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The Implementation of Augmented Reality for Vocabulary Teaching and Learning: A Systematic Review

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ABSTRACT

With the rapid growth of Augmented Reality (AR), more research is being conducted to determine how well this technology works in the educational setting. However, a review of the effectiveness of AR in students' vocabulary learning is scarce despite its importance in sustaining education. Thus, this paper employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method to highlight AR technology's potential as an educational tool. Advanced searching has been used through Scopus and Web of Science (WoS) databases, the main platforms for article sources. Based on the search results, we discovered (n = 20) published articles that associated AR in vocabulary teaching and learning were extracted out of (n = 83) from 2018 to 2023. The results suggested the research objectives, methods and tools, participants, and AR applications. Expert scholars decided to develop three themes, which are (1) the usage of AR in vocabulary teaching and learning, (2) the effect of AR-assisted on student's learning performance, and (3) issues and obstacles. This study also demonstrated that AR technology might be perceived as a platform for personalized learning, which is one of the affordances of this technology. It might improve learning outcomes, particularly in vocabulary acquisition and learning satisfaction. It might also help with the development of linguistic performance. In conclusion, this systematic study aims to add crucial information to the current knowledge, providing valuable insights for educators, researchers, and policymakers, ultimately paving the way for more targeted and impactful AR-assisted vocabulary learning experiences in diverse educational settings.

Keywords:
Augmented reality; teaching; learning vocabulary

1. Introduction

In recent years, the field of education has witnessed a significant transformation with the integration of technology into various teaching and learning processes. One such technological

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advancement that holds great promise for enhancing vocabulary teaching and learning is Augmented Reality (AR). AR refers to the blending of virtual elements with the real-world environment [1-4], thereby creating an interactive and immersive learning experience [5]. With its potential to engage students and provide them with a contextualized understanding of vocabulary, AR has emerged as a promising tool in language education. AR also functions as a tool in e-learning to increase student motivation in the learning process [6-8], long-term memory retention, language associations, and learning spatial structures [9-10].

This systematic review aims to explore the implementation of AR in vocabulary teaching and learning, identifying its benefits, challenges, and potential for future research and development. By critically examining existing literature and studies on this subject, this review aims to provide a comprehensive understanding of the current state of AR implementation in vocabulary education.

The importance of vocabulary acquisition is unable to be overstated, as it serves as a fundamental building block for language proficiency. However, traditional methods of vocabulary instruction often rely on rote memorization and isolated word lists, which can be mundane and ineffective [11]. Hence, AR solves this problem by creating dynamic and interactive learning environments that promote active engagement and meaningful vocabulary acquisition [12-13].

One of the key advantages of AR is its ability to provide learners with real-world context, making vocabulary acquisition more authentic and memorable [14-16]. By overlaying digital information onto physical objects or environments, AR applications can create a multisensory learning experience that enhances comprehension and retention [17]. For instance, students can utilize AR-enabled mobile devices to scan objects and instantly access relevant vocabulary words, definitions, and examples [18]. This immersive approach allows learners to associate words with visual cues, facilitating deeper understanding and long-term retention [19-20].

Furthermore, AR can cater to diverse learning styles and individual needs. Traditional classroom settings often struggle to accommodate the varying learning preferences of students; however, AR technology can provide customizable and adaptive learning experiences. Learners can interact with AR applications at their own pace [21], adjusting the level of difficulty or receiving personalized feedback based on their performance. This individualized approach promotes learner autonomy and motivation, fostering a positive learning experience [22].

The potential benefits of AR in vocabulary teaching and learning are evident, and some challenges need to be addressed. For instance, integrating AR into the curriculum requires adequate technical infrastructure and resources, which may pose limitations in certain educational settings [23]. Additionally, the design and development of high-quality AR applications require collaboration between educators, technologists, and instructional designers [24]. Therefore, this review also aims to identify the barriers and limitations of AR implementation, providing insights into the necessary considerations for successful integration.

In conclusion, this systematic review will examine the current state of AR implementation in vocabulary teaching and learning. By analyzing existing literature, this review aims to describe how AR technology has been adopted in various studies focusing on vocabulary teaching and learning. We also highlight the benefits and effects of AR-assisted instruction on student performance, challenges, and potential future directions for AR integration in language education. The findings of

this review will provide educators, researchers, and policymakers with valuable insights into the effective use of AR as a tool to enhance vocabulary acquisition, ultimately contributing to the advancement of language education in the digital age.

2. Methodology

2.1 Identification

Three fundamental stages of the systematic review procedure were employed to select a substantial number of pertinent papers for this investigation. In the first stage, keywords are selected, and similar terms are looked for using thesauri, dictionaries, encyclopedias, and previous research. The search strings for the databases Scopus and Web of Science (WoS) (Table 1) have been made once all pertinent terms have been decided. As a result, 83 papers from both databases were successfully retrieved by the current study project during the initial stage of the systematic review procedure.

