

Augmented Reality in Higher Education: Application in Industrial Design Course

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Abstract

With the rapid development of digital technologies, education continues to be transformed, especially design education. Augmented Reality (AR) has emerged as a unique technology that can transform learning experiences across diverse disciplines. This paper outlines the development of a mobile-based AR (MAR) application for learning Industrial Design (ID) subjects. The discussion focus on Industrial Design education. Therefore, the objectives of this paper are to develop a prototype of a MAR application for Industrial Design subjects as a learning tool and to investigate the impact of the MAR application on undergraduate industrial design students' engagement. The paper reviews existing research on the topic, compiles secondary data, and discusses theoretical approaches. The prototype development of the MAR application involved conducting classroom observation, requirement analysis, and design modifications based on the content of the ID program. This analysis helped inform the design and development process, ensuring that the application aligned with the specific needs and objectives of the learning subject. In the results of this study, there was a significant difference between the formative and summative evaluations of the MAR application.

Keywords: Augmented Reality (AR), Mobile Application, Industrial Design, Higher Education, Student Engagement

Introduction

Industrial Design (ID) is a key component of product development. It advances innovation, helps businesses succeed, and contributes to a better quality of life by improving the functionality or aesthetics of a product or utilizing technology to enhance it (Dumas, 2000). Even though lecturers and students are expected to understand the complexity of professional practice during the teaching and learning process, learning how to implement the industrial design process and skills in design education can be challenging, especially for first-year industrial design students (Meyer & Norman, 2020). Most students find it challenging as they do not have any prior knowledge of the industrial design process. Following their entry into the institute, they begin to gain relative knowledge.

Rendering technique is one of the subjects in ID. It is essential in the design process as it allows students to visualize their ideas through drawings with the use of 2D and 3D software. This helps them to create realistic designs that can be used in the product development process.

However, learning rendering techniques solely through 2D and 3D software can be limited, as it may not provide students with a comprehensive understanding of how their designs would look and feel in the real world. As a consequence, students also have difficulty developing their design renderings as they lack an understanding of size and shape.

Student engagement is widely recognized as a critical factor influencing teaching and learning in higher education (Kahu, 2013). Integrating technologies into the classroom can significantly enhance student engagement and learning, ensuring students keep pace with the demands of a technology-driven world (D'Angelo, 2018). The use of AR technology offers highly interactive learning environments, encouraging students to participate actively in learning activities and improving their skills and knowledge (Wei et al., 2015).

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Research has discovered that AR has the potential to significantly improve the instructional and learning processes. AR in education has the capability to improve on existing learning methods (Sumadio & Rambli, 2010). The implementation and willingness to use Augmented Reality in teaching English reading are excellent among Malaysian secondary school teachers, and there is a strong association between acknowledgement and desire utilise AR in instructing English reading, (Jamrus & Razali, 2021). Rau et al. (2018) mentioned that reading content is often stored in a variety of formats, including publications, website information, and books. Augmented reality visual interfaces include text, and reading performance on Augmented Reality might vary from that on a standard text format for a variety of factors. By boosting the level of instruction and student achievement in higher education, undergraduate students will have access to world-class education, promoting the development of high-quality intellectual resources. This involves the creation of instructional tools as well as the redesign of university programmes and processes (Mohd. Deni et al., 2014). According to Mohd. Deni et al. (2014), several efforts are being implemented at the national and faculty levels to improve teaching effectiveness in Malaysian institutions. Auditing and accrediting university programmes, as well as getting quality management certification, assist to strengthen programme administration and standardise students' learning experiences. Unfortunately, these do not ensure high-quality instruction in the classroom. Efforts at the faculty level do not guarantee great teaching since staff development is frequently conducted through seminars and training sessions that seldom produce long-term learning, ending in little effect on instructional practice.

