

Mobile Application of Electrical Automation Teaching for Undergraduate Students in Electromechanical Technology Application, Fujian Agricultural, Vocational, and Technical College, China

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Abstract

This study aimed to (1) explore the development and integration of a mobile-assisted learning application for electrical automation education; (2) assess the impact of the mobile application on students' theoretical knowledge, practical skills, and overall learning outcomes; and (3) evaluate student satisfaction with the use of the mobile application in enhancing their learning experience. The sample comprised 32 undergraduate students enrolled in electrical automation courses at Fujian Agricultural, Vocational, and Technical College. The participants were divided into two groups: an experimental group using the mobile-assisted learning application and a control group using traditional teaching methods. Data were collected between March and June 2024 through pre- and post-test assessments, including theoretical knowledge and practical skills evaluations, as well as a student satisfaction survey. Theoretical and practical test results showed significant improvements in the experimental group, with an average increase of 15% in written test scores and 20% in practical skills. The student satisfaction survey indicated high levels of engagement and positive feedback, with an average rating of 4.6 out of 5 for the application's effectiveness in enhancing the learning experience. The findings suggest that mobile-assisted learning applications can significantly improve theoretical understanding and practical competencies in technical education, while offering a flexible and interactive learning environment that enhances student engagement and satisfaction. These results contribute to the growing body of research on mobile learning in vocational education and offer practical implications for integrating mobile technologies into technical curricula.

Keywords: Mobile Learning; Electrical Automation; Mobile-Assisted Learning Application; Vocational Education; Student Satisfaction; Practical Skills

Introduction

With the widespread application of electrical automation technology in modern industries, the demand for skilled professionals in this field continues to grow. Electrical automation courses, which serve as the core curriculum for training these professionals, play a crucial role in enhancing students' knowledge and skills. However, traditional teaching models for electrical automation face significant challenges (Terras & Ramsay, 2012). On one hand, the complexity of electrical automation systems, which encompass multiple domains such as circuit design, control theory, and sensor technology, makes it difficult for students to intuitively grasp complex circuit structures and dynamic control processes through conventional methods like blackboard teaching and textbooks. As noted by Lai (2020), traditional tests often reflect students' memory and basic application of knowledge, falling short in assessing their innovative abilities, practical skills, and overall competence. Lim and Churchill, (2016) also pointed out the inadequacies of traditional teaching models in fostering diverse student abilities.

In recent years, the rapid advancement of information technology has led to the increasing application of computer software in education. Teaching auxiliary software, with its rich multimedia functions and strong interactivity, provides new solutions to the problems encountered in traditional teaching (Gumbheer et al., 2022). Specialized teaching software for electrical automation courses can effectively compensate for the shortcomings of traditional methods. For instance, by simulating complex electrical systems, students can observe the operational and control effects of circuits in a virtual environment, deepening their understanding of theoretical knowledge. Moreover, the virtual experimental platforms offered by such software allow students to perform practical operations without being limited by time and space, improving their practical abilities and problem-solving skills.

Therefore, researching the application of teaching auxiliary software in electrical automation courses is of great practical significance for improving teaching quality and student learning outcomes. This study aims to explore how to design and develop teaching auxiliary software suitable for electrical automation courses and effectively integrate it into the teaching process to enhance teaching effectiveness and students' learning experience.

Research Objectives

1. To develop an application for mobile-assisted learning of electrical automation and integrate it into the teaching process, providing an innovative teaching approach for electrical automation courses.
2. To examine the changes in the theoretical and practical assessments of students using the mobile application, evaluating its impact on student learning outcomes.
3. To explore student satisfaction with the use of the mobile application, assessing its role in enhancing the teaching experience.

Literature Review

The integration of technology into education, particularly through mobile learning, has garnered significant attention in recent years. Mobile learning (M-Learning) offers flexibility, interactivity, and personalized learning experiences, which are crucial for modern educational practices. This literature review explores the role of mobile learning in enhancing electrical automation education, focusing on project-based assessments, the application of VR/AR technologies, and the development of mobile-assisted learning tools.