Table 1
The search string

Scopus	TITLE-ABS-KEY (“augmented reality” AND teaching AND learning AND vocabulary) AND PUBYEAR > 2017 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “COMP”)) AND (LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (LANGUAGE, “English”)) AND (LIMIT-TO (SRCTYPE, “j”)) AND (LIMIT-TO (PUBSTAGE, “final”))
WoS	“Augmented reality” AND teaching AND learning AND vocabulary (Topic) and 2018 or 2019 or 2020 or 2021 or 2022 or 2023 (Publication Years) and Article (Document Types) English (Languages)

* Date of access: October 2023

2.2 Screening

After identifying articles, the screening process occurred, and duplicate papers were disqualified during the initial screening. Duplicate papers were purposefully eliminated from the initial screening to ensure that only original and distinctive items were considered for additional examination. Six papers in all were excluded from the first phase since they were duplicates. Moving on to the second stage, a careful screening of 31 papers was performed. Several inclusion and exclusion criteria that the researchers had carefully designed were put to use throughout this screening process. Consideration of literature, particularly research articles, as the primary source of useful knowledge was one of the main criteria considered. As a result, the current study did not include any systematic reviews, reviews, meta-analyses, meta-syntheses, book series, books, chapters, or conference proceedings. In addition, the review was restricted to works published in English. Remember that the strategy was created for the recent six-year term (2018-2023), and the review was limited to Social Science and Computer Science articles. Fifty-two publications, in all, were disqualified based on specific standards.

2.3 Eligibility

The eligibility evaluation, or third phase, involved compiling a collection of 25 papers. At this point, we meticulously examined each article's title and key points to ensure they matched the inclusion requirements and were pertinent to the ongoing study goals. Due to the fact that two papers did not relate to the research domain, had unimportant titles, or had abstracts pertinent to the study's aims based on empirical data, they were omitted from the analysis. As a result, 20 articles were retained for additional analysis (Table 2).

Table 2
The selection criterion is searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2018 – 2023	< 2018
Literature type	Journal (article)	Conference, book, review
Publication stage	Final	In press
Subject area	Social Science & Computer Science	Besides Social Science & Computer Science

2.4 Data Abstraction Analysis

In this study, one of the assessment strategies included the use of an integrative analysis to review and synthesize a range of research approaches (quantitative, qualitative, and mixed methods). The competent study's objective was to determine pertinent subjects and subtopics. Data collection was the initial phase of the theme's development. Figure 1 displays how the authors meticulously analyzed a compilation of 20 publications for assertions or material relevant to the topics of the current study. Consequently, the authors evaluated the current significant studies related to AR implementation. Investigations are conducted into both the research findings and methods employed in all studies. The author then worked with other co-authors to create themes based on the data in the context of this study. A log was kept throughout the data analysis process to record any analyses, viewpoints, conundrums, or other concepts that would be relevant to the data interpretation. After comparing the results, the authors searched for any inconsistencies in the theme design process. It is significant to notice that the authors discuss any conceptual disagreements they may have with one another. To ensure uniformity, the themes created underwent final revisions. The analysis selection was conducted by two experts, one in education (Mohd Feham Md Ghalib – expert in educational technology and media) and the other in social science (Radhwa Abu Bakar – expert in linguistics), to determine the validity of the problems. By defining the domain, the expert review process ensures that each subtheme is clear, significant, and appropriate.

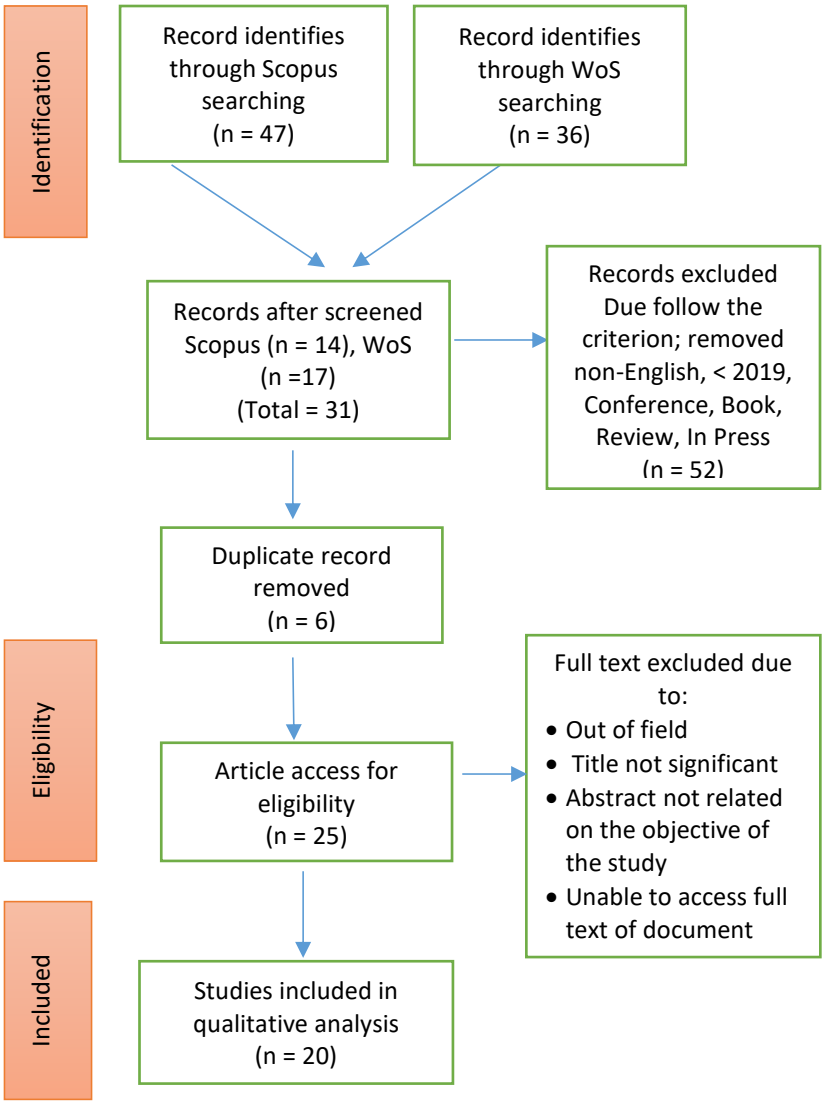

Fig.1. Flow diagram of the proposed searching study [25]

3. Results

Based on the search results, we discovered 20 published articles from 83 between 2018 and 2023 that were related to AR in vocabulary teaching and learning. The study's objectives, techniques, tools, participants, and applications for AR were all revealed by the findings. The three main themes on which all papers were categorized were the usage of AR for vocabulary teaching and learning, the effects of AR technology on vocabulary teaching and learning, and issues and obstacles related to AR implementation. The findings have been systematically summarized in Table 3.

