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Augmented Reality: A Digital Tool to Explore an Enjoyable Way of Learning in EFL Classrooms

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Abstract

The purpose of this article is to highlight the importance of implementing AR (Augmented Reality) inside the EFL (English as a Foreign Language) classroom and how this digital tool can assist teachers to make their classes more meaningful and interactive. Thus, 46 articles were reviewed and it led to analyze and identify some strengths and usefulness of using augmented reality for educational purposes. This review revealed that AR has a positive effect among teachers and students when providing information, promoting constant interaction and autonomy, engaging students into the topic, working on the different skills of the language, and facilitating the learning and teaching process. Finally, this article demonstrates that the

advantages of using AR outweighed the disadvantages since teachers can make their classes more student-centered, and enjoyable while students become more independent, and motivated.

Keywords: Augmented Reality, Language Teaching, English as a Foreign Language, digital materials, interactive learning

1. Introduction

The globalized world in which we live today and the vast technological advances and innovations that people are exposed to have made educators reconsider how they are teaching and be open to the endless opportunities in which the new generations of students can learn. For doing so, it is helpful to analyze how current technological tools are used worldwide and in their national context. As Haleem et al, (2022) affirm, digital technologies are currently helping to access information and learning immediately, developing evaluations faster, and leading towards classroom engagement. Additionally, the incorporation of technological devices such as projectors, computers, and other gadgets is making learning more dynamic, interesting, and entertaining.

Currently, digital devices are commonly used and the vast majority of people around the world can have access to at least one smartphone (Wise, 2022). This fact could lead both teachers and students to use these devices for carrying out classes, making resources available, and organizing and managing daily academic activities. Some of the current applications of technology are the development of online libraries, distance learning, virtual classrooms, inclusive learning environments, the gain of self-learning abilities, the access to up-to-date materials, and the reduction of teacher workload, among others (Haleem et al, 2022).

Consequently, with today's constant use of mobile devices, wearable computers, and immersion technologies, the concept and implementation of AR have gained recent attention (Kai Wu et al, 2012). AR is flexible and can be implemented in different fields that students can be interested in, such as science, medicine, history, archeology, architecture, visual arts, and games (Subhashini, 2020). Moreover, with the implementation of AR, learning strategies and tools might help improve constructivism, collaborative learning and the possibility of networking for learning (UNESCO, 2011). In the field of English teaching and learning, for example, Karacan & Akoğlu (2021) affirm that augmented reality could be a helpful tool that can contribute to the development of language skills. Likewise, AR can be really helpful when prompting interest, motivation (Forigua and Orjuela, 2020), increasing satisfaction (Marrahí and Belda, 2022), and guiding in the development of autonomy among other benefits (Liu et al, 2009).

However, more research is needed as the advantages of its implementation and the value it can provide to education depend on how AR is designed and incorporated into teaching and learning settings (Kai Wu et al, 2012). Thus, this article aims to emphasize the significant and valuable contributions that augmented reality could bring to the EFL classroom while making the language learning and teaching experience more significant and stimulating. In doing so, the concept of AR will be explored including its advantages and limitations. Additionally, some current studies where AR has been implemented will be presented.

2. Augmented Reality

The term "Augmented reality" (AR) according to Milman (2018) can be defined as the view of a series of elements which are overlaid in a real-world context. Those elements can be seen

through different electronic devices such as video, graphics, smartphones, videogames etc. Simply put, AR can be deemed as a computer-mediated reality because a computer modifies the view of that reality. However, it is essential to establish a difference between Augmented Reality (AR) and Virtual Reality (VR). The former is intended to enhance the current perception of reality, and the latter recreates an artificial world. Finally, Millman (2018) expresses that the aim of AR is to make any context or situation better, livelier and more enriching.

In addition, according to Subhashini (2020), AR has the advantage of being cross-curricular since it can be implemented in several educational fields; for example, it is used in medicine by simulating the human body to know how to perform a surgery on a patient. It is also used in archaeological research by simulating the land where researchers could explore. Besides, through AR, it is possible to simulate historical events that students can see and even feel. Another example is when anatomy students can see the different systems of the human body in three dimensions and understand how these organs work. Furthermore, AR was used in mobile phone apps such as Pokémon GO, which consists of using GPS to catch virtual creatures that appear in the real world. Subhashini (2020) asserts that AR is also used in architecture, visual arts, marketing, business, map reading, etc.