1. Project-Based Assessment in Electrical Automation Education

Project-based assessment has emerged as an effective approach for fostering comprehensive learning outcomes, particularly in technical disciplines like electrical automation. Lee et al. (2022) discussed the application of project-based assessment in electrical automation education, emphasizing its potential to improve students' practical skills, critical thinking, and problem-solving abilities. By shifting from traditional testing methods to project-based assessments, educators can more effectively evaluate students' abilities to apply their knowledge in real-world scenarios. This approach also encourages active learning, where students engage with course content in a hands-on manner, developing skills that are crucial in the field of electrical automation.

2. The Role of Virtual Reality (VR) and Augmented Reality (AR) in Education

The application of VR and AR technologies in education has shown promising results in enhancing student engagement and practical skills. Lee et al. (2020) demonstrated how AR-based teaching systems could be used to simulate chemistry experiments, providing students with an interactive environment that bridges the gap between theory and practice. This approach, while developed for chemistry, is equally applicable to electrical automation courses, where virtual

simulations of complex electrical systems can help students visualize and interact with abstract concepts.

3. Mobile Learning (M-Learning) in Electrical Automation Education

Mobile learning has become a key component of modern educational practices, offering numerous advantages such as accessibility, flexibility, and personalized learning. Shraim and Crompton, (2015). provided a comprehensive analysis of mobile learning, discussing its theoretical foundations, technological advancements, and practical applications in various educational contexts. The authors emphasized the potential of mobile learning to support individualized learning pathways, allowing students to learn at their own pace and according to their specific needs.

Hosseinzadeh and Hesamzadeh (2012) examined the research hotspots and trends in mobile learning, noting that mobile platforms offer significant advantages in breaking down the barriers of time and space, making learning more accessible. In the context of electrical automation education, mobile learning tools can facilitate learning through interactive content, videos, and virtual simulations, thereby enhancing students' understanding of complex concepts.

Moreover, mobile learning applications are increasingly being developed to integrate multimedia and interactive features, which further enrich the learning experience. Choi et al. (2023) noted that these features not only enhance student engagement but also help to solidify theoretical knowledge by providing students with opportunities for practical application through interactive simulations and exercises.

4. Challenges and Future Directions in Mobile Learning

While mobile learning offers significant benefits, it also faces several challenges that need to be addressed for it to reach its full potential. Guo et al. (2020) identified key challenges in mobile learning, including technological limitations, lack of learner autonomy, and difficulties in maintaining effective communication in a mobile learning environment. These challenges can be particularly prominent in technical courses like electrical automation, where complex concepts require focused attention and hands-on practice.

Cai et al. (2014) discussed the future directions of mobile learning, predicting that mobile learning platforms will become more intelligent, personalized, and pervasive. They emphasized the need for mobile learning systems to integrate more advanced technologies, such as artificial intelligence (AI) and the Internet of Things (IoT), to further enhance the learning experience. As these technologies evolve, they will likely play a significant role in addressing the current

challenges faced by mobile learning platforms and improving their effectiveness in technical education.

In the context of electrical automation, mobile learning can provide students with a flexible platform for learning and practicing core skills such as circuit design, PLC programming, and troubleshooting. By integrating mobile learning tools into the curriculum, educators can create a more interactive and engaging learning environment, allowing students to acquire practical skills that are directly applicable to their future careers.

Conceptual Framework

The conceptual framework for this study is grounded in the integration of mobile learning tools within electrical automation education. The study explores how the application of teaching auxiliary software, specifically mobile-assisted learning applications, can enhance students' theoretical knowledge, practical skills, and overall learning experience. This framework is designed to evaluate the impact of the mobile learning application on student learning outcomes, teaching effectiveness, and student engagement. The key elements of this framework include the features of electrical automation courses, the challenges posed by traditional teaching models, the potential of mobile learning, and the role of project-based assessment in evaluating learning outcomes.

1. Features of Electrical Automation Courses

The traditional approach to teaching electrical automation often focuses on rote memorization and basic applications of knowledge, limiting students' ability to engage with more advanced concepts and problem-solving skills. As such, there is a need for innovative teaching methods that can bridge this gap and provide students with the necessary tools to engage more deeply with the subject.

