ISSN: 2289-7844 | e-ISSN: 0127-9750
DOI: https://doi.org/10.37134/jictie.vol12.1.3.2025

Journal of ICT in Education (JICTIE)
Volume 12, Issue 1, Pages 31-49, 2025

Research Article

An Exploration of Perceptions and Experiences of Language Adventure Game Using Augmented Reality

Wan Irma Sabrina Idris[1*], Nadya Supian[2], Nur Farhana Abd Wahid[3]
Wan Norfadillah Wan Nawi[3], Maxwell Sim Yik Seng[2], Josephine Freni Affrin[4],
Vahid Nimehchisalem[5]

[1]*Department of Multimedia Design & Animation, Faculty of Creative Industry, Universiti Tunku Abdul Rahman, Selangor, Malaysia; sabrina@utar.edu.my*
[2]*Department of Modern Languages, Faculty of Creative Industry, Universiti Tunku Abdul Rahman, Selangor, Malaysia; nadya@utar.edu.my, simys@utar.edu.my*
[3]*Department of Early Childhood Studies, Faculty of Creative Industry, Universiti Tunku Abdul Rahman, Selangor, Malaysia; farhanaw@utar.edu.my, norfadillah@utar.edu.my*
[4]*Department of English Units, Faculty of Multidisciplinary and Sustainability Studies, International College of Advanced Technology Sarawak, Sarawak, Malaysia; josephine@icats.edu.my*
[5]*Faculty of Humanities and Arts, University of Economics and Human Sciences in Warsaw, Poland; nimechie@gmail.com*

Received: 24 October 2024; Revised: 20 February 2025; Accepted: 29 March 2025; Published: 15 April 2025

**corresponding author*

Abstract

The integration of augmented reality (AR) in education has demonstrated significant potential to transform traditional learning into interactive and immersive experiences, particularly in language learning. This study explores the perceptions and experiences of undergraduate student facilitators in designing and implementing an AR-enhanced adventure game to improve English proficiency. The research involved 23 participants utilizing the EyeJack application to develop situational learning activities that incorporated cognitive and language skills. A convergent mixed-methods approach was employed, combining surveys, structured interviews, and artifact-based observations to evaluate communication, the quality of instructional materials, the use of AR tools, and logistical considerations. The results reveal that AR significantly enhanced engagement, motivation, and practical language application among participants. However, challenges such as technical constraints, the need for facilitator training, and adaptation to diverse learning contexts were highlighted. Participants emphasized AR's potential to foster meaningful and enjoyable educational experiences while advocating for improvements in logistical support and training. The findings provide valuable insights for educators and policymakers into how AR can be effectively integrated into language learning to enhance collaboration, critical thinking, and task-based learning. Furthermore, this study contributes to the broader academic field by advancing knowledge on the pedagogical applications of AR, offering a framework for scaling its implementation across diverse educational settings. This study concludes that AR-enhanced activities, when strategically designed and executed, can revolutionize language education by bridging traditional and technology-enhanced methodologies. By addressing current challenges, AR tools can serve as transformative resources, promoting inclusive and innovative learning practices that align with the evolving demands of education in the digital age.

Keywords: augmented reality, language learning, adventure game, educational technology, instructional design

INTRODUCTION

In recent years, AR has emerged as a transformative tool in education, seamlessly blending digital and physical environments to create interactive and immersive learning experiences. Its versatility allows educators to enhance engagement and learning outcomes across diverse disciplines, including science, history, and language education. AR's potential is particularly promising in language learning, where traditional approaches often lack the authenticity and interactivity needed to sustain student engagement. For English as a Foreign Language (EFL) students in non-English-speaking nations, the absence of an "authentic" learning environment presents a significant barrier to effective language acquisition. Research suggests that integrating AR into situational learning environments can provide practical, real-world contexts that enhance language learning outcomes (Chang et al., 2020).

Game-based learning (GBL) further amplifies AR's effectiveness by incorporating play into the educational process, which increases motivation and facilitates collaborative, task-based learning. Adventure games, in particular, create opportunities for immersive problem-solving, critical thinking, and language application through sequential challenges. Studies have shown that combining AR with GBL fosters greater student enthusiasm and engagement, making it an effective approach for modern language classrooms (Ying et al., 2021; Rizki et al., 2023). However, while AR and GBL have been extensively explored independently, limited research exists on their combined impact on language learning, highlighting a critical gap in the literature.

This study seeks to bridge this gap by investigating the experiences and perceptions of undergraduate student facilitators in designing and implementing AR-enhanced adventure games for language learning. Specifically, the study aims to:

1) Explore student facilitators' perceptions of augmented reality applications for language learning.
2) Assess their perceptions of the suitability of AR-enhanced adventure game activities.
3) Examine their experiences in the development and implementation of these activities.

To achieve these objectives, the research addresses the following questions:

1) What are student facilitators' perceptions regarding the use of augmented reality applications in language learning?
2) How do student facilitators perceive the suitability of AR-enhanced adventure game activities for language learning?
3) What are the experiences of student facilitators in designing and developing AR-enhanced adventure game activities for language learning?

By addressing these questions, this study contributes to the growing body of research on innovative pedagogical tools, offering valuable insights into the combined use of AR and GBL for language education. The findings aim to inform future educational practices and research, providing strategies for the effective integration of AR-enhanced activities in diverse learning contexts.

LITERATURE REVIEWS

Augmented Reality (AR) in Education

The use of AR is an exciting new way of engaging learners. Recent advancements in mobile technologies have facilitated the widespread application of AR across diverse industries such as military, engineering, medicine, tourism, and advertising. The adoption of AR in education has grown significantly, driven by its many advantages (Wu et al., 2013). AR leverages devices like tablets, mobile phones, and wearables

to enhance the learning experience by overlaying digital information onto physical environments, including 3D multimedia and location-based applications (Godwin-Jones, 2016; Fan et al., 2020). As mobile technologies become increasingly affordable, educational AR is projected to emerge as a key technological innovation of the next decade (Alakärppä et al., 2017) and is believed to become a prevalent and mainstream tool in education after 2020 (Huang et al., 2012). Research into the use of AR in education has identified several key features, including the ability to access learning materials from any location at any time, require only a camera-equipped smartphone instead of special devices (Punar Özçelik et al., 2022), and deliver immersive, contextual, and situational learning environments (Johnson et al., 2011; Wu et al., 2013). Since smartphones are commonly owned, researchers opted to utilize AR apps on this handheld device for this study as it is a more cost-effective, accessible, and affordable approach to students.

