Development of the 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program

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Abstract

Augmented Reality (AR) offers numerous benefits across various fields by displaying the 3D models of complex structures as real objects in digital information. For improvement of the educational service for many undergraduate students per year at the Applied Computer Science-Multimedia Program in King Mongkut's University of Technology Thonburi, the 3D models in AR for educational equipment were created to improve the equipment borrowing service process. The AR media were made available through QR codes which students can simply scan with their mobile to make visualize understanding better than the 2D picture without the risk of real equipment damage. This approach not only aided in better visualization and understanding of complex equipment but also fosters a more efficient and informed decision-making for equipment selection. The 3D models of real objects were created using the 3D scanner and displayed with AR, which were assessed the qualities by three expert professors. The satisfaction after using AR media of all 3D models was then evaluated with a sample group of 30 undergraduate students in the Applied Computer Science-Multimedia Program, selected by simple random sampling. The tools in this study were the quality assessment form and the satisfaction assessment forms using 5-score rating. This study indicated that the overall qualities of the AR were rated as very good, and the satisfaction level of the sample group was high. Therefore, the implementation of 3D augmented reality media has significantly enhanced the equipment borrowing service for undergraduate students.

Keywords: Augmented Reality Media, 3D Models, Equipment Borrowing Service

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Introduction

The integration of immersive technologies like Augmented Reality (AR) has emerged as a transformative approach in various fields, including education. AR blends real-world environments with interactive digital content, providing an enhanced user experience that improves comprehension and engagement. By allowing users to visualize complex structures as 3D models in real-world contexts, AR offers significant advantages in terms of understanding and interaction. This capability makes it an invaluable tool in educational environments where visual learning and practical understanding are crucial.

At King Mongkut's University of Technology Thonburi, the Applied Computer Science-Multimedia Program serves hundreds of undergraduate students annually, many of whom rely on educational equipment for practical coursework and projects. However, traditional equipment borrowing processes often involve inefficiencies and risks, such as insufficient understanding of the equipment's functionality and potential damage due to improper handling. These challenges highlight the need for innovative solutions that enhance the borrowing process while ensuring the longevity of valuable resources.

This research aims to address these issues by developing 3D AR media to support the equipment borrowing service for undergraduate students. By integrating 3D models into AR applications, the project seeks to improve students' understanding of equipment through detailed visualizations that reduce reliance on physical handling. QR codes are employed to provide easy access to AR media, enabling students to scan and view the models directly on their mobile devices. This approach minimizes the risks of equipment damage while offering an interactive and engaging learning experience.

The study focuses on the development, quality evaluation, and user satisfaction assessment of the AR media. High-quality 3D models were created using a 3D scanner, designed to replicate real-world educational equipment accurately. The AR media's quality was evaluated by three expert professors specializing in multimedia and educational technologies, ensuring its effectiveness in meeting educational objectives. To measure user satisfaction, a sample group of 30 undergraduate students was selected through simple random sampling and surveyed using a 5-point Likert scale.

The findings of this study indicate that the developed AR media significantly improves the equipment borrowing service by enhancing students' understanding and decision-making capabilities. The AR models were rated as very good by experts, and the satisfaction level among users was high, demonstrating the effectiveness of this innovative approach. This research not only highlights the potential of AR in revolutionizing educational services but also provides a foundation for future applications of immersive technologies in academic settings.

Objectives

1) To develop 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program.
2) To evaluate the quality of 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program.

3) To assess the satisfaction of the sample with 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program.

Literature Review

Augmented Reality Media

Augmented Reality (AR) is a transformative technology that superimposes virtual elements onto the real world, enhancing the viewer's experience. (Mujumdar, 2022) by providing additional valuable information. It is applied across various fields, including education, to enrich learning through interactive virtual objects (Permana et al., 2023) and improving the educational process for students, making AR a valuable tool in education, marketing, and healthcare (Salmiyanti et al., 2023). Augmented Reality (AR) media has emerged as a transformative tool in educational settings, enhancing engagement and understanding across various subjects. The integration of AR into learning environments allows for interactive experiences that can significantly improve student outcomes (Shi, 2024). Effectiveness in Learning, AR-based learning media has shown substantial improvements in student understanding. AR has been successfully applied in various subjects, including economics, where it simplifies complex concepts, leading to significant learning gains (Panjaitan et al., 2024). In creative fields, AR enhances traditional poster-making by providing interactive elements that enrich the learning experience (Multazam et al., 2024). Technological Integration, the incorporation of AI and computer vision into AR systems allows for more intuitive user interactions, enhancing the overall educational experience. This integration supports real-time data processing and contextual awareness, making learning more personalized (Shi, 2024).