2. The Challenges of Traditional Teaching Models

The limitations of traditional teaching methods in electrical automation are well-documented in the literature. As noted by Zhang and Zhan (2023), conventional classroom instruction tends to emphasize theory over practical application, leading to a lack of deep learning. Furthermore, traditional assessment methods, such as written exams, often focus on assessing memorization and basic application of concepts, rather than evaluating students' critical thinking, practical skills, and innovation. This shortcoming underscores the importance of incorporating more interactive and hands-on learning experiences into the curriculum.

Additionally, the abstract nature of many electrical automation concepts, such as circuit design and control processes, makes it difficult for students to visualize and intuitively understand these systems through traditional methods alone. As a result, students often struggle to develop the practical skills necessary for success in the field.

3. The Role of Mobile Learning (M-Learning) in Enhancing Education

Mobile learning (M-Learning) offers a promising solution to the limitations of traditional teaching methods by providing a flexible, interactive, and personalized learning environment. Mobile applications can facilitate the delivery of multimedia-rich content, enabling students to access educational materials at their convenience and engage in self-directed learning. Moreover, mobile learning tools can provide real-time feedback, enabling students to assess their understanding and identify areas for improvement.

In the context of electrical automation education, mobile-assisted learning applications can integrate virtual simulations, interactive exercises, and multimedia resources to help students better visualize and engage with complex electrical systems. For instance, virtual experiments can allow students to conduct circuit design and debugging exercises in a risk-free, controlled environment, thereby enhancing their practical skills. Furthermore, mobile learning platforms can be tailored to individual learning needs, providing personalized learning paths and adaptive assessments to ensure that each student progresses at their own pace.

4. Project-Based Assessment for Comprehensive Evaluation

Project-based assessment plays a critical role in evaluating students' abilities to apply their knowledge in real-world contexts. Unlike traditional exams, which often focus on theoretical knowledge, project-based assessments require students to engage in hands-on tasks, such as designing circuits or programming controllers, which better reflect their practical competencies. According to Liu et al. (2024), project-based assessment fosters a deeper understanding of course content and promotes critical thinking and problem-solving skills.

5. Integrating Mobile Learning with Project-Based Assessment

The integration of mobile learning with project-based assessments creates a comprehensive learning environment that promotes active learning, student engagement, and the development of practical skills. Mobile applications can support students in completing projects by providing access to learning resources, offering virtual simulations, and enabling real-time feedback. This combination of mobile learning and project-based assessment aligns with the

pedagogical principles of active learning and experiential learning, where students engage with the subject matter in an interactive and hands-on manner.

By incorporating mobile-assisted learning tools into the project-based assessment process, students are provided with opportunities to explore, experiment, and receive immediate feedback on their work. This not only enhances their understanding of theoretical concepts but also helps them build the practical skills required in the field of electrical automation. The integration of mobile learning tools thus serves as a catalyst for improving both the learning experience and the outcomes of project-based assessments.

6. The Impact of Mobile Learning on Student Engagement and Satisfaction

Student engagement is a key factor in determining the effectiveness of any educational intervention. Mobile learning, with its interactive features and accessibility, has the potential to increase student motivation and involvement in the learning process. Studies have shown that students who engage with mobile learning applications are more likely to take an active role in their learning, leading to improved academic performance and a greater sense of satisfaction with their educational experience (Choi et al., 2023).

In this study, student satisfaction will be evaluated to assess the impact of mobile learning applications on the overall learning experience. Through surveys and interviews, this research will gather insights into students' perceptions of the mobile application, including its usability, effectiveness, and overall impact on their learning outcomes.