Augmented Reality (AR) and Adventure Games in Language Learning

The incorporation of AR technology into education has demonstrated numerous benefits for language learning in various aspects. In a study by Solak and Cakir (2015), AR-designed materials were shown to significantly motivate undergraduate students in learning English vocabulary, with this motivation positively influencing their academic achievements. Similarly, Jamrus and Razali (2019) highlighted that AR fosters students' motivation to learn English, particularly in improving reading skills. Chang et al. (2020) further revealed that AR exposure enabled EFL students to concentrate better on speaking tasks through engagement with real-life scenarios. Collectively, these findings demonstrate the multifaceted potential of AR in enhancing language learning.

Besides applying AR technology, this study also utilized the concept of an adventure game, which involves a series of activities that have a continuous storyline by incorporating specific missions that require students to solve physical tasks that test their cognitive thinking and language proficiency. In the past, traditional adventure games were implemented in physical forms, either indoors or outdoors. Nowadays, since teenagers are easily captivated by digital games, digitalizing traditional adventure games using AR as a platform is a potentially effective way to boost students' motivation and enthusiasm (Rizki et al., 2023). Studies focusing on transforming those traditional adventure games into digital form are rarely found, hence it is worth investigating the possibilities of this technology implementation. The use of the adventure game genre with the integration of AR offers an engaging approach to language learning. However, current available researches predominantly focus on the development of AR games tailored for science, technology, engineering, and mathematics (STEM) education (Zaki et al., 2018; Kalana et al., 2020; Ying et al., 2021; Rizki et al., 2023), indirectly indicating the necessity for the creation of innovative AR-based pedagogical tools to enhance language proficiency, particularly among young learners. Therefore, this research employed an AR-enhanced adventure game designed using the EyeJack application implemented in a situational learning setting with a group of undergraduate students.

Perception of User in Terms of AR Usage in Learning for Students and Educators

Student engagement and motivation have always been key factors in successful learning, and selecting the correct engagement and incentive tactics can help students learn more effectively and efficiently. Instructors are developing creative ways to teach, utilizing a variety of instruments to assist the learning process and increase student involvement (Mundy et al., 2019). The primary function of AR is to enhance a person's perspective of the world around them by combining the virtual and real worlds into a new interface (Rakhman, 2020). The capabilities of AR provide various advantages to student learning. Many AR applications offer a three-dimensional investigation of the topic. These 3D graphics promote learning and improve students' capacity to grasp difficult and abstract topics by allowing them to examine an

object's spatial connections. The 3D pictures help the learner better understand the physical dimensions of the thing and how they relate to other objects in the field. AR has been used for visualization, training, entertainment, and education, and it is becoming more widely available as technology advances (Sural & Osmangazi, 2017).

There are challenges associated with employing AR in the classroom. One concern might be the need for maintenance on AR-equipped devices. Device problems, such as GPS errors or software latency, can be annoying for both students and teachers. Wu et al. (2013) explain that AR-based learning activities often incorporate innovative methods, including participatory simulations and studio-based pedagogy. This method contrasts with teacher-centered instruction and may limit the quantity of information that may be taught. In addition to topic education, the instructor will need to educate the student on how to utilize the novel technology. Students who are inexperienced with AR might easily get overwhelmed, which can lead to misunderstanding**.**

EyeJack Augmented Reality (AR) Creator Application

Various creation-based augmented reality platforms (CB-ARPs) are available in the market, enabling users from non-programming backgrounds to design, develop, and deliver content in the form of augmented reality with zero coding knowledge (Cherner & Russo, 2022). One of the most popular apps is the EyeJack Creator, an AR tool for artists and creators to ‘bring art to life as AR with animation and sound. Due to its flexibility in application for various contexts, it has been used for media and information literacy classrooms (Capul et al., 2024), simplifying abstract mathematical concepts (Alibraheim et al., 2023), designing printed textiles (El-Salam & Mohamed, 2023), supporting effective international learning in an Erasmus+ funded project (Caldwell et al., 2020), and STEM-based teacher training (Alshehri, 2021).

Previous Studies on Facilitators' Preparation and Training in AR Setting

Mobile devices' capability and affordability make them an ideal platform for AR, resulting in more genuine and engaging learning experiences. Hwang et al. (2015) found that game-based learning via mobile augmented reality increases children's positive attitude toward learning and enhances their performance. Furthermore, another advantage of mobile AR in education has been the creation of engaging learning environments for pupils (Pasalidou et al., 2023). Teachers and students who have access to these resources may now easily construct their own AR learning artifacts and engage with digital objects in a variety of media (e.g., 3D objects, sound, video, photos, text, links) at any time and from any location. Therefore, AR is "generated and rendered with mobile devices in mobile environments, addressing a wide range of application areas" (López-Faican & Jaen, 2020).

Despite the proliferation of AR apps, platforms, and tools, the usage of AR in schools remains restricted. Previous studies have reported several challenges that hinder the success of AR in teaching and learning, including the lack of technical infrastructure and devices in schools, the limited number of educational applications (Arici et al., 2021), usability issues, and technical problems (Akçayır & Akçayır, 2017), and the high cost of devices and applications (Ajit, 2021). When engaging in professional development, it is recommended to adhere to best practice standards, but activities should be tailored to the educational requirements of the institutions and facilitators (Hallmark et al., 2021). Workshops, conferences, observation, hands-on training, self-evaluation, and feedback from peers and AR specialists can all help facilitators develop, depending on their developmental stage (Al-Ghareeb & Cooper, 2016). When it comes to gaining and sustaining facilitating competency, facilitators prefer to practice with feedback from someone proficient in using AR. The use of debriefing evaluation tools that give structured, objective

feedback can help facilitators discover areas for growth and improve debriefing quality. In this study, this approach was adopted to assess students' perceptions and experiences with the AR-enhanced language adventure game, which will be further explained in the methodology section.

RESEARCH METHODOLOGY

This research investigates the utilization of AR-enhanced adventure game technology that intends to improve English language proficiency and boost student motivation. The study involved 23 undergraduate students from a university in Malaysia and used a convergent mixed methods approach, where both qualitative and quantitative data were collected in a single phase. The qualitative data collection was in the form of group interviews and artifacts, which took place after the implementation of the adventure game using AR technology. In the interview, the students were asked about their experiences of using the AR technology for the first time, the sequence and nature of the activities, and their perceptions of the overall suitability of this adventure game for learning English in high schools in Malaysia. The quantitative data collection using a survey took place immediately after the completion of the interviews. More information on the questionnaire will be provided in the following section.

