In this context, questionnaires were sent to 32 teachers who participated in the focus group interview and feedback was received from 18 teachers. The obtained data were transferred to the computer, and all the calculations required for the implementation of the AHP method were performed using a code written in MS Excel, and the results were evaluated.

Focus group interviews carried out within the scope of the research can be defined as a technique of using the effect of group dynamics in the unstructured interview and discussion between a small group and the moderator, obtaining in-depth information and generating ideas. The purpose of focus group interviews is to obtain in-depth, detailed and multidimensional qualitative information about the participants' perspectives, lives, interests, experiences, tendencies, thoughts, perceptions, feelings, attitudes and habits on a specified topic. It is important for the participants to express their opinions freely during the focus group discussions. The most important advantage of focus group discussions is that new and different ideas emerge as a result of in-group interaction and group dynamics. This technique is widely used in social sciences as preliminary research. Detailed data from focus group interviews provide a solid basis for one-on-one interviews and surveys [52].

Multi-Criteria Decision Making, on the other hand, is a sub-branch of Decision Sciences and relies on modeling and analyzing the decision process according to criteria [53]. Allows the decision maker to choose by evaluating

based on at least two criteria within a set of countable finite or uncountable numbers of options. For this reason, multi-criteria decision-making methods help the decision-maker evaluate the options to achieve the research objectives according to various criteria by ensuring a good analysis of the findings helping the decision-maker to determine the most appropriate option. AHP, one of the multi-criteria decision-making methods, is an approach where knowledge, experience, individual thoughts and intuitions are combined in a logical way [54]. It is based on determining weight, importance, or superiority in order to be able to choose among various alternatives by considering multiple criteria. In AHP, both subjective and objective opinions of decision makers can be included in the decision process. Therefore, AHP is a mathematical method that takes into account the priorities of the group and the individual and evaluates qualitative and quantitative variables together in decision-making. This situation makes AHP stronger than other decision-making methods. This method is used to evaluate the factors that are independent from each other at each level in their hierarchical structure [55]. It transforms significant differences in decision points in the hierarchy into percentage distributions with binary comparisons using a predefined comparison scale. Thus, in a systematic approach, numerical performance measurements are combined with subjective evaluations, and results are obtained [56].

3. RESULTS

In this part, firstly the results of the focus group study, in which the answers to the sub-research questions were found, and then the results of the AHP study, in which the answer to the research question was found, will be presented.

3.1. Findings of Focus Group Meeting

In this study, for the answer to the first sub-question, the difficulties encountered in English education were divided into four different categories: difficulties caused by the student, difficulties caused by the education system, difficulties caused by materials and difficulties caused by teachers. Among the difficulties caused by the students; inability to learn the word in context, fear of making mistakes while speaking in a foreign language, lack of motivation, insufficient practice in English, different grammar, word and alphabet structure between English and his/her native language, inability to have a command of the grammar of his/her native language, not allocating enough time for foreign language lessons, low cultural awareness, and status of not knowing how to learn. Among the difficulties caused by the education system; lack of in-service training, not starting language learning at an early age, providing only exam-focused education in schools, deficiencies caused by the curriculum, lack of sufficient quantitative and qualitative teachers, difficulties arising from measurement (multiple choice exam), and the fact that knowledge level of students are different. Lack of correct and high-quality materials, difficulties in learning

in crowded classrooms, and deficient use of technology are among the difficulties caused by the material. Finally, lack of practice in English speaking, using the native language mainly in foreign language teaching and restricting active speaking, deficiencies in teaching ability, lack of knowledge in teacher's English level, and inability in self-improvement are among the difficulties caused by the teacher. In this focus group interview, while the same categories were determined as the main categories in Önaçan and Kulakoğlu [45], it was decided to make some changes in the sub-categories.