3D Models

3D modeling is a dynamic and essential process in various fields, enabling the creation of virtual representations of objects and environments. This technology encompasses a range of techniques and applications, from animation and gaming to architecture and product design. Fundamental Components of 3D model include Vertices, Edges, and Faces: These are the building blocks of 3D models, forming meshes that define geometry (Ghuge, 2023). 3D models play a crucial role in enhancing Augmented Reality (AR) experiences across various domains, from education to assembly instructions. By integrating real-world imagery with computer-generated models, AR creates interactive environments that engage users in unprecedented ways (Bhuvaneswari et al., 2024). 3D models for equipment borrowing services can enhance user experience and operational efficiency in various contexts. These models facilitate self-service interactions, allowing users to borrow and return items seamlessly (Tu et al., 2021). In this research, 3D models of borrowing equipment play a crucial role in guiding users through the borrowing process.

Equipment Borrowing Service

The equipment borrowing service encompasses various systems and methods designed to facilitate the lending and returning of equipment efficiently. These services leverage technology to streamline processes, enhance user experience, and ensure accountability (Ashar & Iqbal, 2024). The equipment borrowing service in educational institutions is a critical support system that ensures students have access to necessary tools and resources.

Traditional systems often face challenges such as inefficiency, lack of clarity, and user dissatisfaction (German et al., 2021). Incorporating AR and 3D models into the borrowing service can address these issues by providing clear instructions, real-time guidance, and an engaging user interface. Research demonstrates that digital solutions like AR can streamline service operations and improve overall user satisfaction by reducing confusion and enhancing the efficiency of transactions.

Research Method

The researchers divided the research method into 3 phases.

Phase 1 System Development. The system development process follows the ADDIE model that include 5 steps as follows 1) Analysis 2) Design 3) Development 4) Implementation and 5) Evaluation.

1) Analysis: Identify user requirements, challenges in the existing equipment borrowing process, and the feasibility of AR technology in addressing these challenges.
2) Design: Develop storyboards, 3D models, and AR interactions for the system. Key features include a virtual catalog of equipment, step-by-step borrowing guidance, and real-time status updates.
3) Development: Utilize tools or similar platforms to build the AR media system. Incorporate feedback from stakeholders to refine the system.
4) Implementation: Deploy the system in a controlled environment for pilot testing with target users.
5) Evaluation: Assess the system's quality using expert reviews and user feedback.

Element of AR media	Element of 3D model	Addle Model	Element of Equipment Borrowing Service
• 3D Objects or Models • Display Devices • Cameras and Sensors • Software and Algorithms • Interaction Tools • Markers	• Realism and High Resolution • Object Scanning • Realistic Texture Mapping • AR Optimization • Interactivity • Integration with Borrowing System • Clear Visualization without Physical Equipment	• Analysis • Design • Development • Implement • Evaluation	• 3D Model Visualization via AR • QR Code Integration • Improved Understanding of Equipment Usage • Interactive Information DisplayEvaluation • Minimized Physical Equipment Handling • Improved Learning Process • Enhanced User Experience

