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การพัฒนาบทเรียนอีเลิร์นนิงโดยใช้เทคโนโลยีความเป็นจริงเสริม

The Development of e-Learning Lessons Using Augmented Reality

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[1]สาขาวิชาระบบสารสนเทศและคอมพิวเตอร์ธุรกิจ คณะบริหารธุรกิจและเทคโนโลยีสารสนเทศ มหาวิทยาลัยเทคโนโลยีราชมงคลสุวรรณภูมิ จังหวัดนนทบุรี 11000
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บทคัดย่อ

งานวิจัยนี้มุ่งเน้นไปที่การพัฒนาบทเรียนอีเลิร์นนิงที่บูรณาการเทคนิคความเป็นจริงเสริม (Augmented Reality: AR) เพื่อเพิ่มประสิทธิภาพในการเรียนรู้และความเข้าใจเนื้อหาของผู้เรียน วัตถุประสงค์ของการวิจัย ได้แก่ การพัฒนาบทเรียนอีเลิร์นนิงที่ใช้เทคนิค AR และเปรียบเทียบผลสัมฤทธิ์ทางการเรียนของนักเรียนก่อนและหลังการใช้บทเรียนดังกล่าว นอกจากนี้ การวิจัยยังมีเป้าหมายในการออกแบบและพัฒนาบทเรียนที่เน้นการมีส่วนร่วมของผู้เรียน การมีปฏิสัมพันธ์กับเนื้อหา และการปรับแต่งบทเรียนให้ตรงกับความต้องการของผู้เรียน ผลการวิเคราะห์พบว่า เทคนิค AR ทำให้อีเลิร์นนิงมีความน่าสนใจและมีประสิทธิภาพมากขึ้น โดยช่วยให้ผู้เรียนสามารถมองเห็นและมีปฏิสัมพันธ์กับวัตถุเสมือนในรูปแบบ 3 มิติที่ผสานเข้ากับโลกแห่งความเป็นจริงได้อย่างไร้รอยต่อ นอกจากนี้ การใช้ AR ยังช่วยเพิ่มความเข้าใจและการจดจำเนื้อหา ตลอดจนกระตุ้นการมีส่วนร่วมและความสนใจของผู้เรียน ผลการศึกษาสรุปว่า การใช้ AR ในอีเลิร์นนิงสามารถเป็นเครื่องมือที่ทรงพลังในการพัฒนาผลสัมฤทธิ์ทางการเรียน และมอบประสบการณ์การเรียนรู้ที่มีความสมจริงและน่าสนใจมากยิ่งขึ้น โดยผลการวิจัยแสดงให้เห็นว่า คะแนนเฉลี่ยก่อนเรียน (pre-test) อยู่ที่ 6.9 ขณะที่คะแนนเฉลี่ยหลังเรียน (post-test) อยู่ที่ 16.2 การเปรียบเทียบผลสัมฤทธิ์ทางการเรียนของนักเรียนผ่านอีเลิร์นนิงที่ใช้ AR พบว่า คะแนนหลังเรียนสูงกว่าก่อนเรียนอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05

ABSTRACT

This research focused on developing e-learning lessons incorporating Augmented Reality (AR) techniques to enhance learning effectiveness and content comprehension among students. The objectives were to develop e-learning lessons with AR techniques and compare students' learning achievements before and after using these lessons. Additionally, the study aimed to design and develop lessons emphasizing learner engagement, interaction with content, and customization of lessons to meet learners' needs. The analysis results indicated that AR techniques made e-learning more engaging and effective by allowing learners to visualize and interact with virtual objects in 3D, seamlessly integrated with the real

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world. Furthermore, the use of AR enhanced content understanding and retention, as well as stimulated learner participation and interest. The study concluded that using AR in e-learning can be a powerful tool to improve learning outcomes and provide a more immersive and engaging learning experience. The research results showed that the average pre-test score was 6.9, while the average post-test score was 16.2. The comparison of students' learning achievements through AR-based e-learning revealed that the post-test scores were significantly higher than the pre-test scores at the 0.05 level of statistical significance.