3.1 The Usage of Augmented Reality for Vocabulary Teaching and Learning

The discussion of the results begins with the first theme about the usage of AR technology for vocabulary teaching and learning in previous studies. The studies reveal that AR technology can significantly enhance vocabulary teaching and learning outcomes. By adapting the method, participants, language focus, and AR applications to specific educational contexts, educators can harness the potential of AR to create engaging and effective vocabulary learning experiences.

Table 3
The research article findings based on the purpose search criterion

Titles & authors	Objectives	Methods and tools	Participants	AR platforms
Improving the experience of teaching and learning kindergarten-level English vocabulary using augmented reality [26]	Investigating the potential for AR technology to enhance kindergarten students' and instructors' educational experiences as well as to allay parents' worries that a child's health may be negatively impacted by prolonged use of electronic gadgets.	Software development, a quantitative approach using usability evaluation	Kindergarten students, teachers, and parents (the specific number of participants is not mentioned in the abstract).	Mobile AR instructional and learning tool
The Effects of Augmented Reality on Motivation and Performance in EFL Vocabulary Learning [27]	Comparing the traditional lecturing approach and the AR method in order to assess the differences in students' English vocabulary learning performance as well as the motivation of the instructional materials.	Mixed method approach, experimental design study using English vocabulary tests, Instructional Materials Motivation questionnaire, and structured student interviews	Forty-two students from two fifth-grade classes in an elementary school in Central Taiwan.	AR-supported vocabulary materials
Augmented reality and visuospatial bootstrapping for second-language vocabulary recall [16]	Examining the effectiveness of using AR with visuospatial bootstrapping (VSB) compared to the well-established Quizlet method in second-language vocabulary memorization.	Quantitative, experimental design employing a delayed post-test	A sample of university students who were attempting to learn a second language (The specific number of participants is not mentioned in the abstract).	AR-VSB technique
The effectiveness of augmented reality for English vocabulary instruction of Greek students with intellectual disabilities [28]	Evaluating how well an AR intervention taught English vocabulary to individuals with Intellectual Disabilities (ID).	Quantitative, experimental design employing a pre-test and post-test	Three students with ID.	AR vocabulary instruction
Integrating Augmented Reality into a Task-Based	Exploring the effective integration of AR into language curricula for	Design-based research, mixed method design, using	Students (The specific number of participants is	"Post Reality" app as a tool for the AR

Thematic Language Teaching Unit [29]	English speaking and listening skill development.	surveys and a focus group interview to assess students' perceptions and the impact on their language skills	not mentioned in the abstract).	component
The Use of Augmented Reality through Assemblr Edu to Inspire Writing in an Ecuadorian EFL Distance Program [30]	Assessing the use of Assemblr Edu and its AR components, especially in areas like paragraph organization, structure, grammar, vocabulary, and punctuation in EFL students' writing skills enrolled in distance learning.	Mixed method approach, experimental design using pre-tests, post-tests, written assignments evaluated using a rubric, and surveys	40 first-year university students who had a basic level of proficiency in English.	AR on the Assemblr Edu platform
AR Computer-Assisted Learning for Children with ASD based on Hand Gestures and Voice Interaction [31]	Developing and evaluating a gesture and voice-based learning framework using AR for children with autism spectrum disorder (ASD) to increase children's engagement and focus during the session	Mixed method approach, development of an AR-based learning framework and prototype for children with ASD, along with a pilot study to evaluate its effectiveness	18 children diagnosed with ASD, aged 2-12 years, three therapists or parents.	AR-based game
Efficacy of augmented reality-based flashcards on learning Basic Tamil words among primary learners during the neo-normal period [32]	Assessing the efficacy of an AR-based flashcard application in teaching basic Tamil words to primary school students.	Quantitative, experimental design employing a pre-test and post-test	67 primary school students.	AR-based flashcard application
Augmented reality for preschool children: An experience with educational content [8]	Assessing the impact of an AR-based program on the motivation, attention, and conceptual skills of preschool children.	Quantitative, experimental design employing a pre-test and post-test	26 preschool children, all in the 4-5 age group.	AR-based program
An examination of vocabulary learning and retention levels of preschool children using augmented reality technology in English language learning [33]	Measuring preschool children's vocabulary learning, retention levels, and perspectives of English language learning using AR technology.	Mixed-method approach, experimental design employing a one-group pre-test and post-test design, student interviews	39 preschool children aged between 5-6 years old.	AR-supported educational toys for preschool
		Quantitative,		

