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# Assessing Teacher Acceptance of Augmented Reality Games for STEM Education

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**Abstract**

In the rapidly evolving digital era, Augmented Reality (AR) technology has demonstrated significant potential across various fields, particularly in education. The application of AR in Science, Technology, Engineering, and Mathematics (STEM) education has garnered attention due to its ability to make learning more engaging and effective. However, the acceptance and use of this technology in STEM education remain issues that require further in-depth investigation, especially in rural areas. This study evaluates the acceptance of AR games in teaching STEM subjects among secondary school teachers. The research was conducted with 20 secondary school teachers in the Hilir Perak district using a survey method. The instrument used was a technology acceptance questionnaire based on the five main constructs of the Technology Acceptance Model (TAM). The survey of teachers' perceptions indicated agreement that the usefulness, ease of use, enjoyment, attitude towards use, and intention to use AR games applications for STEM subjects that meet learning objectives can enhance the teaching process more engagingly and effectively. The implications of this study highlight the need to develop AR-based teaching material to support immersive and interactive learning, thereby optimizing creative teaching practices across the curriculum.

**Keywords:** Teacher Acceptance, Stem Education, Augmented Reality Games, Teaching And Learning, Technology Acceptance Model.

## Introduction

Digital education has grown rapidly along with the increased use of technology in transforming the teaching and learning process. A technology-based learning approach not only increases student engagement, but also enriches the learning experience through access to extensive and interactive digital resources (Cardullo, Wilson, & Zygouris-Coe (2018). In this context, Augmented Reality (AR) appears as one of the technologies that combines multimedia elements such as text, images, audio, video, and animation with real-world elements to create an enhanced interactive experience. In AR, digital content in the form of multimedia is overlaid on the real-world view through devices such as smartphones, tablets , or AR glasses, allows users to interact with these elements in the real environment (Dargan et

al., 2023). This innovative technology bridges the gap between the virtual and real worlds, providing students with unique opportunities to engage with complex concepts through immersive experiences that enhance their understanding and retention of subject matter. Moreover, overlaying digital information onto the real world, students can visualize and interact with concepts that may be abstract or challenging to grasp through conventional teaching techniques, thus enriching the educational experience and promoting deeper engagement with the material being studied (Pal & Ade, 2022). Specifically, for teachers, this technology presents an opportunity to create a more interactive, engaging, and effective learning experience.

STEM (Science, Technology, Engineering, and Mathematics) education plays an important role in preparing students to face the challenges of a modern world that is increasingly driven by technology. AR emerged as one of the innovations capable of bringing significant changes in education, STEM by making abstract concepts easier to understand and able to attract students' interest. By integrating digital elements with the physical environment, augmented reality games facilitate exploration and interaction, allowing students to undertake simulations that deepen their understanding of STEM topics and cultivate practical skills necessary for real-world applications (Ibáñez & Kloos, 2018). For example, students can witness simulations of complex science experiments or interactively explore 3D models of molecular structures, which were previously difficult to achieve through textbooks or oral teaching only.

By combining game elements and AR technology, STEM learning can be transformed into a more immersive, interactive, and relevant experience. Games can make AR applications more interactive and enjoyable, while AR can elevate gameplay by integrating real-world elements into the digital gaming experience. Through elements such as rewards, challenges, and gradual progress, AR games can make learning more fun and quality (Videnovik et al., 2020). A study by Lu et al, (2020) found that AR-based games can increase students' motivation to learn science, with students showing improvements in problem-solving and critical thinking abilities. Furthermore, students can see the practical application of STEM concepts through contextual learning, such as in the construction industry, medicine, or information technology (Yu, Denham, & Searight, 2022). This not only makes learning more meaningful but also helps students understand how STEM knowledge can be applied in their daily lives and future careers. AR games bring a new dimension to STEM education, making learning more interactive, fun, and relevant. By combining the power of AR and game elements, STEM education can be optimized to meet the needs of a generation of tech-savvy students, equipping them with the skills and knowledge needed to meet the challenges of the future.

The body of research on the evaluation and implementation of AR games in education is relatively small, likely because this field is still emerging and there are not yet many functional AR educational applications available (Amanatidis, 2022). However, to realize the full potential of this AR games, the acceptance and involvement of teachers is very important. Teacher acceptance of technology is a critical factor in its successful implementation in the classroom. Without full acceptance and support from teachers, new technologies such as AR may not be used effectively or may only be used minimally, which will reduce its potential impact in improving student learning. By understanding these aspects, more effective

strategies can be developed to support teachers in integrating AR in STEM education (Pombo & Marques, 2021).

The purpose of this study is to assess the level of teacher acceptance in integrating AR games in STEM teaching based on a robust theoretical framework, Technology Acceptance Model (TAM). The TAM model originally introduced by Fred Davis in 1989 is one of the most influential models to explain how users accept and use technology. This research contributes to the field by providing a comprehensive analysis of the determinants that drive or hinder teachers' adoption of AR games. By examining real-world classroom scenarios and teacher experiences, the study offers actionable insights that can inform policymakers, educational technologists, and curriculum designers on how to better support teachers in embracing AR technologies. By understanding teachers' perspective on their acceptance of this AR games, this study seeks to provide guidance that can help in improving AR-based teaching strategies and increasing the effectiveness of its implementation in STEM education, further supporting the improvement of student learning outcomes in this field with the development of effective teaching aids.