Mobile Augmented Reality (MAR) applications, taking advantage of real-time interactive environments with both real and virtual properties, enable users to view objects in three dimensions on their smartphones (Azuma, 1997; Daniela & Lytras, 2019; Turan & Atila, 2021). MAR is growing in popularity and is rapidly becoming an ongoing phenomenon (Abdullah & Jamil, 2021). MAR technology has been used in many fields of education, but its application to the field of design and art education has not been fully explored. Thus, MAR offers a valuable solution by allowing students to overlay virtual designs onto physical spaces, giving them a more immersive and realistic experience. This not only enhances their understanding of the design process but also prepares them for real-world challenges in industrial design.

Objectives

Therefore, the objectives of this paper are to develop a prototype of a MAR application for industrial design subjects, particularly rendering design techniques, as a learning tool and to investigate the impact of the MAR application on undergraduate industrial design students' engagement.

Method

The development of the MAR prototype began with a thorough requirement analysis. During this stage, the lesson content was reviewed to define the necessary requirements. A 2-hour classroom observation was conducted to understand the problem student encounter and identify their needs and learning characteristics. To ensure the MAR application was learner-centered and user-friendly, different students' learning styles were also taken into consideration.

The MAR application incorporates various design techniques, such as material textures, spatial composition, and environment. By overlaying virtual designs onto different environment, students can experiment with different design styles, explore various material options, and see how their designs interact with the surrounding environment. After the initial prototype design, the MAR application was refined according to the contents of the course until it met all the requirements. The final design of the prototype was then completed by the lecturing faculty member.

To identify any shortcomings in the MAR application, a pilot study was conducted with six participants from a college. Furthermore, the study was conducted in a classroom setting in order to minimize the impact of varying environments. The study began by asking participants use their mobile phones to download the MAR application. They were then provided with ivory cards containing images of different product and environment, allowing them to self-explore the application. Finally, participants were requested to complete questionnaires to provide feedback on their experience.

Lastly, a qualitative method involving a 2-hour classroom observation was conducted at a college in Johor Bahru, including both instructors and students. The qualitative content analysis used in this study, as mentioned by Assarroudi et al. (2018), is recognized as a reliable, transparent, and comprehensive approach for qualitative researches.

Findings

The MAR application in this study features AR images of different product and the environment, allowing users to interact with detailed representations through augmented reality. The design of this function aims to enhance the learning experience by providing a tangible, visual understanding of the product and its context within the augmented reality environment. Figure 1 and Figure 2 display images of the product and environment as seen on the MAR application. Through the application, students can easily interact with both the product and the environment (Figure 3).

The findings of the pilot study align with previous research on augmented reality in education, which has consistently demonstrated the positive impact of AR on student engagement and learning outcomes. The pilot study confirmed that the MAR application is an effective learning tool, as evidenced by the participants' high levels of fulfillment and achievement. These results further support the potential of AR technology to revolutionize teaching and learning in higher education, particularly in design education.



Figure 1. The image of the product as seen on the MAR application.



Figure 2. The image of the environment as seen on the MAR application.



Figure 3. The overlay of the product and environment as seen on the MAR application.

Additionally, the pilot study identified areas for improvement in the MAR application. Based on participants' feedback, potential enhancements include providing more guidance within the app to help users navigate and understand its features. While the MAR application

positively impacts student engagement, incorporating interactive elements could further enhance engagement and motivation for ID students.

Conclusion

This section presents a summary of the findings based on the research objectives. According to the results, the research objectives have been achieved. The discussion primarily focused on literature review and prototype identification. The MAR application was developed as a learning tool for ID students, and a significant difference was noted in the formative and summative evaluations.

The research findings indicated that the MAR application successfully provided an engaging learning experience and enhanced student learning outcomes. Students' fulfillment and achievement have been shown to improve when augmented reality is incorporated in learning and instruction (Özcan et al., 2017), demonstrating the potential of AR technology as an effective teaching and learning tool. For higher education, this represents a novel approach to teaching and learning tool and student engagement in the ID learning process. It also enhances student engagement in design education. Researchers hope that this study will assist ID educators in improving student engagement in higher education.

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