Similarly, AR also transforms the field of education; Elmqaddem (2019) argues that several didactic contents can be accessed by scanning a QR code, or images can be visualized with a smartphone. Moreover, educational materials such as textbooks, flashcards, and slides contain embedded "markers" which can be scanned by an AR device, providing additional information to the student in a multimedia format. This is advantageous for students because they not only see the materials but also have the opportunity to interact with the learning context, broadening their knowledge.

Regarding language teaching, it is necessary to note that AR, according to Karacan and Akoğlu (2021), has a positive effect when developing language skills. Liu, (2009) expressed that listening and speaking skills were enhanced through the use of AR. Moreover, Wang (2017) argues that writing can be improved through AR because content control, article structure and wording are improved. AR also helps to develop long-term memory, motivation and a more organized writing process. Another skill to be developed is vocabulary. The studies implemented by Hwang et al. (2016), Solak & Çakır (2015), and Ibrahim et al. (2018) showed that AR helped to increase students' vocabulary, develop a better retention of words and learn vocabulary easily.

In conclusion, AR technology appears as a useful tool that allows students to enhance their learning skills because it presents a variety of applications that make learning more effective and attractive for students in a real context (Weng et al, 2016). Taking into account the usefulness of AR inside the language classroom, the next section will present some studies that show in detail how AR is an effective tool that enhances students' performance when learning a foreign language.

2.1 International studies applying AR

The first study to be analyzed was conducted in a public elementary school by Savitri and Martyani (2020) in Padalarang, Indonesia. The target audience was 30 second-grade students who were divided into an experimental group and a control group. A situation quite similar occurred in Taiwan with a study developed by Tsai, (2018) with 66 third-grade pupils at an elementary school. The main focus of both studies was on the effectiveness of vocabulary mastery as compared to the use of more traditional resources such as flashcards. The groups were tested before being exposed to augmented reality resources and after using them.

In Padalarang's study, during the time of application, the experimental group had the opportunity to interact with the object by accessing AR flashcards and a tablet or smartphone. Consequently, they could observe all sides of the object as if it were in real life in front of them and additionally, they could also get detailed information such as origin or size, among other characteristics. In Taiwan's study, participants were grouped according to their proficiency level of English so that their characteristics in terms of English proficiency were similar. The experimental group of participants from Taiwan not only had the opportunity to create relationships between the vocabulary and image while interacting with AR flashcards, but they were also able to listen to the sounds related to the word being studied.

In both studies, the results showed that the scores of the experimental group were higher during the vocabulary post-test as compared to the results of the control group. Moreover, these findings evidenced that students had fun while using AR for learning vocabulary and that the interaction with multimedia elements activated their motivation.

A third study also shows that motivation can be enhanced with older students while implementing AR in foreign language classes. This study was carried out by Chang, Chen, and Liao, (2020) with 40 junior high school students from the Da-li district of Taichung City. During this research, teachers and students used an AR App as an auxiliary tool for teaching and learning since this allowed advanced image recognition and the experience of making printed content come to life. This research was developed over 18 weeks with 19 students in the control group and 21 participants in the experimental group. On the one hand, teachers could create their materials such as videos about a situational context, and on the other hand, the experimental group of students could use their smartphones to scan images, get videos related to conversational content, and interactive dialogues to practice listening and get familiarized with specific situations from real life such as experiences at the airport. While the experimental group used this kind of technological resource, the control group only used PowerPoint materials.

The study was developed in 3 phases. During the first phase, students were given a pre-experiment English test that was based on Harmer's two indicators for checking English language proficiency: language input and output. Both groups of students had similar results on this test. Then, they also participated in listening, speaking, reading and writing tests. Next, the experimental group was taught using the AR technique and the control group was exposed to a traditional method. Finally, during the third-phase a post-experimental test was carried out to

discover the difference in the results among both groups and the learning effect of the experimental teaching method.

At the end of the stage, the results of the post-test of the experimental group showed to be higher than those of the control group. These results indicated that the experimental group could easily be immersed in the situational context as the AR technique brought enjoyable and interesting immersion experiences and students could repeat the AR videos. Furthermore, a questionnaire based on the ARCS model (attention, relevance, confidence, and satisfaction) was developed to analyze the student-learning performance. These results also revealed that the learning interest in using augmented reality in teaching design and methods positively affects the learning attitude of students and their behavior, satisfaction, and effectiveness while learning. Besides, as the technique uses real-life scenarios for situational context teaching, students were shown to gain confidence and improve their situational conversation and narrative practice when applying it in daily life.

