

Evaluating The Impact of an Augmented Reality-Based Multimedia Learning App on Accounting Education: Enhancing Student Achievement and Self-Efficacy

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ABSTRACT:

Traditional accounting classroom teaching methods are increasingly failing to meet students' learning needs in today's rapidly developing technological era. Augmented Reality (AR), as an important representative of emerging technologies, has gradually been integrated into traditional teaching models in recent years, and has been proven by numerous studies to have good teaching effects. Over the past decade, AR-assisted teaching methods have demonstrated significant advantages, especially in higher education. Despite the widespread attention given to AR in education, research on its application in accounting education remains relatively limited, especially empirical research in basic accounting courses. This study seeks to address this gap by evaluating the effectiveness of an augmented reality-based multimedia learning app (ARML) for undergraduate accounting students in Shandong, China. Utilizing ARML, the study assesses students' learning achievement and self-efficacy through standardized tests and validated questionnaires. The research results indicate that, compared with conventional multimedia learning (CML), augmented reality (AR)'s interactivity and unique technological advantages can create a more engaging learning experience, thereby significantly improving students' academic performance and self-efficacy.

Keywords: Augmented reality; Accounting education; Higher education; Learning method.

Introduction

This research responds to the “Quality Education” goal formulated in the United Nations’ Sustainable Development Goal 4, which emphasizes improving the quality of education

through innovative teaching and learning approaches (United Nations, 2022). As digital technologies continue to reshape higher education, the integration of AR into accounting education has emerged as a promising approach

to improving students' understanding of complex and abstract accounting concepts. By combining virtual information with real-world learning materials, AR enables students to visualize accounting processes, enhances conceptual understanding, and supports more engaging and effective learning experiences.

Despite these advantages, accounting remains a challenging subject because many accounting concepts are abstract, procedural, and require a high level of accuracy. Traditional accounting instruction mainly relies on lectures, textbooks, and two-dimensional learning materials, which often make it difficult for students to visualize accounting concepts and connect theoretical knowledge with practical applications. Therefore, identifying more effective instructional approaches for accounting education is essential. In China, accounting is one of the most widely offered undergraduate majors due to the increasing demand for qualified accounting professionals. By 2023, a total of 676 universities had established accounting as an undergraduate major (Chinese University Ranking, 2023), highlighting the importance of enhancing the quality of accounting education. However, there remains a need for innovative instructional technologies that can enhance students' understanding of complex accounting concepts and improve learning outcomes. Therefore, this study developed multimedia learning app to

facilitate student learning in accounting course. Additionally, the researcher assessed the impact of the app on student achievement and self-efficacy. To address these objectives, researcher explored the following research questions:

RQ1: Does the ARML significantly affect students' accounting achievement compared with CML after controlling for pre-test scores?

RQ2: Does the ARML improve students' accounting self-efficacy compared with CML?

Guided by the aforementioned research questions, this study constructs the following corresponding research hypotheses:

H0₁: There is no significant difference in the learners' learning achievements between the ARML and CML after controlling for pre-test scores.

H0₂: There is no significant difference in the learners' self-efficacy between the ARML and CML.

Conceptual Framework

Three categories of variables make up the conceptual framework used in this research, namely Dependent Variables (DV), Independent Variables (IV), and Moderator Variables (MV). The IV consists of the two levels of learning modes, which are ARML and CML. The DV consists of the two levels of learning modes, which are achievement and self-efficacy.

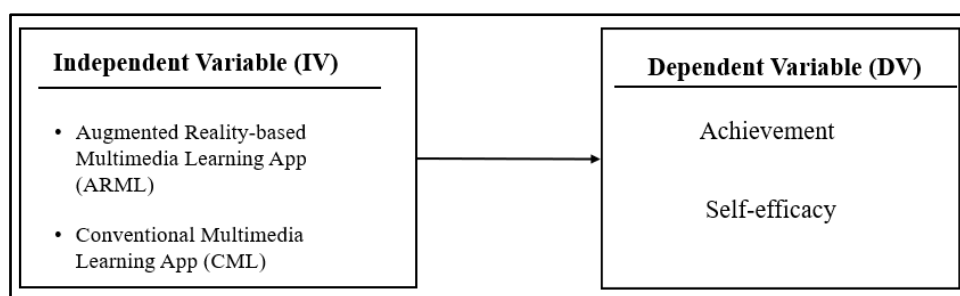


Figure1. The conceptual framework of the study

Literature review

AR in education

In recent years, Augmented Reality (AR) has attracted increasing attention from scholars in the field of education. AR is a technology that merges the real world with virtual information to provide