Before data collection, students were tasked with utilizing the Eye-Jack application, accessed through QR codes strategically placed throughout the room. These QR codes served as triggers, initiating animations that provided students with hints about the location of each of their 5 designated checkpoints inside the classroom. At each checkpoint, students engaged in physical activities that tested their cognitive thinking and language proficiency. The activities were designed to foster critical thinking through active learning, as well as develop language skills. Feedback from both students and lecturers was collected to evaluate the effectiveness of the AR-based adventure game as a learning approach for enhancing their language learning. The duration taken to complete each activity by the checkpoints was given in about 20-30 minutes.

The findings reveal that students perceived AR as an effective tool for engagement in meaningful learning experiences that could lead to prospective improvement in their language learning. Furthermore, it underscores the significance of collaborative efforts between educators and technology developers to optimize AR applications for educational purposes. This study contributes to the growing body of research on AR technology's potential in education and its impact on language proficiency and motivation.

Sample

A total of 23 participants, comprising undergraduate students participated in this research. Participants were selected based on their academic background and their willingness to serve as potential facilitators for a subsequent study. This forthcoming study aims to target low-performing high school students, with a larger scope and a different sample set, where the selected participants will be facilitated.

The study incorporated five activities, each meticulously designed to gauge and gather feedback on the participants' (acting as facilitators) experiences, engagement levels, and proficiency in managing AR-enhanced adventure game activities aimed at language learning. These activities were structured around a series of checkpoints to systematically observe the participants' interaction with the AR elements. To navigate through the activities, participants engaged with the EyeJack application, an AR platform. The journey began with participants scanning a QR code via the application, which prompted the appearance of an AR-generated animated character. This character served as a clue leading participants to the location of the first checkpoint. At each checkpoint, groups of five were tasked with completing specific assignments. Successful completion required scanning another QR code provided by the administrators

to unveil the next AR-generated clue, guiding them to subsequent checkpoints. This sequence was repeated until all five checkpoints were completed, with the first group to finish all activities declared the winner.

Instrumentation for Assessment

The effectiveness of the AR-enhanced activities and identification of potential issues were evaluated using the following instruments:

- ***Self-developed Questionnaire:*** The domains of the feedback survey were aligned with established frameworks such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) to comprehensively evaluate the AR-enhanced learning activities in classroom settings. The domain on Communication between the Research Team and Facilitator reflects UTAUT's Facilitating Conditions, which emphasize the role of effective support structures in ensuring technology adoption in educational contexts (Venkatesh et al., 2003; Koumpouros, 2024). The Quality of Activity Briefs and Facilitator Guides aligns with TAM's Perceived Usefulness and UTAUT's Effort Expectancy, focusing on the clarity, comprehensiveness, and instructional relevance of materials in enabling facilitators to perform effectively (Davis, 1989; Venkatesh et al., 2003). The domain on the Use of AR-enhanced learning Tools maps to TAM's Perceived Ease of Use and Perceived Usefulness as well as UTAUT's Performance Expectancy, evaluating how engaging, user-friendly, and pedagogically impactful the tools were in addressing diverse learner needs (Al-Adwan et al., 2023; Davis, 1989). Finally, the Logistical Aspects of the Research Project align with UTAUT's Facilitating Conditions, which include the adequacy of resources and infrastructure to support AR-based activities (Venkatesh et al., 2003; Koumpouros, 2024). This mapping ensures the survey captures critical dimensions of AR adoption and its practical impact on language learning activities, as highlighted by recent research into metaverse-based platforms and AR's user acceptance.

- ***Data Collection through Artifacts:*** This study employed artifact-based observation to enhance the qualitative analysis. Various artifacts were collected, including works produced by the participants and photographs captured during the activities. These artifacts provided contextual insights into the participants' engagement and creativity. An observation checklist was utilized to systematically document key aspects of the activities, ensuring consistency in data collection. The checklist included criteria such as participants' interaction with materials, observed challenges, and the completion and presentation of their works. This approach allowed for a richer understanding of the process and outcomes of the activities. See Figure 1(a) for the participants' completed works and Figure 1(b) for a visual representation of their progress during the creation process.

- ***Interviews:*** Structured qualitative interviews were conducted to obtain comprehensive insights into the participants' experiences and feedback regarding the AR-enhanced learning activities. This method facilitated a systematic exploration of their perceptions and allowed for consistent data collection across all participants.

These instruments were pivotal in assessing the impact of AR technology on language learning, as well as in identifying areas for improvement in the design and implementation of AR-enhanced educational activities.

(a) (b)

Figure 1: (a) Participants completed the task assigned, and (b) participants' progress during the task completion.

Game Description

The ARmazing Race Adventure Game comprised of 5 challenges comprising a combination of language activities, at 5 different checkpoints in 5 locations. Each checkpoint featured one domain-specific activity, supervised by a member of the research team. Activities ranged from (1) a listening activity to develop their listening skills and ability to follow instructions, (2) a reading activity featuring a scavenger hunt using newspaper articles for identification of words in the present perfect tense, reflexive pronouns and sentence construction; (3) translation of lyrics from Malay to English, (4) a vocabulary learning activity where participants had to guess compound nouns from picture clues, and finally (5) an oral activity where they worked in groups to complete a task of writing with a string connected to all team members, coordinating through communication using imperatives. In teams of 5-6 participants, QR codes were scanned to activate the clues leading them to the respective checkpoints. All activities at the checkpoints were to be completed in sequence, and participants were to communicate solely in English with each other during the activities, and when seeking clarification. Throughout the game, observations were noted and recorded at each checkpoint. Refer to Figure 2 for one of the shots taken when the AR animated character was generated after the participants scanned the QR code.

Data Collection

Data was collected in 2 phases. The first phase involved a self-developed survey used to collect data on the participants' feedback after the adventure game was completed by all the teams. The survey consisted of four domains. The first was Communication between the Research Team and the Facilitators (5 items, 1 to 10-point Likert scale, 2 to 5-point Likert scale items, and 3 multiple choice items), which analysed their perception on the quality of the communication between the team and the facilitators in terms of accuracy and transmissibility of the information. The second was Quality of Activity Briefs and Facilitator Guides, which was to determine gaps in the activity briefs as well as the facilitators' manuals (7 items consisting of 4 to 5-point Likert scale items, 1 multiple choice and 1 open-ended question). The third was the Use of AR-enhanced learning tools in the activity, which investigated their perception of the EyeJack application's user-friendliness and potential application for language learning (6 items consisting of 5 5-point Likert scale and 1 open-ended question). The concluding section was to gather feedback on

the Logistical Aspects of the Research Project (2 items comprising 1 5-point Likert scale and 1 open-ended question).