คำสำคัญ: อีเลิร์นนิง เทคโนโลยีความเป็นจริงเสริม การพัฒนาบทเรียน

Keywords: e-learning, Augmented Reality Techniques, Lesson Development

INTRODUCTION

The global economy and society have undergone significant changes. The application of technology in various aspects of daily life helps improve the quality of life. In 2008, a pivotal development occurred when the Ministry of Education introduced the Basic Education Core Curriculum. This framework provided with guidelines for curriculum development. In addition, Information and Communication Technology (ICT) was strategically positioned as the third core subject area within the Career and Technology learning domain. The development of grade-level and key stage indicators drew upon the foundational standards established in the 2001 curriculum, incorporating developmental considerations to ensure age-appropriate content distribution and progression in difficulty. This curriculum emphasizes practical ICT applications, and ethical project development. The fundamental programming competencies aligning with ICT's expanding role in professional and personal spheres. The technology learning strand, particularly in Computing Science, aims to develop students' computational thinking, analytical proficiency, and problem-solving abilities. The application of computer science to solve real-life problems effectively (Institute for the Promotion of Teaching Science and Technology, 2024).

Recent studies have increasingly focused on intelligent e-learning systems, highlighting how their adoption has revolutionized the accessibility and efficiency of educational resources (Liu and Yu, 2022). Advanced technologies have enabled more sophisticated e-learning platforms capable of data analysis, content adaptation, and personalized recommendations. The shift toward blended and adaptive learning approaches has emphasized the need for enhanced e-learning capabilities. The study examines the integration of innovative information and communication technologies to strengthen e-learning services, aiming to develop intelligent learning systems that support modern education (Liu and Yu, 2022).

The future directions of e-learning will focus on utilizing advanced technologies to create more effective and personalized learning experiences. The augmented reality (AR) is a technology that plays an important role in e-learning development. The system integrates digital information with the physical environment through devices creating a seamless fusion of virtual and real-world elements while maintaining users' connection to their natural surroundings. Within AR techniques, supplementary information can be included in the real environment to enhance understanding and interaction with learning content. Also, it developed a learning model utilizing AR technology and QR codes to complement traditional teaching methods to enhance students' learning efficiency (Martinez-Garcia *et al*., 2023) (AlNajdi, 2022).

E-learning represents an integrated digital educational framework to support learning beyond traditional classroom boundaries. This approach utilizes diverse content delivery methods to enable flexible and accessible education across multiple platforms (Revathy, 2021). Studies of intelligent e-learning systems emphasize the critical role of Big Data analytics and AI in transforming educational delivery. These technologies enable sophisticated analysis of learning patterns and support personalized instruction, automatically adapting content and teaching methodologies to match individual learners' behaviors, interests, and capabilities. The system integrates advanced recommendation algorithms with predictive analytics to personalize learning experiences and forecast academic outcomes. Its comprehensive framework encompasses multi-modal assessment strategies. This technological foundation facilitates hybrid learning environments. In summary, intelligent e-learning will utilize modern technology to enhance learning efficiency and analyze data to continuously improve teaching and learning. (Liu and Yu, 2022)
Comparative studies that highlight the advantages of e-learning to traditional learning. E-learning utilizes multimedia formats that can be accessed anywhere at anytime. Content delivery in e-learning ranges from online lectures and videos to digital notes and text-based materials. This enables instructors to convey knowledge effectively across multiple platforms (Revathy, 2021). Furthermore, emphasis was placed on promoting cognitive engagement among students by encouraging self-instruction to foster independent learning skills, and researching the psychological and emotional impacts of learning remotely. Innovations in e-learning to enhance learning experiences. the study highlighted the potential of mobile learning and the integration of social media into education. Furthermore, the development of learning analytics systems and data mining techniques to improve teaching and learning efficiency. In summary, future trends in e-learning will center on leveraging advanced technologies, and creating more effective, engaging, and learner-centered educational experiences (Martinez-Garcia *et al*., 2023).

The study from Saudi Arabia explored the effectiveness of AR, in enhancing student learning through the national education portal (iEN). Conducted in a secondary school in Tabuk, two classrooms were assigned as experimental and control groups. While both groups studied the same lesson traditionally, the experimental group accessed supplementary AR content. Pre- and post-tests were used to assess learning outcomes. Surveys captured students' opinions, with QR codes and digital resources. Key components of the study included blended learning, digital media integration, home-based exercises, stakeholder involvement, and immediate feedback via iEN. The findings recommend that AR technology and QR codes can effectively supplement traditional teaching, improving learning efficiency and student engagement (AlNajdi, 2022). One interesting study applied the ADDIE Model (Analysis, Design, Development, Implementation, and Evaluation) to develop an e-learning module for disseminating supported employment in community mental health programs in New York State. The ADDIE Model is a systematic and flexible instructional design framework comprising five stages, as follows. 1. Analysis, 2. Design, 3. Development, 4. Implementation, and 5. Evaluation (Patel *et al*., 2018; Dick *et al*., 2009).