users with immersive and interactive learning experiences (Dargan et al., 2023). Since its application in education in 1995, AR has continuously enriched the learning environment, creating a more vivid and efficient learning experience for learners and bringing numerous

educational advantages (Garzón, 2021). Numerous studies have shown that AR technology can present teaching content in a more intuitive and visual way, helping students better understand and master classroom knowledge, thereby effectively stimulating learning interest and enhancing learning motivation (Cheng & Tsai, 2013). Furthermore, research on the effectiveness of AR in education further confirms that AR can significantly improve students' academic performance (Khan et al., 2019). Compared with traditional teaching methods, AR has a significant advantage in promoting knowledge retention, enhancing students' memory retention ability, and enabling them to maintain their mastery of learned knowledge for a longer period of time (Chiang et al., 2022).

AR in accounting education

Multiple studies have confirmed that AR has been successfully applied in accounting education and has shown promising application prospects. Zainuddin et al. (2021) developed Lively, an AR-based learning platform that provided a virtual classroom where lecturers and students could interact, access learning materials, and complete assessments. The application significantly improved students' motivation and engagement in learning accounting. Hadi et al. (2022) developed an AR application to teach accounting ethics through interactive case studies, enabling students to evaluate the consequences of their ethical decisions. The findings indicated that the application effectively enhanced students' understanding of accounting ethics. Similarly, Omar et al. (2023) designed an AR-based application that integrated flashcards with three-dimensional visual explanations to facilitate accounting learning. The application improved students' conceptual understanding, and most participants perceived it as user-friendly and beneficial for learning. Overall, these studies suggest that AR can enhance students' engagement, motivation, conceptual understanding, and learning experiences in accounting education. In addition, AR-based learning environments enable lecturers to customize instructional content to accommodate

different learning styles (Al-ansi et al., 2023). Building on these findings, the present study develops ARML to improve university students' learning achievement and self-efficacy in learning asset-related concepts.

self-efficacy

Self-efficacy is a key factor influencing student learning outcomes, referring to the confidence and belief that students possess in successfully completing academic tasks or achieving expected goals (Schunk & Zimmerman, 2008). The relationship between self-regulation and self-efficacy is an important topic in learning research. Müller and Seufert (2018) demonstrated in a multimedia learning environment that guiding students to engage in self-regulated learning activities during their initial learning phase significantly enhances their self-efficacy in subsequent learning stages. This finding suggests that learners' ability to effectively manage their own learning process contributes to increased learning confidence. DeBacker et al. (2022) highlighted that students with high self-efficacy are more inclined to embrace challenging learning tasks and goals, which in turn, boosts their motivation. This dynamic interaction enables students to remain focused and motivated, even in the face of complex and difficult learning material. Moreover, they are adept at recovering swiftly from setbacks following academic failures, thereby maintaining their motivation.

Methodology

Participants

This study employed a quantitative quasi-experimental research design. This study included 64 students aged 18 to 20 from two classes at a university in Shandong Province. Prior to the commencement of the experiment, informed consent was obtained from all participants. Because the university uses a traditional class-based teaching model, classes were not reorganized. Subsequently, participants were set as the ARML group and the CML group, receiving augmented reality mobile learning and traditional multimedia learning, respectively. The ARML group, consisting of students using

ARML for accounting learning, was designated as the experimental group; the CML group, consisting of students using CML for accounting learning, was designated as the control group.