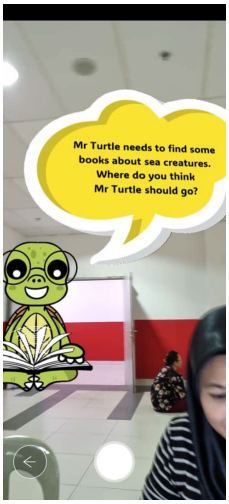

Figure 2: Sample of shots taken when the AR animated character was generated after the participants scanned the QR code.

The survey consisted of four domains aimed at gathering detailed feedback from respondents, as shown in Table 1.

Table 1: Description of domains in the feedback survey

Survey Domains	Explanation
Communication between the research team and the facilitator	This section assessed facilitators' perceptions of the quality of communication with the research team, focusing on the accuracy and clarity of information shared. It comprised six items: one 10-point Likert scale item, two 5-point Likert scale items, and three multiple-choice items.
Quality of activity briefs and facilitator guides	This section aimed to identify gaps in the activity briefs and facilitators' manuals. It included six items: four 5-point Likert scale items, one multiple-choice item, and one item with open-ended responses.
Use of AR-enhanced learning tools	This section evaluated facilitators' perceptions of the EyeJack application, particularly its user-friendliness and potential for language learning. It contained six items: five 5-point Likert scale items and one item with open-ended responses.
Logistical aspects of the research project	This section collected feedback on the logistical aspects of the project, consisting of two items: one 5-point Likert scale item and one item with an open-ended response.

Table 2: Mapping between the Technology Acceptance Model (TAM) and the Universal Theory of Acceptance and Use of Technology (UTAUT) to the survey domains

Survey Domains	TAM Constructs	UTAUT Constructs	Description
Communication between the Research Team and Facilitator	N/A	Facilitating Conditions	Assesses the adequacy of support provided to facilitators, including responsiveness and clear communication.
Quality of Activity Briefs and Facilitator Guides	Perceived Usefulness	Effort Expectancy	Evaluates the clarity, comprehensiveness, and alignment of instructional materials with learning objectives.
Use of AR-Enhanced learning tools	Perceived Usefulness, Perceived Ease of Use	Performance Expectancy	Measures the effectiveness, engagement, and user-friendliness of the AR tools in enhancing learning outcomes.
Logistical Aspects of the Research Project	N/A	Facilitating Conditions	Reviews the organization, technical support, and availability of resources necessary for project execution.

The survey domains in Table 2 were designed to capture key aspects of the AR-enhanced learning experience by focusing on areas critical to technology adoption and effective implementation. These domains were aligned with constructs from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). TAM constructs, such as Perceived Usefulness and Perceived Ease of Use, informed questions about the user-friendliness and effectiveness of the AR tools. UTAUT's constructs, including Facilitating Conditions, Effort Expectancy, and Performance Expectancy, shaped the evaluation of organizational support, ease of implementation, and the tool's ability to meet learning objectives. By mapping these survey domains to established frameworks, the study ensured a robust approach to evaluating the adoption, usability, and impact of AR in language learning contexts. Interviews were conducted face-to-face after the game session to collect feedback on their perception and experiences with the adventure game. All interviews were recorded and then transcribed verbatim, which included utterances in their first language, Bahasa Melayu, which were then translated into English.

Data Analysis

Quantitative data from the survey were analyzed using descriptive statistics to identify trends and participant satisfaction levels across the four domains. Qualitative data from interviews and observations were subjected to thematic analysis, identifying recurring patterns and insights. Triangulation was employed to integrate findings from both data sets, allowing for cross-validation and a deeper understanding of the study's outcomes.

Ethical Considerations

Ethical protocols were strictly adhered to throughout the research process. Participants were provided with detailed information about the study's objectives, procedures, and potential benefits before their

involvement. Written informed consent was obtained from all participants, ensuring they fully understood their rights and the voluntary nature of their participation.

To protect participant confidentiality, all data were anonymized, and unique identifiers were assigned to each participant for analysis. Audio recordings and transcriptions were securely stored on password-protected devices, accessible only to the research team. The study protocol was reviewed and approved by the university's ethics committee, ensuring compliance with ethical standards for research involving human subjects.

RESULTS

Table 3: Illustration of the data analysis from the survey

Domains	Category	Percentage	Details
Communication between the Research Team and Facilitator (QUAN)	Communication Clarity	87%	Participants agreed that communication was done clearly.
	Opportunities for Input/Feedback	82.6%	Agreed opportunities were provided, and suggestions were taken into consideration.
	Promptness in Addressing Concerns	78.3%	Participants agreed that questions and concerns were addressed promptly and satisfactorily.
	Clarity of Project Objectives	73.9%	Rated as "Excellent" for clarity in explaining objectives and facilitator roles.
Quality of Activity Briefs and Facilitator Guides	Visual Aids Effectiveness	100%	Rated as effective in using visuals to enhance understanding.
	Learning Objectives Conveyed Clearly	95.7%	Rated briefs/manuals as effective in conveying learning objectives and purpose.
	Activity Briefs & Facilitator Guides	78.3%	Agreed the briefs/manuals were clear, comprehensive, and easy to follow.
	Training Preparedness	78.3%	Agreed that training sessions and resources prepared them sufficiently for their facilitator roles.
	Adaptability for Challenges	69.6%	Felt the materials guided adapting to unexpected situations.
Use of AR-Enhanced Learning Tools	Facilitator Support	82.6%	Felt the app provided adequate support and guidance for facilitators.
	Engagement & Effectiveness	73.9%	Found it engaging and effective for enhancing the learning experience.

	Support for Diverse Needs	73.9%	Agreed, it addressed rural students' diverse learning needs.
	EyeJack User-Friendliness	60.9%	Agreed, the application was easy to use as an AR teaching tool.
Logistical Aspects of the Research Project	Provision of Refreshments	95.7%	Sufficient refreshments were provided.
	Time Allocation	78.3%	Felt adequate time was allocated to accommodate the needs of students and facilitators.
	Organisation of the Adventure Game	73.9%	Agreed, the game was well-organized with clear instructions for setup and operation.
	Diverse Needs Accommodation	73.9%	Believed the materials could accommodate diverse learning styles and needs of rural students.
	Suggestions for Improvement	N/A	1. Provide maps or assign guides for student groups. 2. Address internet connectivity issues. 3. Ensure facilitators wear common identifiers (e.g., caps) to assist students. 4. Participants emphasized the need for contingency plans for inclement weather when outdoor settings are involved.