The positive results in the three aforementioned studies were evident from different perspectives. On the one hand, as Tsai, (2018) expresses in Taiwan's study when students interact with augmented reality flashcards, vocabulary learning becomes more realistic since pupils have the opportunity to visualize the real object instead of looking at a cartoon representation of the word. This at the same time helps learners to memorize the vocabulary with ease after passing through a memorable experience that guides students to expand and enrich their vocabulary base. This vocabulary bank that students create serves as the basis to develop reading, listening, speaking, and writing as children have the opportunity to learn the pronunciation and the written form of the word besides creating a concept with the visuals, the meaning of the word and the extra information that can be obtained (Akbulut, 2007).

On the other hand, these kinds of technologies enable students to be more autonomous as they can explore and discover information related to the object in the AR flashcard in an independent way. This means that classes are encouraged to be more student-centered for which students can also access the contents at their own pace, and they can review the information as many times as they consider necessary and according to their abilities. Therefore, teachers adopt the role of organizers and mediators who are not monopolizing the amount of information or the delivery of knowledge, but on the contrary are contributing to building bridges between pedagogy, technology, autonomy, collaborative working, and mobile learning.

By making use of AR and the 21st-century skills, teachers of new generations are taking into account students' interests and needs. This considering that our current young students are digital natives that are used to interacting spontaneously with technological tools as an integral part of their lives. According to Tsai (2018) with these tools, teachers will not only make education more attractive, situational, dynamic and diversified, but they will also foster an engaging environment that can result in higher motivation for learning (Yuen et al, 2011).

2.2 National studies applying AR

AR has also been implemented in English as a Foreign Language (EFL) Colombian classrooms to work on improving the language skills or sub-skills as some studies have evidenced. The first one to be analyzed was conducted under a mixed method approach by Ramirez and Díaz (2021) at Universidad La Gran Colombia with 23 students, 9 men and 14 women, aging from 17 to 21. They were B1 (intermediate English) learners, randomly chosen to be part of an experimental group and control group. This study aimed at finding out the effects of applying innovative teaching materials using AR for improving listening comprehension.

This study was carried out in three stages. In the first stage, there was a need analysis process to choose the imperative sub-skills such as key words, listening for prediction, and listening for specific information, used to design the materials; additionally, the PET (Preliminary English Test) was applied as the pre-test to measure students' English level. In the second stage, three learning units that included AR visuals were elaborated through "blender", "unity", "photoshop" and "vuforia developer" technological tools; these tools considered the needs analysis and the theory based on listening sub-skills development and AR. Thus, these units included some markers not only for listening to the audio but for watching and having a visual input so that students could interact aurally and visually. In the last stage, a post-test was implemented, the results analysis of the unit's implementation was carried out and the pre- and post-tests were compared to examine the effects of the implementation of AR in listening comprehension sub-skills.

The results displayed that the experimental group performed better in the post-test than in the pre-test. Similarly, they obtained better results than the control group; therefore, AR materials were effective tools for learners to work listening comprehension since the auditory-visual process allowed them to create connections about what they listened and saw at the same time; nonetheless, following the pre-test, during and post-listening activities were essential for succeeding. This research clearly shows that AR can be useful for working on improving specific skills and subskills of the English language provided that teachers look for the best ways to implement it.

The second national mixed method research to be analyzed was conducted by Forigua and Orjuela (2020) and aimed at implementing AR as a pedagogical tool to improve English vocabulary of seventh graders from Institución Educativa Departamental Campo Alegre del Rosal Cundinamarca. The population was chosen considering their low academic results in English, good access to technological resources, and lack of motivation at the moment of learning English; thus, 21 learners participated, 8 males and 13 females whose age ranged from 11 to 13.

The instruments used in this study included a field journal to carry out class observation, a pre-test of vocabulary applied through Google forms, a Google forms survey that contained questions related to the methodology used in the class, and a post-test of vocabulary. During the study, students' autonomy was prompted; they were given some codes to access the Metaverse and Aumentaty apps that included AR experiences through a large bank of 3D

images that could be superimposed on the reality that the mobile device camera saw and with which students could interact to explore the selected vocabulary in the different units.