Research procedure

Researchers strictly followed established procedures to conduct the experiment and collect data from the target participants. One week before the experiment began, the researchers formally applied to the presidents of two universities for permission to conduct the research. The research was planned to take place at Yantai University of Technology in Yantai City, Shandong Province. The researchers submitted basic information about the research along with the permission application letter, but did not disclose specific details about ARML and CML to the universities. The universities were only informed that their participation was in a research and development project on learning accounting knowledge in the field of multimedia education. After obtaining approval, the researchers obtained informed consent forms from the presidents of both universities. Subsequently, all participants completed a pre-test in the classroom. During the first week of the study, participants were randomly assigned to two different experimental groups: the experimental group used ARML for learning, and the control group used CML. The entire experimental treatment lasted seven weeks, with teaching activities for both groups taking place in classrooms arranged by the presidents. Classes were held once a week for 25 minutes each time, for seven consecutive weeks. The entire study was completed between September and October 2025. This study designed the experiment to last seven weeks to ensure participants had sufficient time to engage with and use the learning materials, and to fully reflect changes in learning outcomes. This duration was considered suitable for examining the effects of ARML and CML learning interventions on cognitive processing and memory retention. Furthermore, the seven-week period helped maintain experimental control, reducing participant fatigue, sample attrition, and interference from uncontrollable external learning factors on the research results.

This experimental duration is also consistent with similar quasi-experimental studies in the field of educational technology, thus providing theoretical and practical basis for the methodological design of this study.

Research Instruments

Learning achievements

This study assesses participants' learning achievements by comparing their achievement in pre-tests and post-tests. Both tests were designed and developed by the researchers, and each test lasted 20 minutes. This study measured participants before and after the intervention, with the pre-test conducted one week before the intervention and the post-test conducted after the intervention. Both the pre-test and post-test consist of 20 multiple-choice questions, which mainly assess students' mastery of basic knowledge related to assets. Specifically, the first four questions tested the definition of assets, including their basic characteristics; questions 5-8 tested the classification of assets, including long-term and short-term assets, and tangible and intangible assets; questions 9-12 tested asset borrowing, including asset increases and decreases; questions 13-16 tested asset management, including asset management methods; and questions 17-20 tested asset depreciation, including depreciation calculations using the useful life method. The content of the questions used in the pre-test and post-test was identical. All participants received the same learning materials and completed the same number of lessons. To ensure consistency between the pre-test and post-test, the two tests contain the same questions, with only the order in which the questions are presented being adjusted. To prevent participants from influencing their post-test results by memorizing the order of the pre-test questions, the post-test questions were randomly ordered.

The Self-Efficacy Scale

The Self-Efficacy Scale (SES), a psychometric tool used in this study, was developed by Canadian psychologist Bandura (1977). This scale assesses an individual's confidence in successfully

completing a task in a specific situation; this level of confidence is commonly referred to as “self-efficacy.” The GSES contains 10 questions, requiring participants to rate their confidence in each statement. Each question primarily assesses a participant's confidence in coping with challenges, overcoming obstacles, and achieving goals. Examples include “Even if things are difficult, I can find a way to solve the problem” and “I can solve most problems.” These questions determine whether participants possess the confidence and motivation to cope with problems without relying on external support or encouragement. Furthermore, each question guides participants to prepare for the task and actively face the challenge, such as “With effort, you can overcome most difficulties.” This example reflects an action-oriented belief that the participant believes they can complete the task through effort.

Data analysis

This study used SPSS 27.0 software to perform statistical analysis on the collected data. Analysis of covariance (ANCOVA) was used to compare the differences in academic performance between the two groups of students, and pre-test scores

were included as covariates in the analysis to eliminate the potential influence of differences in students' initial knowledge levels. Furthermore, an independent samples t-test was used to further examine the significance of the differences in self-efficacy between the experimental and control groups.

Results

Results for RQ1: Impact on learning achievement

The hypothesis test for homogeneity of regression slopes showed that the hypothesis was valid ($F = 2.49, p > 0.05$). As shown in Table 1, after controlling for pretest scores as covariates, the analysis of covariance (ANCOVA) results showed that learning patterns had a significant impact on student academic performance ($F = 26.73, p < .01, \eta^2 = 0.305$). The adjusted post-test mean was higher for the experimental group (Adjusted Mean = 49.97, SE = 2.98) than for the control group (Adjusted Mean = 34.55, SE = 2.98), indicating that the ARML significantly improved students' learning achievement in accounting education. The effect size ($\eta^2 = .305$) indicated a large effect. Therefore, H_{01} was rejected.