3D Augmented Reality Media — **Equipment Borrowing Service**

Development of the 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program
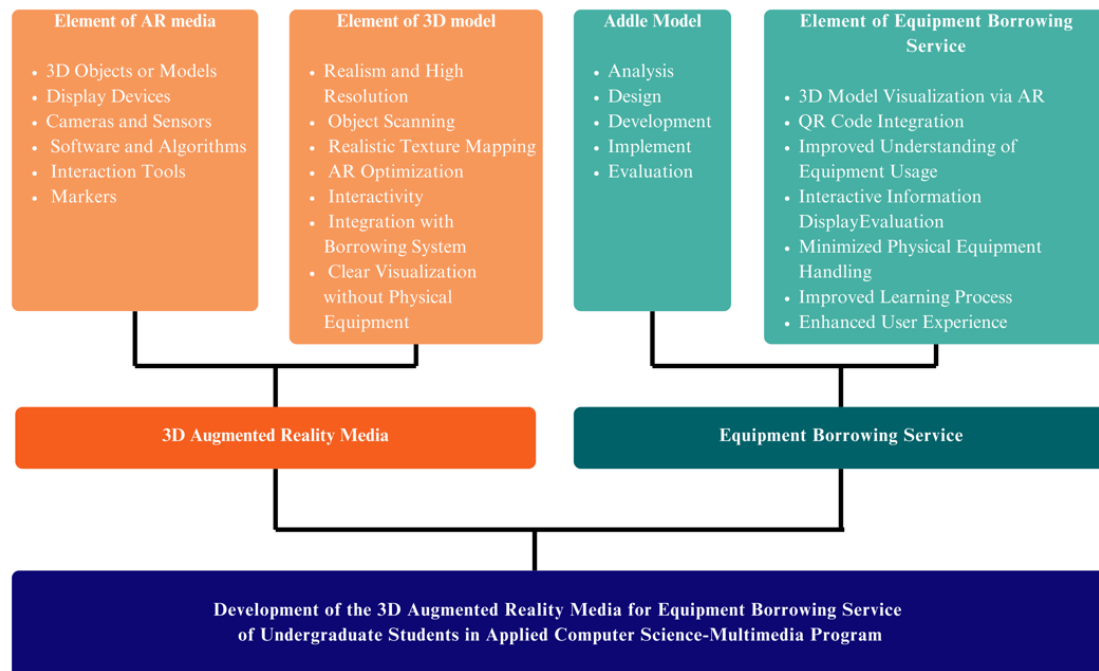
Figure 1: Conceptual Framework

The development of the 3D Augmented Reality (AR) media for the equipment borrowing service is a significant step toward improving the borrowing process and enhancing the educational experience for undergraduate students in the Applied Computer Science-Multimedia Program. This research combines advanced AR technology with 3D modeling to

create a system that is interactive, user-friendly, and highly efficient. The following is an in-depth exploration of the elements and processes involved in this innovative system.

1) Elements of AR Media key elements include 3D Objects or Models, which are used to create realistic and accurate visual representations of the equipment. Display Devices such as smartphones or tablets, which serve as the primary interface for users to interact with AR media. Cameras and Sensors that detect markers or QR codes, facilitating the activation and visualization of AR content. Software and Algorithms that process data and create AR experiences. Interaction Tools allowing users to explore the media interactively. Markers, such as QR codes, that connect the physical and digital worlds, enabling quick access to the AR system. These elements work together to create a robust and efficient system that bridges the gap between physical equipment and digital representation.

2) Elements of 3D Models key elements include the 3D models are designed with realism and high resolution, providing detailed and lifelike representations of the equipment. Object scanning is employed to capture the physical characteristics of the equipment and translate them into digital models. This process is further enhanced by realistic texture mapping, which adds depth and authenticity to the models. To ensure optimal performance, the system undergoes AR optimization, which ensures that the media is responsive and user-friendly. It also supports interactivity, allowing users to engage with the models dynamically. Furthermore, the AR media is designed for integration with the borrowing system, enabling smooth transitions between viewing equipment and completing the borrowing process. Importantly, the system offers clear visualization without physical equipment, reducing the need for students to handle real devices, thereby minimizing potential damage.

3) ADDIE Model for System Development key elements include 5 steps as follow 1) Analysis: Identifying problems in the existing borrowing system and defining user requirements. 2) Creating: a blueprint for the AR media, including the design of 3D models and user interfaces. 3) Development: Building the 3D models and integrating them into the AR system, ensuring functionality and user-friendliness. 4) Implementation: Deploying the system in a real-world setting for users to test and experience. And 5) Evaluation: Assessing the system's performance, identifying areas for improvement, and ensuring that it meets user expectations. This model ensures that the system is well-designed, thoroughly tested, and aligned with the needs of the users.