**Methodology**

This study employs a quantitative approach with a survey design to evaluate teachers' acceptance of AR games as a pedagogical tool in STEM education, specifically in the subject of Mathematics at the lower secondary level. The quantitative approach was selected for its capacity to provide objective and statistical measurements of the constructs under investigation, aligning with the study's objective of obtaining measurable and comparable insights into teachers' acceptance of AR technology (Creswell & Creswell, 2023). The survey method is particularly appropriate as it enables data collection directly from respondents within their natural environment, facilitating the generalization of findings to a broader population (Gideon, 2012).

The primary instrument utilized in this study is a questionnaire based on the Technology Acceptance Model (TAM). This questionnaire employs a 4-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." Respondents were asked to indicate their level of agreement with five key constructs related to the use of AR in teaching, as outlined in Table 1. The Likert scale was selected for its effectiveness in capturing the subtleties of attitudes and perceptions, making it a popular choice in studies of technology acceptance (Joshi et al., 2015).

Table 1
*Questionnaire constructs and items to assess teacher acceptance of augmented reality (AR) games for STEM education*

| **Constructs** | **Items** |
|---|---|
| Perceive Usefulness (PU) | PU1. I believe the use of AR games can make it easier for my students to understand certain concepts in STEM learning especially for Mathematics. |
| | PU2. I believe the use of AR games is useful to teach my students more effectively |
| | PU3. I believe my students performance (knowledge & skills) will increase with the use of AR games as a learning tool/material. |
| Perceived Ease of Use (PEU) | PEU 1. I believe that I can handle my teaching process equipped with AR games easily. |
| | PEU 2. I believe teaching modules equipped with AR games are easy to learn. |
| Perceived Enjoyment (PE) | PE 1. I believe I will be excited to teach when using modules equipped with AR games. |
| | PE 2. I believe my students are also excited to learn when it involves activities that use AR games. |
| | PE 3. I believe my students can learn while playing when using AR games. |
| Attitude Towards Its Use (AU) | AU 1. I believe learning becomes more interactive with AR games. |
| | AU 2. I believe learning using AR games is a good innovation. |
| | AU 3. I believe my students don't get bored quickly when performing activities that use AR games. |
| | AU 4. I am interested in teaching using AR games. |
| Intention of Use (IU) | IU 1. I am interested in creating learning/teaching innovations based on AR games. |
| | IU 2. I think there is a need for a teaching aids that uses AR games. |

The respondents of this study comprised 16 Mathematics teachers from various schools within the Hilir Perak district. These teachers were selected through random sampling. The study was conducted following the receipt of official permission from the Hilir Perak District Education Office, which authorized the inclusion of eight schools under its jurisdiction. Prior to the distribution of the questionnaire, each respondent was informed of the study's purpose, the data collection procedures, and their right to withdraw from the study at any time without penalty. Informed consent, whether written or verbal, was obtained from all respondents before their participation in the study.

The study respondents were assembled in a hall where the questionnaires were distributed to them directly. Each respondent received clear instructions on how to complete the questionnaire and was assured that their responses would be kept confidential and used solely for research purposes. They were given approximately 15 to 20 minutes to complete

the questionnaire, with the researcher available to help in case of any confusion or questions regarding the questionnaire.

The collected data were analyzed using descriptive statistics using SPSS software This analysis primarily involved calculating the mean and standard deviation for each construct in the questionnaire. Descriptive statistics were deemed suitable for providing an initial understanding of the patterns of acceptance and the challenges teachers encounter in integrating AR games into STEM learning. The findings of this analysis are presented through tables, graphs, and narrative discussions to ensure a clear and comprehensive presentation of the results.

**Findings and Discussion**

The survey results assessing teachers' acceptance on AR games for STEM education indicate a generally positive acceptance among the participants. As reflected in Table 2, the overall mean score across all items was 3.02, which corresponds to a high level of acceptance.

Table 2
*The teachers' acceptance results of augmented reality (AR) games for STEM education*

| Constructs | Items | Mean | Std. Deviation |
|---|---|---|---|
| Perceive Usefulness (PU) | PU1. | 3.00 | 0.37 |
| | PU2. | 3.06 | 0.44 |
| | PU3. | 3.00 | 0.52 |
| Perceived Ease of Use (PEU) | PEU 1. | 2.69 | 0.60 |
| | PEU 2. | 2.81 | 0.54 |
| Perceived Enjoyment (PE) | PE 1. | 2.87 | 0.62 |
| | PE 2. | 3.19 | 0.66 |
| | PE 3. | 3.25 | 0.58 |
| Attitude Towards Its Use (AU) | AU 1. | 3.25 | 0.58 |
| | AU 2. | 3.25 | 0.45 |
| | AU 3. | 3.13 | 0.50 |
| | AU 4. | 3.06 | 0.44 |
| Intention of Use (IU) | IU 1. | 2.81 | 0.66 |
| | IU 2. | 2.94 | 0.44 |
| **OVERALL** | | **3.02** | **0.40** |

This positive response is particularly noteworthy given that a significant proportion of the teachers surveyed (75%, n=12) reported limited prior exposure to AR technology. Despite this lack of familiarity, the teachers demonstrated a favorable attitude towards the potential of AR to enhance educational outcomes. This finding suggests that, while AR games is relatively new to these educators, there is an inherent openness and willingness to embrace innovative teaching tools that integrate digital and augmented reality applications especially games.