Table 1. The analysis of the ANCOVA on students' learning achievement

Group	N	Mean	SD	Adjusted mean	Std. error	η^2
Experimental group	32	50.31	16.60	49.97	2.98	0.305
Control group	32	34.22	10.63	34.55	2.98	

* $p < 0.01$

Results for RQ2: Impact on self-efficacy

To examine the differences in self-efficacy between the two different groups, this study used the t-test for analysis. The results are shown in Table 2, and the difference between the two groups reached a statistically significant level ($t = 2.33, p = .02$). The self-efficacy of students in the

ARML was significantly higher than that of the CML, with a mean score of 31.44 ($M = 31.44, SD = 4.18$) in the experimental group and 28.91 ($M = 28.91, SD = 4.49$) in the control group. These results indicate that ARML has a positive effect on improving students' self-efficacy. Therefore, H_{02} was rejected.

Table 2. The t-test result of the two group's overall self-efficacy

Group		N	Mean	SD	t	P
Overall self-efficacy	Experimental group	32	31.44	4.18	2.33	0.02
	Control group	32	28.91	4.49		

* $p < 0.05$

Discussions

Achievement

This study developed ARML aimed at enhancing university students' learning achievement in accounting. The finding is consistent with the mobile AR technology can help students continuously and proactively acquire local cultural information during field exploration, improving the effectiveness of cultural knowledge learning. Research results show that students' understanding and cognitive abilities regarding local culture are enhanced (Cheng, 2023). AR technology can effectively improve students' achievement and learning experience. Researchers developed the "Cell AR" learning system. The experimental group of students used traditional textbooks in addition to AR systems, while the control group of students only used traditional teaching materials. The results showed that the experimental group students had significantly higher academic performance and learning motivation than the control group (Capeocchi, 2024). However, this finding differs from the conclusions of Chen et al. (2023). The latter indicated that after learning about lantern culture, the achievement of students in both the AR and Web groups improved, with no significant difference between the two groups. This discrepancy could be attributed to differences in learning environments outside the classroom between the two studies.

Self-Efficacy.

This study developed ARML designed to enhance college students' self-efficacy in accounting learning. The findings are consistent with existing empirical literature, which indicates that higher personal academic expectations are a significant predictor of subsequent academic performance. Richardson et al. (2012) pointed out that there is a certain correlation between academic performance and academic self-efficacy ($r = 0.31$). Academic self-efficacy refers to an individual's cognitive evaluation of their ability to complete academic tasks and their level of confidence, and this belief has an important influence on students' motivation regulation during the learning process. Related research

further demonstrates that self-efficacy is one of the important psychological factors influencing the formation of learning outcomes. Therefore, enhancing students' learning experience and engagement through technologies such as ARML can help improve their self-efficacy.

Limitation

In terms of generalization, the study is conducted within the following limitations. Firstly, this study is also limited to multimedia design students taking accounting subjects at the university from Shandong province. Thus, the findings cannot be generalized to mathematics, history, art, medicine, and biology. Secondly, the study's age range was restricted to university students aged 18-20. Due to the narrow age range, the findings may not be entirely applicable to younger or older students. Thirdly, this study only applies to private universities, not public universities.

Conclusion

This study evaluated the impact of ARML on student learning outcomes. The results demonstrate that ARML effectively improves students' achievement and self-efficacy levels compared to CML. These findings suggest that ARML can enhance students' learning experience and support more effective learning in accounting education.

Recommendations for Future Research

There are several potential areas, directions, and foci warranting further investigation, as relevant to the gap in the current study. It is helpful to specify some research work that could directly contribute to filling the gaps. Firstly, in order to refine and upgrade this design and development framework, it is imperative to develop more AR applications using this framework. This will enable a robust and comprehensive framework for ARML to be developed. Secondly, future research could target systems for more abstract subjects, such as physics, biology and chemistry, which are often considered among the most challenging to learn. The ARML may potentially overcome this difficulty by providing an interactive visualization that helps formulate a concrete understanding of abstract accounting

asset knowledge. To this end, it is worthwhile to adapt the experimental systems using other challenging subjects to determine their specific effects on learning. This method can also help demonstrate that ARML is not only relevant to a broad range of subjects, but that its value also lies beyond the boundaries of a specific subject.

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Author Declaration

The authors declare that this manuscript is original, has not been published previously, and is not under consideration for publication elsewhere.

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