4) Elements of the Equipment Borrowing Service key elements include 3D Model Visualization via AR, enabling users to view realistic representations of equipment through their devices. QR Code Integration, which simplifies access to AR content and makes the process more efficient. Improved Understanding of Equipment Usage, as the detailed 3D models and interactive displays provide students with better insights into how to use the equipment. Interactive Information Display, allowing users to engage with the content dynamically. Minimized Physical Equipment Handling, reducing the likelihood of damage to real devices. Improved Learning Process, as students can learn about the equipment in a more engaging and interactive way. And Enhanced User Experience, which makes the borrowing process more intuitive and enjoyable.

The second phase involves assessing the quality of the quality of 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program. This is conducted through in-depth interviews with 3 experts specializing in multimedia and information technologies. The process includes detailed

reviews of the steps and methodologies applied during development. Experts evaluate the system using a 5-point Likert scale to determine its alignment with 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program. Basic statistical methods, such as mean and standard deviation calculations, are employed to analyze the feedback from expert evaluations. The quality of the system is evaluated based on ISO 9241-210 focuses on user ease of use, convenience, and satisfaction. 1) Design quality: The scanned object or model is clear, the objects themselves are realistic and interesting, Objects can provide a unique experience from use, The object is easy to use and consistent in use and the objects themselves can help increase awareness and understanding of equipment. 2) Content quality: The content of the object is accurate and reliable, the content of the object is clear and easy to understand, the amount of content conveyed is appropriate, the ordering of content is appropriate and The content of the object can help increase awareness and understanding of the device. Data collection involves expert reviews. Evaluation tools is questionnaires.

The third phase evaluates the satisfaction of the sample group with 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program. The sample comprises 30 undergraduate students from the Bachelor of Science program in Applied Computer Science-Multimedia, selected through voluntary participation. A 5-point Likert scale is used to measure their satisfaction levels regarding the AR media. Basic statistical analyses, including mean and standard deviation calculations, are applied to interpret the feedback from the sample group. The survey assesses as follows 1) Satisfaction with media design: The object or model is interesting to use, The objects are realistic and easy to use, The object can provide a unique experience from its use, The objects have proper interaction and are easy to use, The objects have proper interaction and are easy to use and The object itself can help increase awareness and understanding of the device. 2) Content satisfaction: The content of the object is accurate and reliable, the content of the object is clear, concise and easy to understand, the amount of content conveyed is appropriate, the content order is appropriate and The content of the object can help increase awareness and understanding of the device.

Results

3D Model

In this research, the researcher conducted an experimental process using 3D model to create a realistic 3D model that can be used effectively in the device lending system. The experimental process can be described as follows: 1) Scanning objects with a 3D scanning application on a mobile phone. The researcher began by using a 3D scanning application on a mobile phone to scan real devices used in the lending system, such as cameras or other multimedia devices. 2) Customizing and increasing the clarity of the 3D model After obtaining a basic model from the scan, the researcher imported the model file into a 3D design program to improve the quality to be clear, including editing the textures and increasing the resolution of the model to make it look more realistic and detailed.
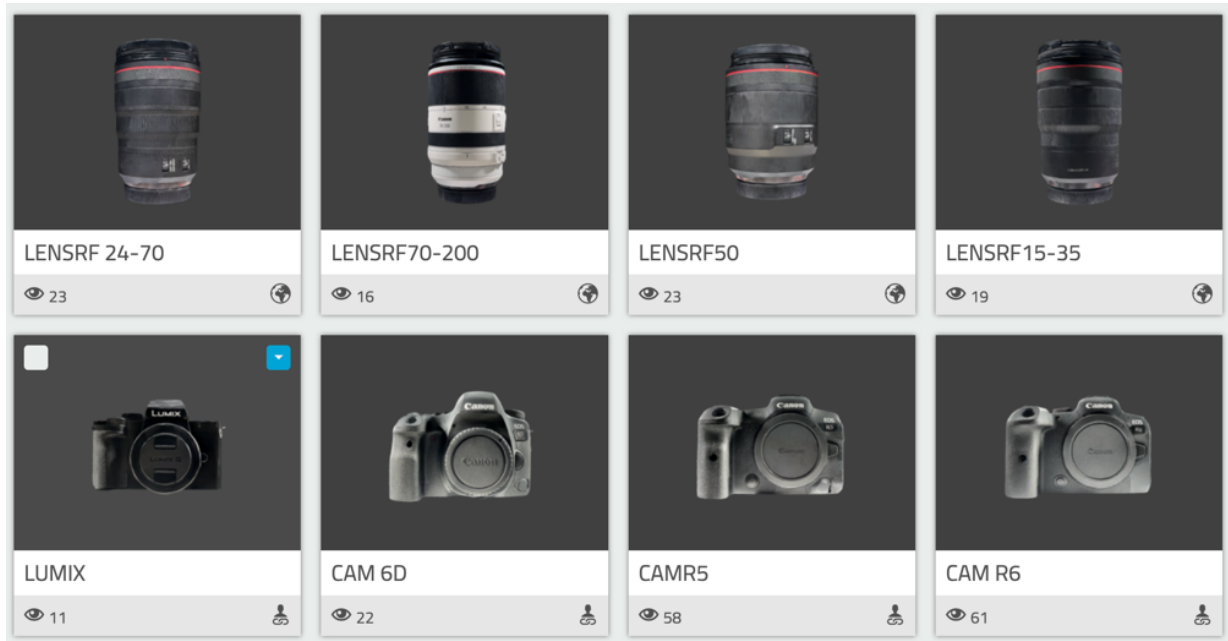
Figure 2: Images of 3D Model Scanning