The Effect of Web Augmented Reality on Primary Pupils' Achievement in English [34]	Exploring the impact of Web AR on the achievement of 4th-year primary school students in English.	experimental design using post-test	A random sample of primary school students, specifically, 4th-year Iraqi students.	Web AR application
The Effect of Using Augmented Reality with Storytelling on Young Learners' Vocabulary Learning and Retention; [Artırılmış Gerçeklik ile Hikâye Anlatımının Çocuk Öğrenenlerin Sözcük Öğrenimi ve Hatırda Kalıcılığına Etkisi] [15]	Analyzing the effectiveness of AR in improving foreign vocabulary learning and retention among young 5th-grade students in Turkish.	Quantitative, experimental design employing a pre-test and post-test	56 5th-grade students in Turkey.	AR technology on flashcards
Exploring the Promise of Augmented Reality for Dual Language Vocabulary Learning Among Bilingual Children: A Case Study [35]	Describing the early stages in the development of a dual language AR application for teaching vocabulary to English Language Learners (ELLs).	Iterative design approach, a case study using multiple cycles of design, testing, and refinement	A random sample of early elementary students and parents in the United States.	AR application for teaching vocabulary to ELLs
The framework of an ar-quest instructional design model based on situated learning to enhance Thai undergraduate students' Khmer vocabulary ability [36]	Proposing a framework for an AR-Quest instructional design model based on situated learning to enhance Thai undergraduate students' Khmer vocabulary ability.	Development and evaluation-based research method, quantitative, experimental design employing a pre-test and post-test, evaluating the AR-Quest instructional model, including proposal, using expert opinions	30 undergraduate students in Thai.	AR-quest instructional design model
A comparison of EFL elementary school learners' vocabulary efficiency by using flashcards and augmented reality in Taiwan [37]	Comparing the effectiveness of traditional English flashcards with an AR vocabulary learning method for elementary school students.	Quantitative, experimental design employing a pre-test and post-test for English vocabulary	66 third-grade students at an elementary school in Taiwan.	AR-based approach with 3D effects
ARabic-Kafa: Design and development of	Producing and developing instructional tools, such as ARabic-Kafa, for learning	Design and development research, quantitative	A random sample of students and teachers at	Mobile AR application: ARabic-Kafa

educational material for Arabic vocabulary with augmented reality technology [38]	Arabic vocabulary using AR technology.	employing usability assessment	selected Quran and Fardhu Ain (KAFA) schools in Malaysia.	
An action research study exploring the effects of augmented reality on English vocabulary learning in an elementary school in Taiwan [7]	Contrasting the usage of conventional English flashcards with the vocabulary-learning approach of AR to observe which is more effective for elementary school students.	Quantitative, action research, experimental design using a pre-test and post-test for English vocabulary	60 students at an elementary school in Taiwan.	AR-based vocabulary learning
User Satisfaction for an Augmented Reality Application to Support Productive Vocabulary Using Speech Recognition [39]	Developing an AR application for children that integrates visual script (orthography) and audio (phonology) through speech recognition to enhance productive Arabic vocabulary learning, evaluating and identifying user satisfaction with the AR-based vocabulary learning method.	Design and development research, mixed method approach through expert interviews, employing a System Usability Scale (SUS) questionnaire	A random sample of teachers and parents of students at selected Quran and Fardhu Ain (KAFA) schools in Malaysia.	AR application for vocabulary learning
Exploring the viability of augmented reality game-enhanced education in WhatsApp flipped and blended classes versus the face-to-face classes [2]	Examining the impact of Augmented Reality Games (ARG) on EFL learners' direction-related language skills.	Quantitative, experimental design employing a pre-test and post-test with written and oral tests and assessment	60 elementary students divided into comparative (flipped and blended) and control groups.	AR games
Augmented Reality-based Oral Teaching System under Human-Computer Interaction [40]	Developing and assessing the effectiveness of the Oral Chinese Teaching Auxiliary System (OCTAS) as an auxiliary system for teaching Chinese as a second language.	Design and development research	The specific number of participants is not mentioned in the abstract.	AR technology in OCTAS

3.1.1 Methodologies and instruments in previous studies

Most reviewed studies adopted true experimental designs and either a quantitative (n = 14) or mixed-method (n = 6) approach. These rigorous research methods allowed for a precise assessment of the impact of AR on vocabulary instruction. To achieve this, researchers employed an array of

instruments. For instance, Carrion-Robles *et al.,* [30] used questionnaires, pre-tests, post-tests, written assignments, and other quantitative tools to evaluate the effects of AR activities provided through the Assemblr Edu platform. This comprehensive approach provided a holistic view of the learning outcomes.

Similarly, Yilmaz *et al.,* [33] combined a mixed-method approach with a true experimental design to assess the effects of mobile AR-assisted learning on various learners with differing learning styles and language proficiency levels. They also incorporated a semi-structured student interview to gain insights into the qualitative aspects of learning motivation and experiences. This combination of quantitative and qualitative data allowed for a thorough evaluation of the impact of AR. In the study by Rapti *et al.,* [28], which focused on students with Intellectual Disabilities (ID), the research employed a quantitative experimental design with pre-tests and post-tests. Using this approach, they could precisely measure the effectiveness of the AR Vocabulary Instruction in teaching English vocabulary related to thematic categories like food and animals. This thematic approach added context and relevance to the vocabulary taught, making it more engaging for the learners.

3.1.2 Participants of previous studies

The participants vary according to the target group. The reviewed studies delved into the use of AR in multiple levels of education. The majority of the studies (n = 9) were conducted in primary schools [2, 7, 15, 32, 34, 35, 37, 38, 41]. Three studies involved university students [16, 36, 42]. Meanwhile, three studies focused on early education, kindergarten students [8, 26, 33]. Two studies recruited special education students [28, 31]. The final study, conducted by Zhang [29] did not specifically mention the target level of AR technology.