The study evaluated the effectiveness of the project across four key domains: communication, quality of materials, AR-enhanced tools, and logistical arrangements, as shown in Table 3. In the communication domain, the highest rate was for communication clarity (87%), followed by opportunities for feedback (82.6%) and prompt responses to concerns (78.3%). Clarity of project objectives received 73.9%, rated as "Excellent." Suggestions for improvement included providing facilitators with common identifiers, such as caps, to make them more approachable for students seeking assistance.

For the quality of activity briefs and facilitator guides, the highest rating (100%) was for the effectiveness of visual aids, followed by clarity in conveying learning objectives and purpose (95.7%). Participants also agreed that the materials were clear and comprehensive (78.3%), although only 69.6% felt they adequately addressed adaptability to challenges. It was suggested that providing maps or assigning guides to accompany student groups could improve the implementation process.

The use of AR-enhanced tools, particularly the EyeJack application, showed that 82.6% of participants agreed facilitators were adequately supported. Engagement and effectiveness were rated at 73.9%, while 60.9% found the tool user-friendly. Participants highlighted the importance of addressing potential internet connectivity issues, which could disrupt the scanning of QR codes in areas with poor signal strength. Finally, in the logistical domain, 95.7% of participants commended the provision of

refreshments, followed by adequate time allocation (78.3%) and clear instructions for organizing the adventure game (73.9%). However, participants emphasized the importance of contingency plans for inclement weather when outdoor settings are involved. This analysis highlights strengths in communication, material quality, and logistical preparation while identifying areas for improvement, particularly in adaptability, AR tool usability, and contingency planning.

Overall, the adventure game received positive ratings (87%), with feedback noting these as "really great activities" that provided students with valuable opportunities to gain knowledge, connect with others, and develop leadership and soft skills. Participants also pointed out the difference between iOS and Android devices, with iOS showing a slower response. The training was regarded as useful for introducing participants to the application of augmented reality software and exploring its potential for language learning, preparing them to facilitate future language learning activities and enhancement programs.

Focus Group Interviews

Qualitative data collection featured interviews with all 23 participants. Through thematic analysis, four main themes were identified: the educational value of AR-enhanced adventure games, enjoyable experience, required improvements and required training. Figure 3 illustrates how these four themes are connected.

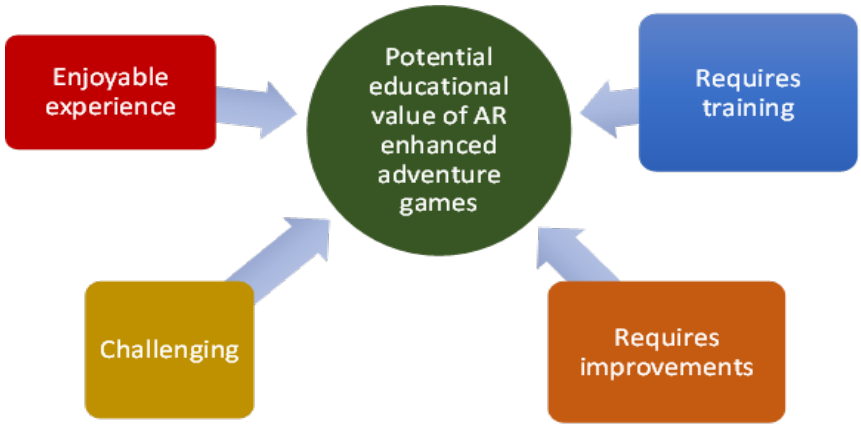

Figure 3: Experience and feedback of the AR adventure game

The Potential Educational Value of AR-Enhanced Adventure Games

The participants shared that they perceived the adventure game with augmented reality to offer promising educational value, particularly for language learning. Observation data showed [H1] that they were excited to unlock clues using the EyeJack application and fully immersed themselves in the activities, framing their experience from the perspective of high school students with varying levels of English proficiency. Each activity held their full attention, providing an immersive experience in applying their language skills. Refer to Figure 4 for the transcribed feedback received from the participants.

- ***N**: What do you think?*
- ***Ss1**: I think it was fun enough.*
- ***I**: Other than that, what do you think can improve?*
- ***N**: Suggestions?*
- ***Ss2**: More games?*
- ***N**: More games, more activities. Woo! You know how to dance, huh? Listen to that, community members. Thank you so much.*
- ***D**: You want more games, huh?*
- ***Ss3**: More games. Thank you.*

Figure 4: Transcribed from the recorded feedback received from the participants.

Enjoyable Experience

The adventure game was particularly enjoyable for the students, as it allowed them to move between checkpoints. Their excitement was evident when they successfully guessed each checkpoint's location using clues scanned from the EyeJack application, hurrying to complete the activities, and collaborating as a team. The newspaper activity took the longest to finish, as it required time to read articles and find both information and the correct words for the task sheet. The listening activity was observed to be the most enjoyable, as it incorporated a 'Total Physical Response' to the given instructions. Refer to Figure 5 for the transcribed feedback received from the participants.

- ***Ss5**: For me, it's quite fun actually. But maybe the instruction in English, maybe it's quite challenged for the kids.*
- ***Ss5**: Maybe simple phrases.*
- ***N**: Simple phrases. Ah, okay, thank you so much for that suggestion.*
- ***Ss7**: I think, I personally think this activity is fine. And I agree with her point because the instructions sometimes are very difficult for children to understand. And I would like to suggest the instructions in a written form so they can read it all over again.*
- ***N**: Alright.*
- ***Ss7**: And the simple also.*
- ***Ss7**: Because like this activity some of the instructions were told verbally, so it's harder for them to hear.*
- ***N**: Right. Maybe that was the listening part, I think.*

Figure 5: Transcribed from recorded feedback received from the participants.

Challenging

Certain aspects of the game were found to be challenging, raising concerns among participants about how these difficulties might impact future student participants, particularly those with lower proficiency levels. Refer to Figure 6 for the transcribed feedback received from the participants.

- ***Ss8***: *My opinion is I, we can (pause) show them first how to play the game because they might not know what they are going to play. So, if we show them first, they can know what to do in that game.*
- ***Ss13***: *I think everything is okay (grinning shyly). Uh....I agree with her about the app. I think we have to demonstrate first how to use it.*
- ***Ss15***: *Yeah, the longest it's going to take time is where we're going to scan the area where it's triggered the eyeJack because we don't know where the place is going to get triggered the eyeJack. And it's maybe going to take a long time there to search where the path is. So I guess, I think that's where it's difficult la.*

Figure 6: Transcribed from the recorded feedback received from the participants

Requires Improvements

The participants also provided feedback and suggestions regarding areas of the game they identified as needing improvement. Since they were expected to serve as facilitators in future activities with school students, they were encouraged to adopt that perspective and draw upon their own experiences as former students to inform their recommendations. Refer to Figure 7 for the transcribed feedback received from the participants.