In line with the answers given by the participants to the second sub-question, some suggestions were made regarding the use of AR in English education and solving the difficulties encountered in English education. Among these suggestions, first of all, it is necessary to use the dictionary for unknown words while reading an English book. This situation is both tiring, boring and difficult to focus. By using AR technology, it may be useful to learn the equivalent of the pointed word by using eyeglasses or mobile phone. As another suggestion, it is considered that developing a mobile application and seeing the English equivalents of the material in the environment on a phone, tablet or glasses may be beneficial in terms of learning the words. With the developed mobile application, translation can be provided by placing the phone on the text. In addition, displaying all parts of any material in 3D and ensuring that they are seen in detail during the lecture can also be beneficial in terms of retention in English learning. It is among the evaluations that a halogen 3-dimensional character can also be used as a teaching aid in English education. For example, as the teacher speaks and gives commands, the 3-dimensional teaching aid (be it an animal or a comic character) can execute the given commands. It is considered that English teaching/learning can be facilitated by gamification in the form of giving English commands to the player in the game and getting points if the player performs them. Animating the shape in an English storybook and making it 3D, reading the story by a native English speaker can be both interesting and easy to learn for a student. Different functions can be evaluated, such as vocalizing the written conversations in English. The suggestions regarding the use of AR in English education were provided below in detail.

3.2. Findings of AHP

In this study, AHP method has been used. In all the analyses within the scope of the study, implementation phases of AHP method have been realized as given below:

- The problem was identified.
- Required criteria for the decision has been determined, criteria priorities were specified. As a result of the focus group study that was carried out with English teachers within the frame of this study, criteria and sub-criteria were determined and the difficulties encountered in teaching English were grouped in terms of four criteria: student-related,

educational system-related, material-related and teacher-related.

- Hierarchical structure was established. In the upper part, there are fundamental target to be achieved. Below it is the criteria of the study and sub-criteria. While the criteria were being set, it was acknowledged that the options in the same level were independent of each other. Nine student-related, seven educational system-related, three material-related and five teacher-related sub-criteria were identified.
- Binary comparisons matrix was created. By using a severity scale that has values between 1 and 9, first the criteria, and then the sub-criteria and finally all the criteria have been taken into account, matrixes in which solution proposals were compared and contrasted according to the criteria were created. Solution proposals were compared according to each criterion separately. Decision matrixes are constructed using the 1-9 comparison scale proposed by Saaty [57], presented in Table 1.
- Binary comparison matrixes have been normalized. Then the priority vector has been calculated. The average of each row sum of the normalized matrix was divided by the size of the matrix, and these values were the criterion weights that were calculated for each criterion. These weights form the priority vector. Then, the fact that whether the criterion weights would be used in the model or not has been investigated.
- The sum of each row of the normalized matrix was multiplied by the criterion weights of that row. The lambda max (λ_{max}) value was obtained by summing the product results and dividing by the matrix size.

Table 1. Saaty scale of comparison

Significance	Description	Statement
1	Equally Significant	Two factors are equally significant
3	Little More Significant	One is little more significant than the other one.
5	Quite More Significant	One is quite more significant than the other one.
7	Much More Significant	One is much more significant than the other one
9	Absolutely More Significant	One is absolutely more significant than the other one

2, 4, 6, 8	Intermediate Values	Used when the preference values are close to each
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- After performing binary comparisons and determining their priorities the consistency of the comparison matrixes has been calculated. With the purpose of finding out whether a matrix created as a result of binary comparison judgment is consistent or not, the coefficient called "Consistency Index-CI", which is one of the various efficient methods, was calculated. In order to evaluate the consistency of the CI coefficient, the "Random Index (RI)" value should be known. The RI values which were defined for the n-dimensional comparison matrixes are indicated in Table 2. The consistency index of the comparative matrix was calculated with Consistency Index $CI = \lambda_{max} - n / n - 1$. After the CI and RI values were specified, the consistency ratio (Consistency Ratio- $CR = CI/RI$) of the comparison matrixes was calculated. Since the consistency ratio was less than 0.10, the comparison matrix was found out to be consistent.

By forming a binary comparison matrix for the criteria, the priority vector of the solution proposals is calculated and this priority vector was also defined as the weight vector for the criteria. Finally, the solution proposals were listed and the priority vectors which were collected for the sub-criteria were combined to obtain the entire priority matrix. The result vector is obtained by multiplying all the priorities matrix and the priority vector of the solution proposals. The solution proposal with the highest weight in this vector has been determined as the solution proposal which will contribute to the solution of the problem and should be preferred first.

Table 2. RI values which were defined for the n-dimensional comparison matrixes

n	1	2	3	4	5	6	7	8
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41
n	9	10	11	12	13	14	15	-
RI	1.45	1.49	1.51	1.53	1.56	1.57	1.59	-

A focus group study was held out to find out the criteria and sub-criteria for selecting the solutions to the difficulties faced in teaching English through using AR technology, and the suggestions which might be possible solutions for these difficulties among the technological products currently available in the market. As a result of this study, four criteria were specified; the difficulties caused by the student, the education system, the material and the teacher. Nine sub-criteria for student-related difficulties, seven for

educational system-related difficulties, three for material-related difficulties, and five sub-criteria for teacher-related difficulties were determined. Within the scope of the study, the following nine solution proposals (decision options) were offered:

S1: Seeing the corresponding word in a written text using AR technology with glasses or a cell phone.