Aside from students, the studies also involved teaching practitioners and experts in the domain of educational technology. For instance, Eang and Na-Songkhla [36] invited experts (university professors) of technology in language learning in Thai to review the AR-Quest Instructional design model based on situated learning to enhance Thai undergraduate students' Khmer vocabulary. In another study, conducted by Wan Daud *et al.,* [38] produced and developed an instruction tool, namely Arabic-Kafa, for Arabic vocabulary teaching and learning. Meanwhile, Amara *et al.,* [31] investigated the impacts of AR-based learning frameworks and prototypes for children with Autism Spectrum Disorder (ASD).

3.1.3 Language focus

Multiple languages were indicated as the main focus of learning and instruction activities. However, most studies (n = 14) adopted AR technology to teach English as a second or foreign language. Next, two studies conducted by Wan Daud *et al.,* [38] and Hashim *et al.,* [39] focused on the Arabic language. The review also discovered that, respectively, one study was oriented to another language, such as Tamil [32], Khmer [36], and Chinese [40].

3.1.4 Augmented reality applications

In these studies, various AR applications are utilized to enhance vocabulary learning. These applications can include AR-enabled educational toys, AR flashcards, and virtual 3-dimensional (3D) objects through Marker-Based Tracking as well as speech recognition. AR technology can also be

integrated with gesture and voice-based learning frameworks, task-based thematic units, and monitoring systems.

Additionally, some AR-enabled games were added to the curriculum to support gamified language learning. The study conducted by Khodabandeh [2] suggested that students can also collaborate via this technology, which helps them produce more words and hone their language skills. Mobile devices like smartphones and tablets can be utilized to access AR technology in its current state to a large extent. However, the lack of software or programmers that can be utilized to help language education remains the current limitation.

In this review, some studies developed AR systems that were aimed specifically at language learning. This type of study conducted by Wan Daud *et al.,* [38], who developed the instructional based on an AR tool, namely Arabic-Kafa. This AR application ensures the marker-based tracking tool. This technique was used, as it could read things and display animated virtual 3D objects through mobile devices. The first step in fixing this problem is to use the Blender application to generate animations, select the image to be used as a Marker, and then export it to Vuforia to develop an AR application for learning Arabic vocabulary. Similarly, Hashim *et al.,* [39] adopted an AR-supported Arabic character specifically developed for learning the Arabic language.

3.2 The Effects of AR-Assisted Instruction on Student's Learning Performance

The second theme concerns the effects of AR-assisted instruction on students's learning performance**.** There are many advantages to incorporating AR technology into language training. It improves language proficiency, learner enjoyment, anxiety reduction, situated learning, collaborative learning, and individualized learning. These capabilities make AR a crucial tool for teaching vocabulary, providing a more interesting and successful learning experience for various learner groups throughout educational contexts. Table 4 summarizes the findings regarding the effects of AR technology.

Table 4
The effects of AR-assisted instruction on students's learning performance

Effects of AR-assisted instruction on student's learning performance	Studies
Language proficiency	[7], [14], [28], [31], [33], [36-38], [41]
Increased learning satisfaction	[8], [29], [35], [39]
Anxiety reduction	[28]
Situated learning	[7], [36]
Collaborative learning	[2], [31]
Individualized learning	[8], [14], [32], [33], [35]

One significant benefit of AR technology, as demonstrated by various studies, is the development of language performance. The study conducted by Tsai [7] involving EFL vocabulary learning indicates that AR improves vocabulary acquisition and enhances language performance. Meanwhile, the study conducted by Eang and Na-Songkhla [35], Hashim *et al.,* [38] discovered that students exposed to AR methods tend to exhibit improved language skills, including pronunciation, fluency, and comprehension. This development in language performance is crucial for effective communication and language acquisition.

Another notable affordance of AR technology is increased learning satisfaction. The use of AR, as exemplified in studies like Zhang [8], Aydogdu [28], Smith *et al.,* [34], Hashim *et al.,* [38], creates engaging and immersive learning environments. Kindergarten students, as well as learners of all

ages and backgrounds, tend to find AR-based instruction more enjoyable and satisfying. This increased satisfaction can lead to higher motivation levels, making learners more eager to engage with the material.

Reduced learning anxiety is another critical benefit of AR technology. Studies like those involving students with ID [28] and preschool children [8, 26, 43] suggest that AR can provide a less intimidating and more supportive learning environment. This reduced anxiety can significantly improve the learning experience, allowing learners to focus on vocabulary acquisition rather than being overwhelmed by anxiety.

Adopting a contextual learning strategy can provide students with a more fulfilling educational experience and aid in developing their language skills. According to Eang and Na-Songkhla [36] and Tsai [7], situated learning promotes the student-centered approach by offering a real-world-like authentic or virtual learning environment. To adopt a situational learning strategy in this regard, AR technology has features that can be tapped into.

A collaborative learning strategy emphasizes the importance of students actively participating in group or pair projects to create their own ideas and knowledge. Studies have proven how AR technology can be used to get students involved in group projects. Furthermore, engaging students in cooperative language learning with their peers can promote interaction, raise enthusiasm for studying, and provide them with meaningful learning experiences. Two studies examine collaborative learning for AR technology integration in language courses. These studies revealed that presenting AR games in a cooperative learning setting offered specific learning settings that aid in explaining abstract concepts through graphics and the game narrative [2, 31].

Finally, AR technology enables individualized learning experiences. These studies demonstrated that the flexibility of AR applications allows learners to tailor their vocabulary learning journey according to their pace and preferences [8, 14, 32, 33, 35]. Students can interact with AR modules at their own speed, revisiting content when needed, leading to more effective vocabulary acquisition.