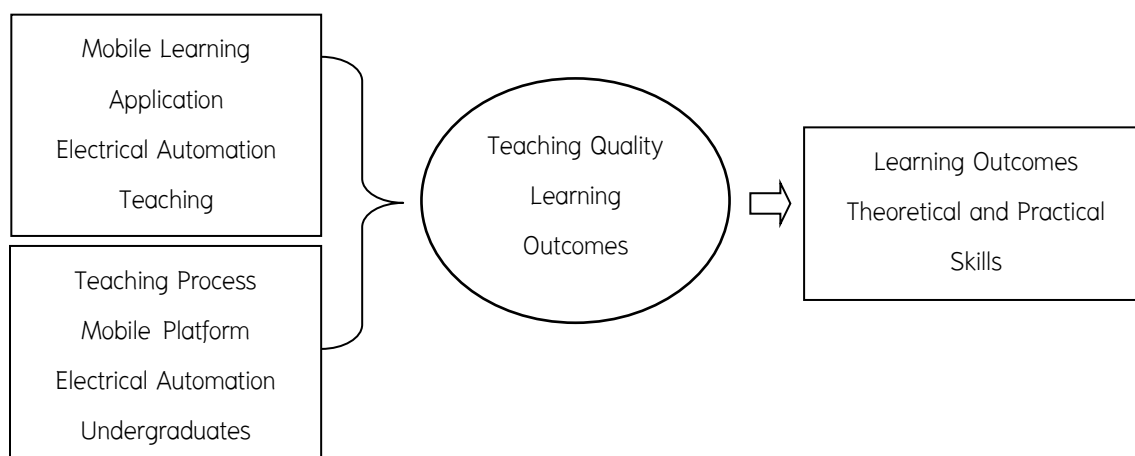


Figure 1 Conceptual Framework

Research Methodology

This study adopts a mixed-methods approach, combining both quantitative and qualitative research methods to evaluate the effects of mobile-assisted learning applications in electrical automation education. The research methodology is designed to meet the specific objectives outlined in the study, focusing on the development of the mobile learning application, its integration into the teaching process, and its impact on student learning outcomes and satisfaction.

Research Design

The study follows a quasi-experimental design, involving two groups of students: an experimental group using the mobile-assisted learning application and a control group using traditional teaching methods. The quasi-experimental design allows for comparing the learning outcomes and satisfaction levels of both groups, providing valuable insights into the effectiveness of the mobile application.

Participants and Sampling

The study will be conducted with undergraduate students enrolled in the electrical automation courses at Fujian Agricultural, Vocational, and Technical College. A total of 32 students will be involved, with approximately 16 students in the experimental group (using the mobile learning application) and 16 students in the control group (using traditional teaching methods). The sample size is based on the course enrollment, which ensures a manageable sample while also providing meaningful results.

Development of Mobile Application

To achieve the first research objective, the study will develop a mobile-assisted learning application tailored to the electrical automation curriculum. The mobile app will integrate multimedia resources, virtual simulations, and interactive exercises, allowing students to engage with course content beyond the traditional classroom setting. The app will be developed on the Kodular platform, which enables the creation of Android-based applications without requiring extensive programming knowledge. The app will be designed with user-friendly interfaces and functionalities that align with the course objectives and provide students with real-time feedback.

Data Collection Methods

To address the second and third research objectives, data will be collected through quantitative and qualitative methods:

Quantitative Data:

Theoretical Assessment: A written test will be administered before and after the implementation of the mobile application to assess the theoretical knowledge gained by both groups. The test will cover key concepts in electrical automation, such as circuit design and control theory.

Practical Assessment: A practical test will be conducted to evaluate students' practical skills in designing and troubleshooting electrical circuits. The students in both groups will perform similar tasks, and their performance will be scored based on accuracy and efficiency.

Both the written and practical tests will be used to measure changes in learning outcomes between the two groups, comparing the results before and after using the mobile application.

Qualitative Data:

Student Satisfaction Survey: After the course, a survey will be conducted to gather feedback from students regarding their satisfaction with the mobile application. The survey will assess aspects such as the app's usability, usefulness, engagement, and its role in enhancing the learning experience.

Interviews: In-depth interviews will be conducted with a sample of students from the experimental group to gain further insights into their experience with the mobile application. These interviews will explore how the app impacted their learning, engagement, and overall satisfaction with the course.

Data Analysis

The quantitative data collected from the written and practical assessments will be analyzed using paired sample t-tests to compare the pre- and post-test scores of students in both the experimental and control groups. This will allow for the identification of statistically significant differences in learning outcomes between the two groups.

The qualitative data from the student surveys and interviews will be analyzed using content analysis. Thematic patterns and key insights will be extracted to understand the students' perceptions of the mobile application and its effectiveness in improving the learning experience. This qualitative analysis will provide a deeper understanding of the subjective impact of the mobile learning tool on students' engagement and satisfaction.