S2: Defining the material in the environment using image processing techniques and displaying its English equivalent on a phone/tablet/glasses.

S3: Displaying the translated version with the original text by placing the phone on the text.

S4: Displaying all parts of any material in three dimensions and ensuring that their details are seen in English during the lecture.

S5: The use of a virtual character as a teaching aid in English education, and this virtual character wandering around the classroom randomly and the teacher occasionally asking the students about where this character is and what it is doing.

S6: Teaching/learning English through gamification in the form of giving English commands to the player in the game and getting points if the player performs them.

S7: Animating the shape in an English storybook by making it 3D and shaping and moving it according to the given commands.

S8: Asking questions in English while a character is being taught and responding in English to these questions by the character as well.

S9: Recognizing the picture in the book with image processing technique and watching the video on that subject on a phone/tablet/glasses.

3.3. Analysis Results of Binary Comparative Matrixes

One of the important evaluation criteria is the difficulties caused by the students. There are nine sub-criteria related to this. These are as follows: 1: inability to learn the word in context, 2: fear of making mistakes while speaking in a foreign language, 3: lack of motivation, 4: insufficient practice in English, 5: different grammar, word and alphabet structure between English and his/her native language, 6: inability to have a command of the grammar of his/her native language, 7: not allocating enough time for foreign language lessons, 8: low cultural awareness and 9: status of not knowing how to learn. While creating the binary comparison matrix table for difficulties stem from

students, the sub-criteria were numbered as 1,2...9, respectively. Binary Comparative Matrix of the student-related difficulties is presented in Table 3.

Table 3. Binary comparative matrix of the student-related difficulties

	1	2	3	4	5	6	7	8	9
1	1,00	2,00	0,20	2,00	7,00	3,00	0,33	7,00	1,00
2	0,50	1,00	1,00	1,00	9,00	3,00	0,50	5,00	0,33
3	5,00	1,00	1,00	1,00	7,00	1,00	0,50	7,00	1,00
4	0,50	1,00	1,00	1,00	7,00	2,00	1,00	7,00	0,50
5	0,14	0,11	0,14	0,14	1,00	0,20	0,14	1,00	0,11
6	0,33	0,33	1,00	0,50	5,00	1,00	0,33	6,00	0,33
7	3,00	2,00	2,00	1,00	7,00	3,00	1,00	9,00	1,00
8	0,14	0,20	0,14	0,14	1,00	0,17	0,11	1,00	0,11
9	1,00	3,00	1,00	2,00	9,00	3,00	1,00	9,00	1,00

As a result of the AHP analysis applied to the binary comparison matrix of the student-related difficulties ($\lambda_{max}=9.800$; $CI=0.100$; $CR=0.069$), it was decided to be consistent since the CR value was less than 0.10.

Another important evaluation criterion is the difficulties stemming from the education system. The sub-criteria of this criterion are; 1: lack of in-service training, 2: not starting language learning at an early age, 3: providing only exam-focused education in schools, 4: deficiencies caused by the curriculum, 5: lack of sufficient quantitative and qualitative teachers, 6: difficulties arising from measurement (multiple choice exam) and 7: the fact that knowledge level of students are different.

As a result of the AHP method analysis ($\lambda_{max}=8.090$; $CI=0.182$; $CR=0.138$), the consistency value was determined to be 0.138 and it was decided that model estimation can't be performed because it was bigger than 0.10. As a result, the difficulties stem from the education system were excluded because the binary comparison matrix was not consistent.

Material-related difficulties are another evaluation criterion, and it has three sub-criteria: 1: lack of correct and high-quality materials, 2: difficulties in learning in crowded classrooms and 3: deficient use of technology. As a result of the AHP analysis, the binary comparison matrix values of the difficulties arising from the material were $\lambda_{max}=3.029$; $CI=0.015$; $CR=0.025$. Likewise, as the CR value is lower than 0.10, it is consistent and model estimation can be made with these criterion weights.

Binary Comparative Matrix of the difficulties stem from the material is presented in Table 4.