3.3 Issues and Obstacles Related to Augmented Reality Implementation

The third theme of this study addresses the issues and obstacles related to AR implementation. Although AR technology has the potential to change language training, it is constrained by several factors. This includes technical difficulties, differences in technological proficiency, social issues, and health issues. In order to effectively utilize AR's educational benefits and guarantee a more inclusive and productive learning environment, it is essential to get beyond these obstacles.

Technical limitations pose a significant challenge to the implementation of AR technology in vocabulary instruction. The studies, such as Lee *et al.,* [26], highlight that access to the necessary hardware and software can be a major hurdle. Not all educational institutions or learners have the required devices or internet connectivity to use AR for learning effectively. This digital divide can create disparities in students' educational experiences, where those with limited access to technology are at a disadvantage.

Moreover, unequal technological competence among teachers and students can hinder the successful integration of AR in the classroom. Tsai [37] discovered that instructors and learners may lack the skills and knowledge required to use AR-based instructional materials effectively. Teachers might require additional training to harness the full potential of AR, while students need guidance to navigate AR applications. This knowledge gap can impede the seamless incorporation of AR into the curriculum.

Social concerns also play a role in the barriers to AR technology in education. As demonstrated in the study conducted by Lee *et al.,* [26] parents may worry about the potential negative impact of prolonged screen time on their children's health. These concerns may lead to resistance to adopting AR-based educational methods, as parents prioritize their children's well-being over the benefits of AR technology. Addressing these concerns through research and transparent communication is essential to overcome this barrier.

Another critical aspect is children's health. The study involving children with ASD [31] touches upon the importance of considering the well-being of students, especially those with specific needs. Prolonged exposure to AR technology might not be suitable for all students, and educators need to consider individual health considerations, including concentration issues or sensory sensitivities.

To mitigate these obstacles, efforts are required at multiple levels. Schools and institutions should invest in the necessary infrastructure to ensure equitable access to AR technology. Training programs can empower teachers and students with the skills to use AR in education effectively. Hence, clear communication with parents, addressing their concerns, and highlighting the educational benefits of AR can foster support for its implementation. Finally, educators should always consider the health and well-being of their students and tailor AR usage to individual needs.

4. Conclusions

The potential of AR technology in education has been recognized as being great. The increased use of mobile technology and ongoing hardware improvements have made AR more widely available and popular with teachers. In this systematic review, we examine the conclusions from 20 research drawn from different databases emphasizing the use of AR technology in educational contexts. The review addressed three important research themes: 1) the usage of AR for vocabulary teaching and learning, 2) the effects of AR-assisted instruction on student’s learning performance, and 3) issues and obstacles related to AR implementation.

Most of the research that was examined used experimental designs with various participant groups, from preschool to higher education, to examine how AR could be used to teach and learn language. Included were learners, subject-matter specialists, and teachers. Although English was the language most often taught, studies also included Arabic, Chinese, Tamil, and Khmer. AR-based teaching methods and AR-based mobile games were both used extensively in the field of language instruction. Previous research highlighted a variety of advantages, including improved language performance and learning outcomes, higher happiness, decreased anxiety when learning, located and individualized learning, and the encouragement of collaborative learning. However, obstacles to the adoption of AR technology have been discovered, including technical restrictions, differences in technological aptitude, and social and health concerns. The review recommends pedagogical strategies to address these findings.

To best utilize AR technology for young learners, this includes encouraging collaboration between teachers and parents, combining varied learning schemes, and promoting the growth of teachers' technological competence. The evaluation urges additional thorough and long-term studies to examine students' adoption of and attitudes toward AR technology. It also urges the conduct of comparison research to evaluate the effects of AR-based gamified learning in both indoor and outdoor language classes.

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References

[1] Taskiran, Ayse. "The effect of augmented reality games on English as foreign language motivation." *E-Learning and Digital Media* 16, no. 2 (2019): 122-135. https://doi.org/10.1177/2042753018817541

[2] Khodabandeh, Farzaneh. "Exploring the viability of augmented reality game-enhanced education in WhatsApp flipped and blended classes versus the face-to-face classes." *Education and Information Technologies* 28, no. 1 (2023): 617-646. https://doi.org/10.1007/s10639-022-11190-6

[3] Bronack, Stephen C. "The role of immersive media in online education." *The Journal of Continuing Higher Education* 59, no. 2 (2011): 113-117. https://doi.org/10.1080/07377363.2011.583186

[4] Dunleavy, Matt, Chris Dede, and Rebecca Mitchell. "Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning." *Journal of science Education and Technology* 18 (2009): 7-22. https://doi.org/10.1007/s10956-008-9119-1

[5] Adnan, A. H. M. "From interactive teaching to immersive learning: Higher Education 4.0 via 360-degree videos and virtual reality in Malaysia." In *IOP Conference Series: Materials Science and Engineering*, vol. 917, no. 1, p. 012023. IOP Publishing, 2020. https://doi.org/10.1088/1757-899X/917/1/012023

[6] Hakim, Arif Rahman, Muhammad Asikin, and Adi Nurcahyono. "The Development of Learning Module with Mobile Augmented Reality Based on 9E Learning Cycle to Improve Problem Solving Skills." *Unnes Journal of Mathematics Education Research* 10, no. 1 (2021): 1-9.