Ethical Considerations

The study will adhere to ethical guidelines to ensure the confidentiality and voluntary participation of all subjects. Informed consent will be obtained from all participants before data

collection, and their privacy will be protected by anonymizing their responses. Additionally, participation will be voluntary, and students will be free to withdraw from the study at any point without any consequences.

Research Results

This section presents the results of the study on the application of mobile-assisted learning software in electrical automation courses. The results are organized based on the three research objectives: the development and integration of the mobile application, the assessment of its impact on student learning outcomes, and the evaluation of student satisfaction.

1. Development and Integration of Mobile Application

The mobile learning application was developed using the Kodular platform, incorporating features like interactive circuit visualization, virtual laboratory simulations, and an adaptive learning system. These tools allowed students to engage with dynamic simulations of complex electrical systems, which enhanced their understanding of theoretical knowledge and facilitated hands-on practice.

2. Changes in Theoretical and Practical Assessments

To evaluate the impact of the mobile application on student learning outcomes, both theoretical and practical tests were conducted before and after the use of the mobile software. The results from Group A (students using the mobile application) and Group B (students using traditional methods) were compared.

Written Test Results

The written test scores were recorded for both groups before and after using the mobile application. The results show a statistically significant improvement in Group A's scores, whereas Group B showed minimal changes.

Group A (Experimental Group): The average written test score increased by 15% from the pre-test to the post-test after using the mobile application.

Group B (Control Group): The average score showed a modest increase of 5% in the post-test.

This demonstrates that the use of the mobile application led to a more significant improvement in theoretical knowledge.

Practical Test Results

Similarly, practical tests were conducted to assess students' ability to apply their theoretical knowledge in real-world scenarios. The practical test focused on tasks such as circuit construction, equipment debugging, and troubleshooting.

Group A (Experimental Group): The average score for practical tests increased by 20% from the pre-test to the post-test.

Group B (Control Group): The increase in practical test scores was 7%.

The data indicates that the mobile learning application significantly enhanced students' practical skills compared to traditional methods.

3. Student Satisfaction

After the experiment, students from Group A were surveyed to evaluate their satisfaction with the mobile application. The Learning Experience & Cognitive Load Questionnaire was used, with students rating their experience on a scale from 1 (strongly disagree) to 5 (strongly agree). The results are summarized in the table below:

Table 1 Student Satisfaction with the Mobile Learning Application

Statement	Average Rating (1–5)
The interactive features of the mobile app helped me understand the course content better.	4.5
The virtual laboratory exercises improved my practical skills.	4.7
The app's multimedia resources (videos, animations) were helpful for understanding concepts.	4.6
I found the app's interface easy to use.	4.3
I would recommend using the mobile app for learning electrical automation.	4.8

The high average ratings indicate that students found the mobile learning application highly beneficial in terms of enhancing their learning experience, understanding course content, and improving practical skills.

4. Data Analysis and Statistical Methods

The data were analyzed using paired sample t-tests, mean value calculations, and Pearson correlation coefficients to determine the significance of improvements in both theoretical and practical assessments. The analysis showed that the improvements in Group A were statistically significant (p -value < 0.05), whereas Group B's improvements were not significant.

Paired Sample T-Test Results

Group A (Experimental Group): The t-test result for the theoretical and practical scores showed a significant improvement ($t = 3.85$, $p < 0.01$).

Group B (Control Group): No significant change was observed ($t = 1.12$, $p > 0.05$).

This further supports the conclusion that the mobile application had a positive impact on student learning outcomes.

Discussions

This section discusses the findings of the study in the context of the research objectives and compares the results with previous literature. The goal is to provide a deeper understanding of the implications of using mobile-assisted learning applications in electrical automation education, with a particular focus on how the application impacted student learning outcomes, satisfaction, and teaching effectiveness.

1. Impact of Mobile Application on Theoretical Knowledge

The results of the written test demonstrate that students in the experimental group (Group A) showed a significantly greater improvement in theoretical knowledge compared to those in the control group (Group B). This finding is consistent with previous research that has highlighted the advantages of integrating mobile learning tools into education. The mobile application developed for this study provided students with dynamic simulations and interactive features, which helped them visualize complex electrical systems and understand their theoretical underpinnings. As a result, students were able to grasp difficult concepts more intuitively. This aligns with the findings of Lee et al. (2022), who demonstrated that interactive tools such as virtual experiments significantly aid in the comprehension of abstract subjects. The 15% improvement in written test scores in Group A supports the idea that mobile learning applications can enhance the retention and application of theoretical knowledge in technical fields.