Table 4. Binary comparative matrix of the difficulties stem from the material

	Lack of correct and high-quality material	Learning difficulties in crowded classrooms	Insufficient Use of Technology
Lack of correct and high-quality material	1,00	1,00	3,00
Learning Difficulties in crowded classrooms	1,00	1,00	5,00
Insufficient Use of Technology	0,33	0,20	1,00

The sub-criteria of teacher-related difficulties are 1: lack of practice in English speaking, 2: using the native language mainly in foreign language teaching and restricting active speaking, 3: deficiencies in teaching ability, 4: lack of knowledge in teacher's English level and 5: inability in self-improvement.

According to the results of the AHP analysis applied for the sub-criteria of this criterion ($\lambda_{max}=5.228$; $CI=0.057$; $CR=0.051$), it was acknowledged that the binary comparison matrix of difficulties stemming from the teacher is consistent. Binary Comparative Matrix of teacher-related difficulties is presented in Table 5.

While the most significant criterion for the difficulties encountered in teaching English is student-related as indicated with the rate of 71%, it is seen that the second is material-related (19%) and the third is teacher-related difficulties (10%). The most important sub-criterion of the student-related criterion of the difficulties faced in teaching English is that students do not (can not) spend enough time on foreign language lessons as indicated by the rate of 18.9%. When Table 6 is examined, it is seen that having no knowledge of how to learn (18.3%) and lack of motivation (15.4%) are other student-related problems. The least effective student-related difficulties are the sub-criteria of different native language grammar, vocabulary and alphabet structure and weak cultural awareness (1.8%). When the sub-criteria of material-related difficulties are examined, it has been observed that the most significant sub-criterion is the learning difficulties seen in crowded classrooms with 57.4%.

While the lack of correct and high-quality materials is in the second rank with the rate of 28.6%, the least effective sub-criteria (14%) is the students' insufficient use of technology. In Table 6, the most important sub-criterion (54.3%) of the student-related difficulties criterion is the inability to self-improvement. In the second rank (24%) comes the teacher's lack of knowledge in English linguistic level. The least effective sub-criterion (5.8%) is seen to be deficiencies in teaching ability.

The values of the solution proposals (decision options) presented by using AR in English teaching were calculated by using the priority matrix value and importance levels of the sub-criteria of each criterion. These values are shown in Table 7. When Table 7 is examined, it is seen that the solution offers are as follows from the top to the low: S5 (%20.5), S7 (%16.6), S4 (%13.4), S3 (%12), S8 (%11.3), S6 (%11), S1 (%6), S2(%4.9) and S9(%4.5). As a result of the research, the best three solution suggestions would be "the use of a virtual character as a teaching aid in English education and this virtual character wandering around the classroom randomly and the teacher occasionally asking the students about where this character is and what it is doing", "animating the shape in an English storybook by making it 3D and shaping and moving it according to the given commands" and "displaying all parts of any material in three dimensions and ensuring that their details are seen in English during the lecture". Detailed result of AHP model is presented on Table 6.

Table 5. Binary comparative matrix of teacher-related difficulties

	Lack of practice in speaking English	Using the native language mainly in foreign language teaching and restricting active speaking	Deficiencies in teaching abilities	Lack of knowledge in teacher's English level	Inability in self-improvement
Lack of practice in speaking English	1,00	1,00	2,00	0,33	0,20
Using the native language mainly in foreign language teaching and restricting active speaking	1,00	1,00	1,00	0,20	0,14
Deficiencies in teaching abilities	0,50	1,00	1,00	0,20	0,14
Lack of knowledge in teacher's English level	3,00	5,00	5,00	1,00	0,20
Inability in self-improvement	5,00	7,00	7,00	5,00	1,00

Table 6. Detailed result of AHP model

Choosing The Best Solution For Teaching English	Value of Comparison
Sub-Criteria of Difficulties Caused by the Student	
Inability to learn the word in context	0,137
Fear of making mistakes while speaking in a foreign language	0,111
Lack of motivation	0,154
Insufficient practice in English	0,119
Different grammar, words and alphabet structures between English and his/her native language	0,018
Student's inability to have a command of the grammar of his/her native language	0,072
Not allocating enough time for foreign language lessons	0,189
Low cultural awareness	0,018
No knowledge of how to learn	0,183
Sub-Criteria of Difficulties Caused by the Material	
Lack of correct and high-quality material	0,286
Learning difficulties in crowded classes	0,574
Insufficient use of technology	0,140
Sub-Criteria of Difficulties Caused by the Teacher	
Lack of practice in speaking English	0,091
Using the native language mainly in foreign language teaching and restricting active speaking	0,068
Deficiencies in teaching abilities	0,058
Lack of knowledge in teacher's English level	0,240
Inability in self-improvement	0,543
Criterion	
Difficulties caused by the student	0,710
Difficulties caused by the material	0,190
Difficulties caused by the teacher	0,100