[7] Tsai, Cheng-Chang. "An action research study exploring the effects of augmented reality for English vocabulary learning in an elementary school in Taiwan." *The New Educational Review* 59 (2020): 163-174. https://doi.org/10.15804/tner.2020.59.1.13

[8] Aydoğdu, Fatih. "Augmented reality for preschool children: An experience with educational contents." *British Journal of Educational Technology* 53, no. 2 (2022): 326-348. https://doi.org/10.1111/bjet.13168

[9] Radu, Iulian. "Augmented reality in education: a meta-review and cross-media analysis." *Personal and ubiquitous computing* 18 (2014): 1533-1543. https://doi.org/10.1007/s00779-013-0747-y

[10] Suhaimi, Elmi Sharlina Md, Zuhaizi Abdullah, Norazreen Muhamad, Nik Khadijah Nik Salleh, and Ahmad Affendy Abdullah. "FIGEE CARD: Pembelajaran Interaktif Kumpulan Berfungsi Kimia Organik: FIGEE CARD: Interactive Learning of Organic Chemistry Functional Groups." *International Journal of Advanced Research in Future Ready Learning and Education* 30, no. 1 (2023): 13-24.

[11] Yang, Weidong, and Weiping Dai. "Rote Memorization of Vocabulary and Vocabulary Development." *English Language Teaching* 4, no. 4 (2011): 61-64. http://dx.doi.org/10.5539/elt.v4n4p61

[12] Saidin, Nor Farhah, Noor Dayana Abd Halim, and Noraffandy Yahaya. "A review of research on augmented reality in education: Advantages and applications." *International education studies* 8, no. 13 (2015): 1-8. http://dx.doi.org/10.5539/ies.v8n13p1

[13] Gargrish, Shubham, Archana Mantri, and Deepti Prit Kaur. "Augmented reality-based learning environment to enhance teaching-learning experience in geometry education." *Procedia Computer Science* 172 (2020): 1039-1046. https://doi.org/10.1016/j.procs.2020.05.152

[14] Larchen Costuchen, Alexia, Stephen Darling, and Clare Uytman. "Augmented reality and visuospatial bootstrapping for second-language vocabulary recall." *Innovation in Language Learning and Teaching* 15, no. 4 (2021): 352-363. https://doi.org/10.1080/17501229.2020.1806848

[15] Yangin Ersanli, Ceylan. "The Effect of Using Augmented Reality with Storytelling on Young Learners' Vocabulary Learning and Retention." *Novitas-ROYAL (Research on Youth and Language)* 17, no. 1 (2023): 62-72.

[16] Larchen Costuchen, Alexia, Stephen Darling, and Clare Uytman. "Augmented reality and visuospatial bootstrapping for second-language vocabulary recall." *Innovation in Language Learning and Teaching* 15, no. 4 (2021): 352-363. https://doi.org/10.1080/17501229.2020.1806848

[17] Hung, Y-H., C-H. Chen, and S-W. Huang. "Applying augmented reality to enhance learning: a study of different teaching materials." *Journal of Computer Assisted Learning* 33, no. 3 (2017): 252-266. https://doi.org/10.1111/jcal.12173

[18] Belda-Medina, Jose, and Victor Marrahi-Gomez. "The impact of augmented reality (AR) on Vocabulary Acquisition and Student Motivation." *Electronics* 12, no. 3 (2023): 749. https://doi.org/10.3390/electronics12030749

[19] Lazou, Chrysoula, and Avgoustos Tsinakos. "Critical Immersive-Triggered Literacy as a Key Component for Inclusive Digital Education." *Education Sciences* 13, no. 7 (2023): 696. https://doi.org/10.3390/educsci13070696

[20] Alemi, Minoo. "General impacts of integrating advanced and modern technologies on teaching English as a foreign language." *International Journal on Integrating Technology in Education* 5, no. 1 (2016): 13-26. https://doi.org/10.5121/ijite.2016.5102

[21] Al-Ansi, Abdullah M., Mohammed Jaboob, Askar Garad, and Ahmed Al-Ansi. "Analyzing augmented reality (AR) and virtual reality (VR) recent development in education." *Social Sciences & Humanities Open* 8, no. 1 (2023): 100532. https://doi.org/10.1016/j.ssaho.2023.100532

[22] Han, Kunni. "Fostering students' autonomy and engagement in EFL classroom through proximal classroom factors: autonomy-supportive behaviors and student-teacher relationships." *Frontiers in Psychology* 12 (2021): 767079. https://doi.org/10.3389/fpsyg.2021.767079

[23] Crossley, Scott A., and Danielle S. McNamara, eds. *Adaptive educational technologies for literacy instruction*. New York, NY: Routledge, 2017. https://doi.org/10.4324/9781315647500

[24] Gottler, Amy. "Collaboration between instructional designers and subject matter experts in digital transformation projects." *Studies in Technology Enhanced Learning* 3, no. 2 (2023). https://doi.org/10.21428/8c225f6e.93df9a6e

[25] Page, Matthew J., Joanne E. McKenzie, Patrick M. Bossuyt, Isabelle Boutron, Tammy C. Hoffmann, Cynthia D. Mulrow, Larissa Shamseer et al. "The PRISMA 2020 statement: an updated guideline for reporting systematic reviews." *Bmj* 372 (2021). https://doi.org/10.1136/bmj.n71

[26] Lee, Lap-Kei, Cheuk-Him Chau, Chun-Hin Chau, Chun-Tim Ng, Jun-Hao Hu, Chun-Yin Wong, Lap-Chung Yu, and Nga-In Wu. "Improving the experience of teaching and learning kindergarten-level English vocabulary using augmented reality." *International Journal of Innovation and Learning* 25, no. 2 (2019): 110-125. https://doi.org/10.1504/IJIL.2019.097661