The study aimed to develop and evaluate the effectiveness of AR techniques in students' learning achievements. The lessons were designed to emphasize learner engagement, interaction with the content, and content customization to meet learners' needs. This approach will allow students to visualize and interact with virtual objects in 3D, seamlessly integrated with the real world. Additionally, the use of AR enhances content comprehension and retention while effectively stimulating learner participation and interest.

MATERIALS AND METHODS

This research has defined the population and sample as follows. The population in this study was primary school students in Grade 1 who live in Bangkok Metropolitan Area. The sample group consisted of 70 first-grade primary school students selected through purposive sampling. The selection focused on students from the special classroom program (MEP), who were admitted after passing an entrance examination prior to their enrollment in the first grade.

Analysis phase

Learner analysis: The target group consisted of Grade 1 students from Bangkok Metropolitan, focusing on age, knowledge level, interests, and technology skills. Content analysis: The scope and appropriateness of AR were defined for presenting computing science content. Learning objective analysis: Learning goals were set to develop students' knowledge, understanding, and skills.

Design Phase

Learning experience Design: AR elements, such as 3D models and additional information, were aligned with the content to enhance learning. Interface and Interactions Design: The interactions between learners and AR content were defined. Technology and Tools Selection: The Assemblr Studio platform was chosen for lesson development. Assessment Tools Design: Tools for measuring learning achievement were created.

Development phase

The virtual lessons were developed using Assemblr Studio to make content engaging. Three experts reviewed the lessons for content and design quality before implementation.

Implementation Phase

The AR-enhanced e-learning lessons were implemented with 70 Grade 1 students. Evaluation Phase. The effectiveness of the lessons was evaluated by comparing students' learning achievement after using AR-based e-learning content.

RESULTS AND DISCUSSION

The researchers developed a virtual lesson using an application called Meta Spark AR, which enhances the lesson's appeal. Before implementing the lesson, the program was evaluated by three experts for its feasibility in terms of content and design. This evaluation was conducted to assess the quality of the e-learning lesson with AR techniques before its actual use with the sample group.

The System development results shown as figure 1- figure 4

Figure 1 Home page

This page allows users to sign up and register their information to the membership database. Users are required to provide their first name, last name, gender, and student ID number in the form provided. After completing the form, clicking the **"Finish"** button will save the entered information. If users choose not to proceed, they can click the **"Cancel"** button to exit the registration process.

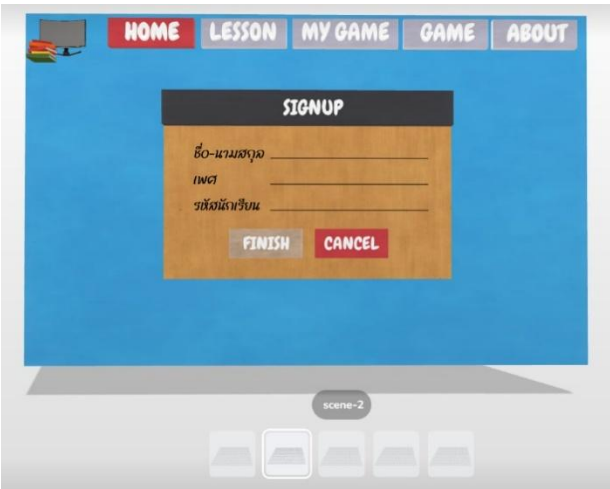

Figure 2 Sign up page

This page is for signing up or registering as a member to add user information to the membership database. Users are required to enter their first name, last name, gender, and student ID number as shown in the form on the website. Once all the required information has been entered, the user must click the "Finish" button to save the entered data. However, if the user does not wish to sign up, they can click the "Cancel" button to cancel the registration process.