After the pedagogical intervention, some opinions were obtained from students through a survey; in fact, a great percentage of students believed that using AR apps was positive for the EFL teaching/learning processes. Some of the most representative insights demonstrated that the use of AR apps allowed them to improve their English vocabulary, that this kind of learning is more meaningful for them, and that it triggered their interest and motivation. Taking into account the pre- and post- test, the first questionnaire showed that students had limited knowledge of vocabulary based on specific topics selected by the teachers. The post-test evidenced the progress that learners made considering students' improvement on vocabulary. AR can be a tool that teachers could use for working on specific language sub-skills, but it also could benefit important factors that can positively impact the learning process as motivation.

3. Advantages and disadvantages of implementing Augmented Reality in the classroom

After analyzing the five aforementioned studies, it can be inferred that AR is useful at the moment of improving skills inside the EFL class. These studies also show that digital tools allow students to explore and construct their own knowledge while interacting with visuals, vocabulary, reading and processing information.

The five studies show that AR brings opportunities to support and enhance EFL learning. The implementation of AR also helped EFL students to improve their language skills because the results displayed that they had a positive attitude towards learning and they also developed learning autonomy as expressed by Aldossari and Alsuhaibani (2021) who mention that AR permits students to learn how to develop time management skills and be timely at the moment of accomplishing a determined task. Furthermore, it allows students to decide the activities they want to do and be more aware of the mistakes they make and correct them.

Through these studies it has also been possible to identify that teachers had positive perceptions about the importance of implementing AR in their lessons because it motivates students to practice the language. Besides, teachers can play the role of facilitators because students are more autonomous and can use the internet and computer with a pedagogical purpose, improving their language and setting learning objectives (Aldossari and Alsuhaibani, 2021). In this manner, some advantages and disadvantages are mentioned in this article since AR allows teachers, students and educational administrators to include this digital tool in the curriculum and assist teachers to improve their teaching strategies.

Accessibility. Currently, smartphones are devices commonly used; according to Wise (2022), more than 80 % of people around the world own one. This is advantageous since students are digital natives that are in contact with technological devices and those devices can be used in the EFL classroom at the moment of implementing AR. However, it is necessary to be aware that both teachers and students may require training to take advantage of the multiple ways this tool can be used and adapted to benefit the development of students' communicative competence in English.

Enhance students' motivation. Marrahí and Belda (2022) express that AR can be used with a mobile phone and students can learn and be in contact with their learning process every day, making students feel more motivated.

Better at presenting a variety of concepts. Olim and Nisi (2020) explain that another advantage of AR is the ease of presenting abstract objects, because students can clearly identify unknown vocabulary and facilitate their learning.

Positive outcomes regarding language skills. Tzima et al. (2019) assert that once AR is implemented in the classroom, there is a positive effect among students. In the studies mentioned in this paper, students improved their language skills after being exposed to AR because they feel that AR materials have improved their performance. For example, students memorize vocabulary easily since they experience the visuals in a more realistic way.

Students' satisfaction is increased. Marrahí and Belda (2022) express that when students are confronted with new tools that improve their learning process, their motivation and sense of satisfaction is increased because they feel a determined topic is achievable.

Students' interaction is boosted. Taking into account that students are more in contact with digital devices, AR appears as a useful tool that enables students to interact with their educational context and , they may even become digital creators of knowledge. This at the same time encourages students to access information as many times as they consider necessary and to be more autonomous.

However, it is important to mention some challenges that educators might encounter when implementing AR in the classroom, those are shown below.

Technological issues and affordability. Alzahrani (2020) argues that some institutions lack a proper internet network and the access to electronic devices is poor because institutions do not sometimes have the means to invest in AR tools.

Pedagogical limitations. Alzahrani (2020) explains that in some cases AR might be a challenge for both teachers and students because of the lack of Augmented Reality pedagogical models. Thus far, AR has been only implemented as a tool to assist teachers inside the classroom. Another aspect to be considered is the lack of training among teachers because in some cases a poor preparation may cause inconveniences at the moment of using AR in the classroom.