- ***Ss19***: *For me, it's actually easy. But not that easy, but moderate. But at the part where the few girls showing convo hat, I think the students might have some difficulties in that because we students know the Dewan Sultan Mizan is for convocation ceremony, but the student might not know about that. So my suggestion is to put some hint or clues regarding that. Or the facilitators can explain to them, "Oh, Dewan (that one) is for the ceremony."*
- ***Ss20***: *So we're going to get now if you want to. I think it's very fun, and it's actually helpful. But a suggestion that I would make is, for some activities, there is some difficulty to search for words. Like, you know the word in BM, but you don't know the word in English. So maybe we can help them find the word. At the same time, they can learn new words in English.*
- ***Ss23***: *So, for me, maybe we can provide a map for the students.*
- ***Ss23***: *So they can, err… senang cari tempat tu, yeah. And this game I feel very interesting because this is the first time I'm using the AR.*
- ***Ss25:*** *Maybe we can consider the weather. If it's too hot, we should provide some shade or water stations.*

Figure 7: Transcribed from the recorded feedback received from the participants

Requires Training to Use EyeJack Apps

Given that augmented reality (AR) was new to the participants, they required some time to familiarize themselves with the EyeJack app. This iteration of the project utilized object triggers through printed QR codes rather than geolocation triggers. Participants were instructed to download the app onto their mobile devices and scan the provided QR codes. Upon scanning, a 2D character accompanied by relevant information would appear within the EyeJack application. Although the instructions were straightforward, participants expressed concern that actual students might encounter greater difficulties and would require additional scaffolding for support. Refer to Figure 8 for the transcribed feedback received from the participants.

- **Ss12:** *"Better we show them how to use the app first..."*
- **Ss12:** *"...even for degree students, we took a long time."*
- **N:** *"I agree with the demonstration, that's a great suggestion."*
- **Ss13:** *"Uh....I agree with her about the app. I think we have to demonstrate first how to use it."*

Figure 8: Transcribed from the recorded feedback received from the participants

DISCUSSION

The adventure game incorporating augmented reality was positively received by participants, despite the need to relocate from an outdoor setting to an indoor facility due to heavy rain. This favorable reception highlights the game's potential to enhance student motivation and engagement, indicating that the activities remained impactful regardless of the environment in which they were conducted.

Perceptions of Augmented Reality Applications for Language Learning

This study found that the EyeJack application is user-friendly for beginners, providing a meaningful and interactive learning context while actively engaging facilitators in the activities, thus demonstrating its potential for immersive language learning. Consistent with findings by Liao et al. (2024), the use of augmented reality (AR) applications can significantly enhance language learning and motivation, particularly in diverse contexts such as rural and urban settings. The EyeJack application, with its low cognitive load and intuitive interface, aligns with these findings, making it particularly suitable for students from rural areas who may have limited access to digital devices featuring AR content. Huang et al. (2021) similarly identified AR's ability to reduce language learning barriers by creating engaging and accessible environments for learners, which resonates with the facilitators' positive experiences during the activities.

However, the study also highlights the importance of training and close supervision for younger students to ensure effective use of the AR tools, a recommendation supported by Marrahi-Gomez and Belda-Medina (2024), who emphasized the necessity of scaffolding and teacher guidance to optimize AR's impact on language learning outcomes. In cases where access to devices is limited, this study suggests that teachers or team leaders could supply the necessary equipment, a strategy that aligns with Cai et al.'s (2022) findings that resource allocation and collaborative learning enhance the efficacy of AR-based tools. Given that strong internet connectivity is essential for activating the AR triggers, it is recommended that the game be conducted in areas with reliable coverage. This recommendation echoes challenges noted by Huang et al. (2021) regarding technical constraints in AR implementation. Additionally, as participants noted that the object trigger mechanism was time-consuming, future iterations of the game will employ geolocation triggers to facilitate faster connections and more seamless access. Such enhancements would address logistical barriers and align with Liao et al.'s (2024) findings that innovative trigger mechanisms in AR applications can improve the overall learning experience, especially for younger or less technologically experienced learners.

Perceptions of the Suitability of the AR-Enhanced Adventure Game Activities

The ARmazing Race Adventure Game was perceived as a highly engaging and enjoyable way to learn English, effectively combining augmented reality (AR) technology with hands-on activities and immersive language tasks. The integration of real-life materials like newspapers, total physical response (TPR) activities, and spoken language production created a dynamic and interactive learning environment.

Translation exercises, sentence construction using tactile elements (string), and collaborative team writing, all coordinated through spoken imperatives, further enhanced the language acquisition process. Participants in the study consistently highlighted the activities' ability to maintain their interest and foster engagement, which aligns with Buchner et al.'s (2022) findings on AR's potential to enhance cognitive engagement when paired with carefully managed cognitive load. Additionally, as Al-Adwan et al. (2023) emphasized, AR-based learning environments can motivate learners by offering immersive and discovery-based strategies, fostering both engagement and academic development.

The immersive nature of the game was amplified by the exclusive use of English in all game instructions, AR trigger clues, and supporting newspaper articles, surrounding students with target language artifacts and enhancing their interaction with the language. This was reflected in participant feedback, which emphasized the game's success in creating a context for practical language use. These results correspond with Fan et al. (2020), as cited in Cai et al. (2022), in demonstrating the potential of discovery-based AR activities to enhance language development.

However, logistical challenges identified in the results, such as occasional internet connectivity issues and initial difficulties with the EyeJack application, underline the importance of well-structured facilitator training and technical preparation. These findings support Koumpouros (2024), who emphasized that user-centered design and robust logistical planning are critical for the successful implementation of AR-enhanced educational tools. Collectively, these insights underscore the necessity of balancing immersive and engaging AR elements with clear instructions, preemptive training, and logistical support to ensure the appropriateness and scalability of such activities in various educational contexts.

Experiences of Student Facilitators in the Development of AR-Enhanced Adventure Game Activities

The response to the ARmazing Race was overwhelmingly positive, with participants providing favourable feedback on the variety and scope of the activities, which offered a welcome departure from the conventional chalk-and-talk methods typically employed in language classrooms. Participants also emphasized the opportunities for teamwork and the development of leadership and soft skills through collaborative elements, such as team communication, turn-taking, providing instructions, and engaging in discussions by giving and receiving feedback on answers. These outcomes align with the findings of Hwang et al. (2015) and Thorne et al. (2009), as referenced by Cai et al. (2022), who highlighted that educational materials situated in real-life contexts encourage meaningful communication and idea exchange. Overall, the game was regarded as an effective tool for introducing augmented reality technology into language learning, offering future facilitators and language instructors an innovative platform for designing language activities and enhancement programs.