Augmented Reality

In this research, the researcher conducted an experimental process using AR Augmented Reality to create a realistic AR Augmented Reality that can be used effectively in the device lending system. The experimental process can be described as follows: 1) The completed 3D model is imported into the AR application or platform to create media that displays the 3D model in augmented reality. The AR system is designed to display the 3D model through the smartphone or tablet screen, so that students can see the image realistically. 2) Linking the AR system to the QR Code The researcher created a QR Code linked to the AR model so that students can scan the QR Code and easily access the 3D model via their mobile devices. The use of QR Code reduces the complexity of access and allows students to learn about the information of the device without touching the actual device. 3) Integrating AR into the device lending system AR media is integrated into the device lending system so that students can see details such as the size, structure, and how to use the device before borrowing it, which will help students understand the device more clearly, reduce errors in use, and reduce damage to the actual device.

Figure 3: Images of Augmented Reality Scanning

Results of Media Quality Assessment

The results of media quality assessment by 3 experts in the field of Development of the 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program are as follows:

Table 1: The Results of Media Quality Assessment

Item	Quality assessment level		
	X	**S.D.**	**Interpretation**
Design quality			
The scanned object or model is clear.	4.67	0.58	very good
The objects themselves are realistic and interesting.	4.33	0.58	good
Objects can provide a unique experience from use.	4.33	0.58	good
The object is easy to use and consistent in use.	4.00	0.00	good
The objects themselves can help increase awareness and understanding of equipment.	5.00	0.00	very good
Content quality			
The content of the object is accurate and reliable.	5.00	0.00	very good
The content of the object is clear and easy to understand.	4.67	0.58	very good
The amount of content conveyed is appropriate.	4.00	0.00	good
The ordering of content is appropriate.	4.33	0.58	good
The content of the object can help increase awareness and understanding of the device.	5.00	0.00	very good
Total	**4.53**	**0.51**	**very good**

From Table 1, The result of overall quality of the media is at a very good level. The mean was 4.53 and the standard deviation was 0.51. When considering each topic, it was found that the topics The objects themselves can help increase awareness and understanding of equipment, The content of the object is accurate and reliable, the content of the object can

help increase awareness and understanding of the device had a very good level of quality. The mean was 5.00 and the standard deviation was 0.00. Topics: The scanned object or model is clear; the content of the object is clear and easy to understand. The quality level is very good. The average is 4.67, the standard deviation is 0.58. The objects themselves are realistic and interesting, Objects can provide a unique experience from use, The ordering of content is appropriate has a good quality level. The topic has a mean of 4.33 and a standard deviation of 0.58. The object is easy to use and consistent in use, The amount of content conveyed is appropriate has a mean of 4.00 and a standard deviation of 0.00.