To sum up, these new generations of students could have the chance to use AR easily due to its accessibility. This eventually could help them boost interaction and work on their motivation, understanding, and language skills and sub-skills. Thus, the benefits of AR inside the classroom outweigh the limitations that could be present at the moment of implementing it.

4. Conclusion

AR is a tool that needs to be deeply explored since it is in an initial phase in the field of education especially in EFL settings; thus, further research must be conducted to analyze the impact of it in EFL classrooms. Nonetheless, its implementation so far has brought positive

results and benefits as shown in the aforementioned studies. Both in the national and international application of AR reported hereby, students have experienced higher results in their language skills, especially in their way of recalling vocabulary. The use of AR has allowed teachers to implement innovative ways of presenting class contents through the use of technology, to captivate students' attention by providing opportunities to interact with more realistic visuals and to encourage the development of student's capacity to self-direct their own learning.

In the same way, students have also expressed that learning with AR has been entertaining and more meaningful since they have been able to access the information independently for reviewing topics, strengthening some skills and practicing some topics based on real-life situations. The AR technique has been advantageous for developing individual learning abilities and individual learning progress. These AR real-life scenarios have increased the motivation and willingness of EFL students to learn the language by themselves.

However, the responsibility of all the educational community including teachers is to learn more about the topic so that they can take advantage of AR as a powerful tool for exploring knowledge while enjoying learning in this innovative way. In summary, AR has shown to enhance the educational teaching and learning processes and has opened the way to explore new possibilities for developing English language competence while enjoying classes, and adopting a positive learning attitude and behavior.

References

Acevedo, T., Valencia, A. & Ortega A. (2021). Educación en tiempos de pandemia: perspectivas del modelo de enseñanza remota de emergencia en Colombia. *Revista Historia de la Educación Latinoamericana, 23*(37), 93-112. https://doi.org/10.9757/Rhela

Akbulut, Y. (2007). Effects of multimedia annotations on incidental vocabulary and reading comprehension of advanced learners of English as a foreign language. *Instructional Science, 35*(1), 499-517.

Aldossari, S., & Alsuhaibani, Z. (2021). Using Augmented Reality in Language Classrooms: The Case of EFL Elementary Students. *Advances in Language and Literary Studies, 12*(6), 1-8. https://doi.org/10.7575/aiac.alls.v.12n.6.p.1

Alzahrani, N.M. (2020). Augmented Reality: A Systematic Review of Its Benefits and Challenges in E-learning Contexts. *Applied Sciences, 10*(16), 1-21. https://doi.org/10.3390/app10165660

Barrow, J., Forker, C., Sands, A., O'Hare, D., & Hurst, W. (2019). Augmented Reality for Enhancing Life Science Education. Proceedings of The Fourth International Conference on Applications and Systems of Visual Paradigms, Rome: Italy.

Chang, Y., Chen, C., Liao, C. (2020). Enhancing English-Learning Performance through a Simulation Classroom for EFL Students Using Augmented Reality—A Junior High School Case Study. *Applied Sciences, 10* (21), 1-24. https://doi.org/10.3390/app10217854

Diaz, G. & Ramírez, D. (2021). Augmented reality for listening comprehension: An innovative strategy for articulating visual and auditory processes [M.A. thesis, Universidad La Gran Colombia]. Institutional repository of Universidad La Gran Colombia https://repository.ugc.edu.co/handle/11396/7111

Elmqaddem, N. (2019). Augmented Reality and Virtual Reality in Education. Myth or Reality? *International Journal of Emerging Technologies in Learning (iJET), 14*(03), 234–242. https://doi.org/10.3991/ijet.v14i03.9289

Haleem, A., Javaid, M., Asim, M., Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275-285.

Hwang, Gwo-Jen, Wu, Po-Han, Chen, Chi-Chang, Tu, Nien-Ting (2016). Effects of an augmented reality-based educational game on students' learning achievements and attitudes in real-world observations. *Interactive Learning Environments, 24*(8), 1895-1906.

Ibrahim, A., Huynh, B., Downey, J., Höllerer, T., Chun, D., O'Donovan, J. (2018). Arbis pictus: A study of vocabulary learning with augmented reality. *IEEE transactions on visualization and computer graphics, 24*(11), 2867–2874.

Kai Wu, H., Wen-Yu, S., Chang, H., Liang, J. (2012). Current status, opportunities and challenges of augmented reality in education. *Computers and education, 62*, 41-49.