CONCLUSION

This study explored the potential of augmented reality (AR) as an educational tool by examining undergraduate facilitators' perceptions and experiences in designing AR-enhanced adventure games for English language learning. Guided by the research questions, the findings revealed that facilitators perceived AR as a highly engaging and motivational approach, offering significant value in fostering language skills through immersive, interactive, and context-driven activities. However, technical challenges and the need for comprehensive facilitator training were highlighted as key barriers to effective implementation. The results showed that AR-enhanced learners' engagement and motivation, particularly by integrating collaborative and task-based language activities that encouraged critical thinking and teamwork. The facilitators emphasized the need for robust logistical support, including reliable

connectivity and adaptable materials to ensure smooth execution. These findings suggest that AR tools, when strategically implemented, can bridge the gap between traditional and technology-enhanced pedagogies, particularly in resource-limited contexts.

While this research provides valuable insights, it is not without limitations. The study involved a small sample of undergraduate students, which may not fully represent the broader facilitator or learner population. Additionally, the reliance on specific AR tools such as EyeJack may limit generalizability to other platforms or educational settings. Future research should focus on scaling the application of AR-based learning tools across diverse contexts, investigating their long-term impact on learning outcomes, and exploring more inclusive designs that cater to varied proficiency levels and learning environments. The study contributes to the growing body of knowledge on AR in education, offering a framework for integrating AR into language learning. By addressing identified limitations and building on these findings, AR-based tools have the potential to transform educational practices, creating more dynamic, engaging, and impactful learning experiences. This research underscores the importance of innovation in pedagogy, aligning technological advancements with the evolving needs of educators and learners.

ACKNOWLEDGMENTS

This work was supported by Universiti Tunku Abdul Rahman, Internal Grant [IPSR/RMC/UTARRF/2016-C2/W01]

CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

AUTHOR CONTRIBUTIONS

Nadya Supian: Conceptualization, Original draft preparation. **Wan Irma Sabrina Idris**: Data curation, Writing- Original draft preparation. **Wan Norfadillah Wan Nawi**: Visualization, Investigation. **Nur Farhana Abd Wahid**: Supervision. **Maxwell Sim Yik Seng**: Reviewing, Editing. **Josephine Anak Freni Affrin**: Writing- Reviewing and Editing. **Vahid Nimehchisalem**: Supervision and Reviewing the manuscript.

DECLARATION OF GENERATIVE AI

During the preparation of this work, the authors used ChatGPT to enhance the clarity of the writing. After using ChatGPT, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

REFERENCES

Alakärppä, I., Jaakkola, E., Väyrynen, J., & Häkkilä, J. (2017). Using natural elements in mobile AR for education with children. *Proceedings of the 19th International Conference on Human-Computer Interaction with Mobile Devices and Services.* https://doi.org/10.1145/3098279.3098547

Alibraheim, E. A., Hassan, H. F., & Soliman, M. W. (2023). Efficacy of educational platforms in developing the skills of employing

augmented reality in teaching mathematics. *Eurasia Journal of Mathematics, Science and Technology Education, 19*(11), em2348. https://doi.org/10.29333/ejmste/13669

Alshehri, A. (2021). The effectiveness of a micro-learning strategy in developing the skills of using augmented reality applications among science teachers in Jeddah. *International Journal of Educational Research Review, 6*(2), 176-183.

Al-Adwan, A. S., Li, N., Al-Adwan, A., Abbasi, G. A., Albelbisi, N. A., & Habibi, A. (2023). Extending the Technology Acceptance Model (TAM) to predict university students' intentions to use metaverse-based learning platforms. *Education and Information Technologies*, 28, 15381–15413. https://doi.org/10.1007/s10639-023-11816-3

Al-Ghareeb, A.Z. & Cooper, S.J. (2016). Barriers and enablers to the use of high-fidelity patient simulation manikins in nurse education: An integrative review. *Nurse Education Today, 36*, 281-286. https://doi.org/10.1016/j.nedt.2015.08.005

Ajit, G. (2021). A Systematic Review of Augmented Reality in STEM Education. *Studies of Applied Economics, 39*(1). https://doi.org/10.25115/eea.v39i1.4280

Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review, 20*, 1–11. https://doi.org/10.1016/j.edurev.2016.11.002

Arici, F., Yilmaz, R. M., & Yilmaz, M. (2021). Affordances of augmented reality technology for science education: Views of secondary school students and science teachers. *Human Behavior and Emerging Technologies, 3*(5), 1153–1171. https://doi.org/10.1002/hbe2.310

Buchner, J., Buntins, K., & Kerres, M. (2022). The impact of augmented reality on cognitive load and performance: A systematic review. *Journal of Computer Assisted Learning, 38*(1), 285–303. https://doi.org/10.1111/jcal.12617

Cai, Y., Pan, Z., & Liu, M. (2022). Augmented reality technology in language learning: A meta-analysis. *Journal of Computer Assisted Learning, 38*(4), 929-945.https://doi.org/10.1111/jcal.12661

Caldwell, H., Whewell, E., Malloch, G., & Garrett, B. (2020). Digital Learning Across Boundaries: Augmented and virtual reality supporting effective international learning. *NAACE Advancing Education Journal*, Summer 2020, 23-29.

Capul, C. B., Sitchon, M. T., Mañebog, J. O., Angellano, D. R. C., Guanzon, M. E., Nate, R. G., Geneblaza, G. V., & Patacsil, F. F. (2024). Development of augmented reality instructional material for the least learned topics for Grade 12 students in Media and Information Literacy subject. *Indian Journal of Science and Technology, 17*(2), 120–133. https://doi.org/10.17485/IJST/v17i2.932

Cardinot, A., & Fairfield, J. A. (2019). Game-based learning to engage students with physics and astronomy using a board game. *International Journal of Game-Based Learning, 9*(1), 42–57. https://doi.org/10.4018/IJGBL.2019010104

Chang, Y. S., Chen, C. N., & Liao, C. L. (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), 7854.

Cherner, T., & Russo, D. (2022). An analysis of creation-based augmented reality platforms: Identifying key functionalities for teaching and learning. *Journal of Educational Multimedia and Hypermedia, 31*(3), 247–272.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340. https://doi.org/10.2307/249008

El-Salam, A., & Mohamed, R. (2023). Utilizing Augmented Reality Technology to Create Interactive Printed Designs for Hanging Fabrics. International Design Journal, 13(3), 147-160.