Figure 3 Lesson content page

This page contains the content for each lesson. Users are required to complete a total of 4 lessons, with each lesson presented in a simplified format to make it easier to understand. This is to ensure that users can grasp all the content. Once a user completes a lesson, they should click the "Finish" button to save their progress, indicating that they have finished that lesson. If the user does not save their progress (click “Finish”), the system will not record the lesson as complete, and the user will need to retake it.

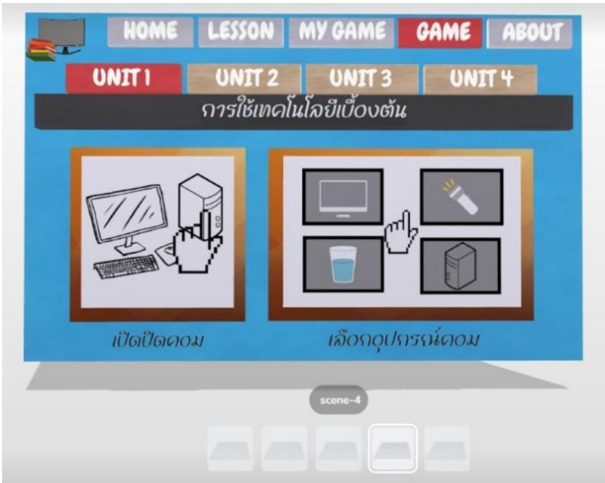

Figure 4 Game page

This page is for playing games, where users can choose to play after completing all 4 lessons, or they can opt to play after finishing just one lesson. Each game is related to the computer-related content covered in the lessons. In Unit 1, there are two simple games available for users to play: one is a game about turning the computer on and off, and the other is a game about selecting computer-related devices. The comparison of students’ learning achievement through e-learning lessons with AR techniques before and after learning was shown in Table 1.

Table 1 Comparison of pre-test and post-test learning achievement of primary school students using e-learning lessons.

Test	n	$\bar{x}$	S.D.	t	*p-value*
Pre-test	70	6.44	1.36		
Post-test	70	10.94	1.61	21.50*	< 0.001

*Significant at the 0.05 level

The results showed that the average pre-test score was 6.44, while the average post-test score increased to 10.94. A comparison of student scores before and after using e-learning lessons with AR techniques revealed a statistically significant improvement at the 0.05 level ($p < 0.05$).

Discussion of Research Results

Our research findings align with several studies, for instance, a study that compares English learning achievements through e-learning and live online broadcasting for 8th-grade students. The results showed that, following learning activities through live online broadcasting and e-learning, the post-test English achievement scores of both sample groups were significantly higher than their pre-test scores, with a statistical significance of $p < 0.05$. A comparison of post-test scores between Group A and Group B revealed that Group A, which participated in live online broadcasting, achieved significantly higher English learning outcomes than Group B, at the 0.05 level of significance (Laksanasut, 2021). These findings are also consistent with Khaled's (2018) study, which compared the learning achievements of students who studied through live online lectures with those who learned from pre-recorded lecture videos. Using a quasi-experimental design, Khaled found that learners in the live online lecture group (experimental group) had significantly higher levels of learning achievement compared to the pre-recorded lecture video group (control group) at the 0.05 statistical significance level. In a different study, the comparison of Grade 4 students' abilities in addition and subtraction of numbers greater than 100,000, using Game-Based Learning (GBL) integrated with constructivist theory, demonstrated significant improvement. The average pre-test score was 10.62, while the post-test score increased to 16.08. Hypothesis testing confirmed that students' abilities in these mathematical operations significantly improved after the lesson, with a *p-value* < 0.05 (Phumingsri *et al*., 2023). This result is consistent with prior research that compared the learning outcomes of students using E-learning lessons enhanced by augmented reality (AR) techniques. This study also found significantly higher post-test scores, supporting the idea that integrating AR into E-learning lessons enhances students' learning outcomes by increasing engagement, fostering content knowledge, and making learning more enjoyable. Such advancements in E-learning offer effective tools for skill practice, focusing on cognitive development and supporting knowledge-building in students.

Recommendations

1. Address educational limitations, such as a small sample size or potential biases in sample selection, to enhance the academic rigor of the study.

2. The relatively short study period limited the scope of data collection from the sample group.

CONCLUSIONS

The study found that the average pre-test score was 6.44, while the average post-test score was 10.94. A comparison of pre-test and post-test scores showed that students' learning achievement improved after using e-learning lessons with AR techniques, with statistical significance at the 0.05 level.

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