Kamarainen, A. M., Metcalf, S., Grotzer, T., Browne, A., Mazzuca, D., Tutwiler, A. S., et al. (2013). EcoMOBILE: Integrating augmented reality and probeware with environmental education field trips. *Computers and Education, 68*, 545-556.

Karacan, C. G., Akoğlu, K. (2021). Educational Augmented Reality Technology for Language Learning and Teaching: A Comprehensive Review. *Shanlax International Journal of Education, 9*(2), 68-79.

Liu, T., Tan, T., & Chu, Y. (2009). Outdoor Natural Science Learning with an RFID Supported Immersive Ubiquitous Learning Environment. *Journal of Educational Technology & Society, 12 (4)*, 161-175.

Liu, T. (2009). A Context-aware Ubiquitous Learning Environment for Language Listening and Speaking. *Journal of Computer Assisted Learning, 25*(6), 515-527.

Marrahí-Gómez, V., & Belda-Medina, J. (2022). The Application of Augmented Reality (AR) to Language Learning and its Impact on Student Motivation. *International Journal of Linguistics Studies, 2*(2), 07–14. https://doi.org/10.32996/ijls.2022.2.2.2

Milman, N. B. (2018). Defining and Conceptualizing Mixed Reality, Augmented Reality, and Virtual Reality. *Distance Learning. 15*(2), 55-58.

Olim, S.C., Nisi, V. (2020). Augmented Reality Towards Facilitating Abstract Concepts Learning. Entertainment Computing – ICEC 2020. ICEC 2020. Lecture Notes in Computer Science, 12523, 188–204. https://doi.org/10.1007/978-3-030-65736-9_17

Savitri, I., Martyani, E. (2020). Integrating Augmented Reality (Ar) in EFL Class for Teaching Vocabulary. *PROJECT (Professional Journal of English Education). 3*(2), 160-167.

Saffar, A. H., Al-Jafar, A. A., & Yousefi, Z. H. (2016). The Effectiveness of Using Augmented Reality Apps in Teaching the English Alphabet to Kindergarten Children: A Case Study in the State of Kuwait. *EURASIA Journal of Mathematics Science and Technology Education, 13*(2), 417-440.

Solak, E., Çakır, R. (2015). Exploring the Effect of Materials Designed with Augmented Reality on Language Learners' Vocabulary Learning. *Journal of Educators Online, 13*(2), 50-72.

Subhashini P., Siddiqua R., Keerthana A., Pavani P. (2020). Augmented Reality in Education. *Journal of Information Technology and Digital World, 2*(4), 221-227 https://doi.org/10.36548/jitdw.2020.4.006

Tsai, C. (2018). A Comparison of EFL Elementary School Learners' Vocabulary Efficiency by Using Flashcards and Augmented Reality in Taiwan. *New Educational Review, 51*, 53-65.

Tzima, S., Styliaras, G., Bassounas, A. (2019). Augmented Reality Applications in Education: Teachers Point of View. *Education Sciences, 9*(2), 1-18. https://doi.org/10.3390/educsci9020099

UNESCO, (2011). Digital natives, how do they learn? How to teach them? Knowledge and learning for digital natives, 7-9.

Wang, M. Callaghan, V., Bernhardt J., White, K. & Peña-Rios, A. (2017). Augmented Reality in Education and Training: Pedagogical Approaches and Illustrative Case Studies. *Journal of Ambient Intelligence and Humanized Computing*, 1391-1402. https://doi.org/10.1007/s12652-017-0547-8

Weng, N. G., Bee, O. Y., Yew, L. H., & Hsia, T. E. (2016). An augmented reality system for biology science education in Malaysia. *International Journal of Innovative Computing. 6* (2).

Wise, J. (2022, August 3). How many people use smartphones in 2023. https://earthweb.com/how-many-people-use-smartphones/

Yuen, S. C.-Y., Yaoyuneyong, G., & Johnson, E. (2011). Augmented Reality: An Overview and Five Directions for AR in Education. *Journal of Educational Technology Development and Exchange, 4*(1), 119-140.

Yunus, M. M. (2018). Innovation in Education and Language Learning in the 21st Century. *Journal of Sustainable Development Education and Research, 2*(1), 33–34. https://doi.org/10.17509/jsder.v2i1.12355