Fan, M., Antle, A. N., & Warren, J. L. (2020). Augmented reality for early language learning: A systematic review of augmented reality application design, instructional strategies, and evaluation outcomes. *Journal of Educational Computing Research, 58*(6), 1059-1100.

Godwin-Jones, R. (2016). Looking back and ahead: 20 years of technologies for language learning. *Language Learning & Technology 20*(2), 5–12. http://llt.msu.edu/issues/june2016/emerging.pdf

Hallmark, B., Brown, M., Peterson, D. T., Fey, M., Decker, S., Wells-Beede, E., Britt, T., Hardie, L., Shum, C., Arantes, H. P., Charnetski, M., & Morse, C. (2021). Healthcare Simulation Standards of Best PracticeTM Professional Development. *Clinical Simulation in Nursing*, *58*, 5–8. https://doi.org/10.1016/j.ecns.2021.08.007.

Huang, H., Schmidt, M., & Gartner, G. (2012). Spatial Knowledge Acquisition with Mobile Maps, Augmented Reality and Voice in the Context of GPS-based Pedestrian Navigation: Results from a Field Test. *Cartography and Geographic Information Science*, *39*(2), 107–116. https://doi.org/10.1559/15230406392107

Huang, X., Zou, D., Cheng, G., & Xie, H. (2021). A systematic review of AR and VR enhanced language learning. Sustainability, 13(9), 4639. https://doi.org/10.3390/su13094639

Hwang, G. J., Wu, P. H., Chen, C. C., & Tu, N. T. (2015). 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. https://doi.org/10.1080/10494820.2015.1057747

Jamrus, M. H. M., & Razali, A. B. (2019). Augmented reality in teaching and learning English reading: Realities, possibilities, and limitations. *International Journal of Academic Research in Progressive Education and Development, 8*(4), 724–737. http://dx.doi.org/10.6007/IJARPED/v8-i4/6696

Johnson, L., Smith, R., Willis, H., Levine, A., and Haywood, K. (2011). *The 2011 Horizon Report*. The New Media Consortium. http://horizon.unc.edu/HR2011.pdf

Kalana, M. H. A., Junaini, S. N., & Fauzi, A. H. (2020). Mobile augmented reality for biology learning: Review and design recommendations. *Journal of Critical Reviews, 7*(12), 579–585. https://doi.org/10.31838/jcr.07.12.104

Koumpouros, Y. (2024). Augmented reality in education: A systematic review of its benefits, challenges, and user acceptance. *Smart Learning Environments, 11*, 28–47. https://doi.org/10.1186/s40561-023-00288-0

Lampropoulos, G., Keramopoulos, E., Diamantaras, K. & Evangelidis, G. (2022) Augmented reality and gamification in education:

A systematic literature review of research, applications, and empirical studies. *Applied Sciences, 12*(13), 1-43. https://doi.org/10.3390/app12136809

Liao, C. H. D., Wu, W. C. V., Gunawan, V., & Chang, T. C. (2024). 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*(2), 307-319.

López-Faican, L., & Jaen, J. (2020). EmoFindAR: Evaluation of a mobile multiplayer augmented reality game for primary school children. *Computers & Education, 149*, 103814. https://doi.org/10.1016/j.compedu.2020.103814

Marrahi-Gomez, V., & Belda-Medina, J. (2024). Assessing the effect of augmented reality on English language learning and student motivation in secondary education. *Frontiers in Education, 9*, 1359692. https://doi.org/10.3389/feduc.2024.1359692

Mundy, M. A., Hernandez, J., & Green, M. (2019). Perceptions of the effects of augmented reality in the classroom. *Journal of Instructional Pedagogies, 22*, 1–11.

Pasalidou, C., Fachantidis, N., & Orfanidis, C. (2023). Utilizing augmented reality and mobile devices to support robotics lessons. In M. E. Auer, R. Langmann, & T. Tsiatsos (Eds.), *Open science in engineering. REV 2023* (Lecture Notes in Networks and Systems, Vol. 763, pp. 491–503). Springer. https://doi.org/10.1007/978-3-031-42467-0_45

Punar Özçelik, N., Eksi, G., & Baturay, M. H. (2022). Augmented Reality (AR) in language: A principled review of 2017-2021. *Participatory Educational Research*, *9*(4), 131–152. https://doi.org/10.17275/per.22.83.9.4

Rakhman, R. T. (2020). Peran augmented reality dalam meningkatkan persepsi visual generasi digital native. *Jurnal Sosioteknologi, 18*(3), 488-496.

Rizki, I. A., Saphira, H. V., Alfarizy, Y., Dwi Saputri, A., Ramadani, R., & Suprapto, N. (2023). Adventuring physics: Integration of adventure game and augmented reality based on Android in physics learning. *International Journal of Interactive Mobile Technologies, 17*(1), 4–21. https://doi.org/10.3991/ijim.v17i01.35211

Solak, E., & Cakir, R. (2015). Exploring the effect of materials designed with augmented reality on language learners' vocabulary learning. *Journal of Educators Online, 12*(2), 50–72.

Sural, I., & Osmangazi, E. (2017). Design for an intelligent augmented reality-based m-learning to improve engineering students' English language skills. In G. Kurubacak & H. Altinpulluk (Eds.), *Mobile technologies and augmented reality in open education* (pp. 215–232). Hershey, PA: IGI Global.

Thorne, S. L., Black, R. W., & Sykes, J. M. (2009). Second language use, socialization, and learning in internet interest communities and online gaming. *The Modern Language Journal, 93*(s1), 802–821. https://doi.org/10.1111/j.1540-4781.2009.00974.x

Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y., & Liang, J.-C. (2013). Current status, opportunities, and challenges of augmented reality in education. *Computers & Education, 62*, 41–49. https://doi:10.1016/j.compedu.2012.10.024

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478. https://doi.org/10.2307/30036540

Ying, O. L., Hipiny, I., Ujir, H., & Samson Juan, S. F. (2021). Game-based learning using augmented reality. In *2021 8th International Conference on Computer and Communication Engineering (ICCCE)* (pp. 344–348). IEEE. https://doi.org/10.1109/ICCCE50029.2021.9467187

Zaki, N.A.A., Zain N.Z.M and Zanilabdin A. (2018). AR-SIS: Augmented reality application to encourage STEM teaching and learning. *International Journal of Multimedia & Its Applications,10*(6), 1-13. https://doi.10.5121/IJMA.2018.10601