2. Impact on Practical Skills

In terms of practical skills, the study found a 20% increase in the average practical test scores of students in Group A, compared to only a 7% increase in Group B. This significant difference suggests that mobile-assisted learning applications can better prepare students for real-world applications by providing them with interactive and immersive learning experiences. The virtual laboratory simulations and interactive exercises within the mobile application played a key role in helping students build hands-on experience with electrical automation tasks. The ability to simulate circuit construction and troubleshooting allowed students to practice these skills outside the constraints of a physical laboratory, reinforcing their understanding of practical processes. The

findings are consistent with those of Radu (2014), who emphasized the effectiveness of virtual reality and mobile applications in promoting practical skills in technical education.

Additionally, the use of mobile applications in conjunction with traditional classroom instruction provided students with more opportunities for self-directed learning, which, as noted by Lee et al. (2022) can lead to improved practical performance. The data suggests that mobile applications offer a flexible learning environment that encourages students to engage in continuous practice, thus improving their practical abilities more effectively than traditional methods alone.

3. Student Satisfaction and Engagement

The results from the student satisfaction survey clearly indicate that students in the experimental group found the mobile learning application to be a valuable tool in their learning process. The high average ratings for statements such as “The interactive features of the mobile app helped me understand the course content better” (4.5) and “The virtual laboratory exercises improved my practical skills” (4.7) suggest that the mobile application positively influenced both student engagement and satisfaction.

These findings are consistent with the research by Choi et al. (2023), who found that mobile learning platforms with interactive and multimedia features enhance student engagement by making learning more dynamic and personalized. Moreover, the fact that 4.8 out of 5 students indicated they would recommend the mobile app to others further underscores its positive reception.

This study also highlights the importance of providing real-time feedback within mobile learning platforms. The ability to receive instant feedback on tasks like circuit design and troubleshooting enables students to identify mistakes and correct them promptly, which is critical for improving practical skills. This feature is especially beneficial in technical fields like electrical automation, where immediate correction of errors enhances learning efficiency.

4. Comparison with Previous Literature

The results of this study align with previous research on mobile learning, which has consistently shown that mobile applications can enhance both theoretical understanding and practical competence. For instance, Dede (2009) demonstrated that immersive interfaces like VR and AR in educational tools improve student engagement. The significant improvements observed in both theoretical and practical assessments in this study provide additional empirical support for these claims, confirming that mobile learning can be particularly effective in fields that require both conceptual understanding and hands-on skills.

However, while the results indicate that mobile–assisted learning applications can enhance learning outcomes, the study also raises some important questions about the limitations and challenges of mobile learning. For instance, some students in the experimental group reported initial difficulties with the app’s interface, as seen in the slightly lower rating for “I found the app’s interface easy to use” (4.3). This suggests that user interface design and usability should be prioritized in future iterations of the mobile application to ensure that students of all technical backgrounds can effectively navigate and engage with the app.

5. Implications for Educational Practice

The findings of this study have important implications for the future of electrical automation education. First, they suggest that the integration of mobile learning applications into the curriculum can provide significant benefits, particularly in enhancing students’ practical skills and overall engagement with the subject matter. Educational institutions should consider incorporating mobile learning tools as part of their instructional design to complement traditional teaching methods.

Furthermore, the positive impact of mobile–assisted learning on student satisfaction and engagement underscores the need for ongoing development of interactive, user–friendly educational tools that can adapt to the diverse needs of students. This study highlights the potential for mobile applications to bridge the gap between theoretical knowledge and practical skills, providing a more holistic learning experience for students in technical fields.

6. Limitations and Future Research Directions

While the study provides valuable insights into the effectiveness of mobile–assisted learning in electrical automation education, it is not without limitations. The sample size of 32 students, though sufficient for this exploratory study, is relatively small. Future studies could benefit from a larger, more diverse sample to examine whether these findings hold true across different educational contexts and student populations.