In assessing the Perceived Usefulness (PU) construct, teachers demonstrated confidence that augmented reality (AR) games could enhance students' conceptual understanding, improve

teaching effectiveness, and ultimately boost student performance in terms of knowledge and skills, with mean scores for items in this construct ranging from 3.00 to 3.06. The findings of this study reveal that teachers have a positive outlook on using AR games in their teaching. Despite their limited exposure to AR applications, these teachers believe that AR games can significantly enhance their teaching effectiveness and engagement. This positive indication aligns with previous research, which support the positive perception from educators that AR application can improve concept comprehension and student engagement in STEM learning (Mokmin, Ariffin, & Hamizi, 2022).

While the Perceived Ease of Use (PEU) of AR games was viewed positively, the lower mean scores (2.69 to 2.81) indicate potential challenges teachers might encounter in managing and learning to utilize AR-equipped teaching modules. Research conducted by Freese et al. (2023) highlights that many educators frequently perceive their digital teaching skills as insufficient and are actively seeking guidance, especially in the utilization of immersive technologies such as augmented reality (AR). Despite their limited experience with AR, teachers show a significant enthusiasm and willingness to integrate this technology into their instructional practices. This indicates a readiness to embrace innovative tools, even though there may be challenges in mastering their use.

Teachers believed that activities incorporating AR games would significantly elevate their own enthusiasm for teaching and their students' engagement with learning, as reflected in the mean scores for the Perceived Enjoyment (PE) construct, which ranged from 2.87 to 3.25. AR technology can be utilized to design digital multimedia instructional tools that create an immersive and contextually rich learning environment. It is not only boosting students' learning performance and efficiency but also increases their motivation and engagement in the learning process (Chang, 2021).

This belief is supported by the perception that students would be more excited and able to learn effectively through play using this technology. Additionally, teachers exhibited very positive attitudes toward using AR games (AU) in their teaching, with mean scores between 3.06 and 3.25, showing strong interest in integrating AR games into their instructional practices. According to Tzima et al. (2019), the key factors for the successful implementation of AR technology in education are enhancing collaboration among teachers from various disciplines and adopting a more flexible curriculum.

Despite this high interest, the lower mean scores for the Intention to Use (IU) construct (2.81 to 2.94) suggest a need for further support or training to assist teachers in developing and implementing AR-based instructional innovations. Teacher feedback often indicate that educators are not adequately equipped or trained to address technical issues and problems when AR technology malfunctions (Billinghurst & Duenser, 2012). Therefore, continuous and effective support from specialists is essential to ensure a positive attitude toward and successful use of AR educational applications (Dede, 2009).

## Conclusion

This study examined teacher acceptance of AR games integration in STEM education, employing the Technology Acceptance Model (TAM) as a theoretical framework. The findings reveal a generally positive reception among educators, indicating a high level of acceptance across all TAM constructs. Notably, despite a majority of participants reporting limited prior exposure to AR games, teachers demonstrated favorable attitudes towards AR integration in educational modules. They perceived AR as a valuable tool for enhancing student comprehension of complex concepts and improving instructional effectiveness. Educators also anticipated positive impacts on student performance in terms of knowledge and skill acquisition.

Particularly salient were teachers' high levels of agreement regarding AR's potential to increase learning interactivity and its capacity to facilitate learning through play. Furthermore, teachers viewed AR integration as a positive educational innovation. While educators expressed enthusiasm for incorporating AR into their teaching practices, there was comparatively lower confidence in their ability to easily manage AR-equipped teaching aids. This disparity suggests a need for targeted professional development and support in AR implementation.

The findings of this study indicate that AR technology has significant potential to enhance STEM education by providing interactive, engaging, and innovative learning experiences. However, successful integration will necessitate addressing teachers' needs for training and support in effectively utilizing AR in their instructional practices. The positive reception of AR technology among teachers, despite limited prior exposure, suggests a willingness to adopt innovative educational tools that can potentially improve student learning outcomes.
This research contributes to the growing body of literature on technology integration in STEM education and provides valuable insights into teacher perspectives on AR implementation. The results highlight both the opportunities and challenges associated with integrating AR into STEM curricula. While teachers recognize the potential benefits of AR in enhancing student engagement and understanding, there is a clear need for support in terms of professional development and technical proficiency.

In conclusion, this study underscores the potential of AR as a transformative tool in STEM education, while also highlighting the importance of addressing teacher readiness and support needs. As educational institutions continue to explore innovative technologies to enhance learning experiences, the insights gained from this research can inform policy decisions, guide professional development initiatives, and contribute to the effective integration of AR in STEM education.

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