Table 7. Values of solution suggestions

Code of the Offered Solution	The Solution Offered by Using Augmented Reality in English Teaching	Values
S1	Seeing the corresponding word in a written text using Augmented Reality technology with glasses or a cell phone	0,060
S2	Defining the material in the environment using image processing technique and displaying it's English equivalent on a phone/tablet/glasses	0,049
S3	Displaying the translated version with the original text by placing the phone on the text	0,120
S4	Displaying all parts of any material in three dimensions and ensuring that their details are seen in English during the lecture	0,134
S5	The use of a virtual character as a teaching aid in English education and this virtual character wanders around the classroom randomly and the teacher occasionally asks students about where this character is and what it is doing	0,205
S6	Teaching/learning English through gamification in the form of giving English commands to the player in the game and getting points if the player performs them.	0,110
S7	Animating the shape in an English storybook by making it 3D and shaping and moving it according to the given commands	0,166
S8	Asking questions in English while a character is being taught and responding in English to these questions by the character as well	0,113
S9	Recognizing the picture in the book with image processing technique and watching the video on that subject on a phone/tablet/glasses	0,045

4. DISCUSSION AND CONCLUSION

Accordingly, this work has aimed to give information about the general concept of AR technologies and reveal their application areas with examples in English education in order to provide suggestions for AR technology applications that can solve the problems and difficulties encountered in English learning. To do so, a focus group interview technique has been applied to a group of English teachers and accordingly priority rankings and importance ratings of encountered difficulties and their categorization in a comparative way have been presented by using AHP Rating Scale. After that, it has been suggested AR technology applications that can solve the problems and difficulties encountered in English education and they have been listed according to their priority rankings.

Similar to Şahin [51]'s study, but with one addition, the difficulties encountered in English education were divided into four groups as student-related difficulties, education system-related difficulties, material-related difficulties, and teacher-related difficulties. In this study, similar reasons were identified as in [46], [47], [48], [49], [50] and these reasons were grouped under four main categories to create a hierarchical structure. It is evaluated that this hierarchy will provide a systematic infrastructure for future studies and implementations.

The teaching materials used in English language education play a crucial role in the effectiveness of the teaching process. Written, auditory, and visual materials used in education appeal to students' different sensory organs, making learning more effective and also reducing the likelihood of forgetting what has been learned.

In parallel with the developments in technology, it is necessary to develop new materials and to benefit from AR technology like many new developing technologies. In education, AR assists students in better learning through visualization and full immersion in the subject. Although new applications will continue to emerge as AR technology develops, this study has identified nine AR applications that can be used in English education, and determined which one would contribute the most to addressing the issues in English education.

Of the nine proposed technologies, three of the most effective are “the use of a virtual character as a teaching aid in English education and this virtual character wandering around the classroom randomly and the teacher occasionally asking the students about where this character is and what it is doing”, “animating the shape in an English storybook by making it 3D and shaping and moving it according to the given commands” and “displaying all parts of any material in three dimensions and ensuring that

their details are seen in English during the lecture”. It is considered that the proposed technologies will develop more and more effectively as they are used in English education and will also shed light on the development of other innovative applications.

As a result, it is evaluated that lots of AR applications can be developed and will increase the effectiveness in learning and teaching English, and in parallel with the developments in technology and the increase in awareness regarding the use of technology in education, the AR can be used intensively and effectively in English education over time. It is hoped that the resulting work is useful for other relevant work in academia and practice.

5. RECOMMENDATIONS

In the future studies, the AR applications mentioned in this study can be implemented and actually can be used in English education, the effectiveness of the AR applications mentioned here can be determined, the benefits of AR applications in English education can be investigated, the results of a similar study conducted with students can be compared with the results of this study, and new applications can be developed by using the AR applications mentioned in this study.

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The focus group study conducted with 32 English teachers in this research is an improved version of [45] that is previously conducted with six English teachers.

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