Results of Satisfaction Assessment

The Assessment of satisfaction with 3D Augmented Reality Media for Equipment Borrowing Service of Undergraduate Students in Applied Computer Science-Multimedia Program by 30 undergraduate students in the Bachelor of Science program, Applied Computer Science-Multimedia by voluntary selection method are as follows:

Table 2: The Results of Satisfaction Assessment of Students

Item	Satisfaction assessment level		
	X	S.D.	Interpretation
Satisfaction with media design			
The object or model is interesting to use.	4.73	0.45	highest
The objects are realistic and easy to use.	4.77	0.43	highest
The object can provide a unique experience from its use.	4.70	0.47	highest
The objects have proper interaction and are easy to use.	4.60	0.56	highest
The object itself can help increase awareness and understanding of the device.	4.67	0.55	highest
Content satisfaction			
The content of the object is accurate and reliable.	4.87	0.35	highest
The content of the object is clear, concise and easy to understand.	4.57	0.57	highest
The amount of content conveyed is appropriate.	4.70	0.53	highest
The content order is appropriate.	4.57	0.57	highest
The content of the object can help increase awareness and understanding of the device.	4.73	0.52	highest
Total	**4.69**	**0.50**	**highest**

From Table 2, The result of overall satisfaction is at the highest level with an overall mean of 4.69 and a standard deviation of 0.50. When considering each topic, it was found that the topic The content of the object is accurate and reliable had a highest level of satisfaction. Has a mean of 4.87 and a standard deviation of 0.35. Topic: The objects are realistic and easy to use. There is a highest level of satisfaction. The average was 4.77 and the standard deviation was 0.43. The topic the object or model is interesting to use had a highest level of satisfaction. The mean was 4.73 and the standard deviation was 0.45. The topic the content of the object can help increase awareness and understanding of the device had a highest level of satisfaction. The average was 4.73 and the standard deviation was 0.52. The object can provide a unique experience from its use had a highest level of satisfaction. The mean was

4.70 and the standard deviation was 0.47. The topic the amount of content conveyed is appropriate had a highest level of satisfaction. The average was 4.70 and the standard deviation was 0.53. The topic the object itself can help increase awareness and understanding of the device had a highest level of satisfaction. has a mean of 4.67 and a standard deviation of 0.55. The topic the objects have proper interaction and are easy to use has a highest level of satisfaction. It has a mean of 4.60 and a standard deviation of 0.56. And the topic the content of the object is clear, concise and easy to understand, the content order is appropriate had the highest level of satisfaction. has a mean of 4.57 and a standard deviation of 0.57.

Discussion and Conclusion

This research aims to address the challenges associated with the equipment borrowing process for undergraduate students by developing a 3D Augmented Reality (AR) media system. The project integrates 3D models into an AR application to enhance students' understanding of the equipment through detailed visual representation, minimizing the reliance on physical handling. By leveraging AR technology, students can interact with accurate 3D visualizations of the equipment, which helps bridge the gap between theoretical knowledge and practical usage without the risk of damaging real equipment.

The system incorporates QR codes as an easy access point to the AR media. Students can scan these codes using their mobile devices, instantly displaying the 3D models on their screens. This approach not only simplifies the process of learning about the equipment but also fosters a more interactive and engaging learning environment. Additionally, the system serves as a valuable tool for decision-making during the borrowing process, enabling students to better understand the functionality and specifications of each piece of equipment before physical use.

To ensure the practicality and effectiveness of the system, the 3D models were created using advanced 3D scanning technology to achieve high accuracy and realism. The quality of the AR media was evaluated by a panel of expert professors, ensuring it meets educational standards. A user satisfaction study was conducted with a group of 30 undergraduate students selected through simple random sampling. The evaluation focused on both the quality of the AR media and its usability in improving the equipment borrowing process.

The findings indicated that the AR system significantly enhanced the borrowing service, providing students with a better understanding of the equipment while reducing the risk of misuse and damage. Moreover, the interactive nature of the AR media encouraged higher engagement and satisfaction among users. The research demonstrates that 3D AR media is not only an effective educational tool but also a practical solution for resource management in educational institutions.

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