[27] Liao, Chin-Huang Daniel, Wen-Chi Vivian Wu, Venny Gunawan, and Tin-Chang Chang. "Using an augmented-reality game-based application to Enhance Language Learning and Motivation of Elementary School EFL students: A comparative study in Rural and Urban Areas." *The Asia-Pacific Education Researcher* 33, no. 2 (2024): 307-319. https://doi.org/10.1007/s40299-023-00729-x

[28] Rapti, Danai, Demetris Gerogiannis, and Spyridon-Georgios Soulis. "The effectiveness of augmented reality for English vocabulary instruction of Greek students with intellectual disability." *European Journal of Special Needs Education* 38, no. 2 (2023): 185-202. https://doi.org/10.1080/08856257.2022.2045816

[29] Zhang, Shenglan. "Integrating Augmented Reality into a Task-Based Thematic Language Teaching Unit (增强现实在任务型主题单元教学中的运用)." (2021).

[30] Carrión-Robles, Fernando, Verónica Espinoza-Celi, and Alba Vargas-Saritama. "The Use of Augmented Reality through Assemblr Edu to Inspire Writing in an Ecuadorian EFL Distance Program." *International Journal of Engineering Pedagogy* 13, no. 5 (2023). https://doi.org/10.3991/ijep.v13i5.38049

[31] Amara, Kahina, Chahrazed Boudjemila, Nadia Zenati, Oualid Djekoune, Drifa Aklil, and Mouna Kenoui. "AR computer-assisted learning for children with ASD based on hand gesture and voice interaction." *IETE Journal of Research* 69, no. 12 (2023): 8659-8675. https://doi.org/10.1080/03772063.2022.2101554

[32] Cygnet, A. Blossom, and P. Sivakumar. "Efficacy of augmented reality-based flashcards on learning Basic Tamil words among primary learners during neo-normal period." *Education and Information Technologies* (2023): 1-18. https://doi.org/10.1007/s10639-023-12192-8

[33] Yilmaz, Rabia Meryem, Fatma Burcu Topu, and Ayşegül Takkaç Tulgar. "An examination of vocabulary learning and retention levels of pre-school children using augmented reality technology in English language learning." *Education and Information Technologies* 27, no. 5 (2022): 6989-7017. https://doi.org/10.1007/s10639-022-10916-w

[34] Hussein, Harith A., Majid Hamid Ali, Muhaned Al-Hashimi, Nahida Taha Majeed, Qabas A. Hameed, and Reem D. Ismael. "The Effect of Web Augmented Reality on Primary Pupils' Achievement in English." *Applied System Innovation* 6, no. 1 (2023): 18. https://doi.org/10.3390/asi6010018

[35] Smith, Sara A., María Soledad Carlo, Sanghoon Park, and Howard Kaplan. "Exploring the Promise of Augmented Reality for Dual Language Vocabulary Learning Among Bilingual Children: A Case Study." *CALICO Journal* 40, no. 1 (2023). https://doi.org/10.1558/cj.22757

[36] Eang, Norphealey, and Jaitip Na-Songkhla. "The Framework of an AR-Quest Instructional Design Model Based on Situated Learning to Enhance Thai Undergraduate Students' Khmer Vocabulary Ability." *LEARN Journal: Language Education and Acquisition Research Network* 13, no. 1 (2020): 161-177.

[37] Tsai, Cheng-Chang. "A comparison of EFL elementary school learners' vocabulary efficiency by using flashcards and augmented reality in Taiwan." *The New Educational Review* 51 (2018): 53-65. https://doi.org/10.15804/tner.2018.51.1.04

[38] Wan Daud, Wan Ab Aziz, Mohammad Taufiq Abdul Ghani, Ahmad Abdul Rahman, Mohd Akashah Bin Mohamad Yusof, and Ahmad Zaki Amiruddin. "ARabic-Kafa: Design and development of educational material for arabic vocabulary with augmented reality technology." *Journal of Language and Linguistic Studies* 17, no. 4 (2021): 1760-1772. https://doi.org/10.52462/jlls.128

[39] Che Hashim, Nurhazarifah, Nazatul Aini Abd Majid, Haslina Arshad, and Waqas Khalid Obeidy. "User satisfaction for an augmented reality application to support productive vocabulary using speech recognition." *Advances in Multimedia* 2018, no. 1 (2018): 9753979. https://doi.org/10.1155/2018/9753979

[40] Zhang, Yingying, and Huiyu Guo. "Augmented Reality-based Oral Chinese Teaching System under Human-Computer Interaction." (2023). https://doi.org/10.14733/cadaps.2023.S9.40-60

[41] Tsai, Cheng-Chang. "The effects of augmented reality to motivation and performance in EFL vocabulary learning." *International Journal of Instruction* 13, no. 4 (2020): 987-1000. https://doi.org/10.29333/iji.2020.13460a

[42] Carrión-Robles, Fernando, Verónica Espinoza-Celi, and Alba Vargas-Saritama. "The Use of Augmented Reality through Assemblr Edu to Inspire Writing in an Ecuadorian EFL Distance Program." *International Journal of Engineering Pedagogy* 13, no. 5 (2023). https://doi.org/10.3991/ijep.v13i5.38049

[43] Ustun, Ahmet Berk, Erdi Simsek, Fatma Gizem Karaoglan-Yilmaz, and Ramazan Yilmaz. "The effects of AR-enhanced English language learning experience on students' attitudes, self-efficacy and motivation." *TechTrends* 66, no. 5 (2022): 798-809. https://doi.org/10.1007/s11528-022-00757-2