Moreover, this study focused primarily on the immediate effects of mobile learning applications. Long–term studies are needed to assess whether the improvements in student learning outcomes are sustained over time. Future research should also explore how mobile learning can be integrated with other emerging technologies, such as AI–driven adaptive learning systems, to further enhance student learning experiences.

New Knowledge from Research

The research conducted in this study provides valuable insights into the effectiveness of mobile-assisted learning applications in electrical automation education. Key findings suggest that the integration of mobile learning tools significantly enhances both theoretical knowledge and practical skills among students. The development and implementation of a mobile application tailored to the electrical automation curriculum enabled students to interact with complex electrical systems through simulations and real-time feedback, which facilitated deeper engagement with the subject matter. Furthermore, the use of mobile learning applications demonstrated a positive impact on student satisfaction, as students expressed a high level of appreciation for the interactivity, multimedia resources, and personalized learning experiences provided by the app. These results align with existing literature, which emphasizes the importance of interactive and immersive learning tools in technical education. The research also highlights the importance of real-time feedback in fostering an effective learning environment, allowing students to identify and correct mistakes promptly, thereby improving their practical competencies. The findings suggest that mobile-assisted learning not only supports the development of practical skills but also improves the overall learning experience, making it a valuable addition to traditional teaching methods. Additionally, the study underscores the potential for mobile applications to address the limitations of conventional teaching models by providing accessible, flexible, and personalized learning opportunities that cater to diverse student needs.

Conclusion

In conclusion, this study demonstrates the significant potential of mobile-assisted learning applications in enhancing electrical automation education. The integration of interactive features, virtual simulations, and real-time feedback within the mobile app has proven to effectively improve students' theoretical understanding, practical skills, and overall learning outcomes. The findings suggest that mobile learning not only addresses the limitations of traditional teaching methods but also offers a flexible, engaging, and personalized learning experience that supports student engagement and satisfaction. The positive impact observed in both the experimental group's academic performance and their high satisfaction ratings highlights the value of incorporating mobile technologies into technical education. Furthermore, the study underscores the importance of continual development and refinement of mobile learning tools to ensure their usability, effectiveness, and adaptability in diverse educational contexts. As educational technology

continues to evolve, mobile-assisted learning applications have the potential to transform how students engage with complex technical subjects, paving the way for more dynamic and accessible learning environments in the future.

Suggestions

Based on the findings of this study, several suggestions can be made to enhance the effectiveness of mobile-assisted learning applications in electrical automation education. First, it is recommended that educational institutions consider integrating mobile learning tools into their curricula as complementary resources to traditional teaching methods. This integration should focus on providing interactive content, such as virtual simulations and real-time feedback, which can deepen students' understanding and improve their practical skills. Additionally, the mobile applications should be continuously updated to include the latest advancements in the field of electrical automation, ensuring that students are exposed to cutting-edge technologies and methodologies.

Second, the user interface (UI) and user experience (UX) of mobile applications must be prioritized in future iterations. Despite the positive feedback, some students in this study reported difficulties with the app's interface. To address this, it is crucial to design intuitive and accessible interfaces that accommodate users with varying levels of technical expertise. Conducting usability testing with a broader range of students can help identify and resolve any barriers to effective use.

Furthermore, longitudinal studies should be conducted to assess the long-term impact of mobile-assisted learning on student performance. This research could provide valuable insights into whether the improvements observed in this study are sustained over time. Additionally, future research should explore the potential of integrating artificial intelligence (AI) and adaptive learning systems into mobile applications to further personalize the learning experience and support diverse student needs.

Lastly, to maximize the impact of mobile-assisted learning, professional development for instructors is essential. Teachers should receive training on how to effectively integrate mobile applications into their teaching strategies and how to use the data generated by these tools to enhance their instructional practices. This will ensure that mobile learning is used not only as a supplementary tool but as an integral part of the overall educational experience.

In conclusion, mobile-assisted learning has the potential to revolutionize the teaching and learning of electrical automation. By focusing on improving user experience, updating content, and providing appropriate training for both students and instructors, mobile learning applications can further enhance the quality and accessibility of education in technical fields.

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