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PAPER

Evaluating the Practicality of Android-Based Courseware in Enhancing Electrical Circuit Proficiency among Vocational Students

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ABSTRACT

The evaluation and analysis of the practicality of Android-based courseware in enhancing vocational students' understanding of electrical circuits (EC) is the primary focus of this research. A quantitative survey-based research approach was employed, utilizing the Practicality Assessment Instrument to evaluate the practicality level of the Android-based courseware among students. The collected data will undergo statistical analysis using descriptive analysis techniques. The practicality assessment results for each aspect will be calculated as a percentage and grouped into various categories. The findings reveal a high practicality level across different aspects, namely 90.19% for Availability and Accessibility, 89.88% for Performance and Responsiveness, 86.96% for Content Compatibility and Completeness, and 90.06% for Functionality and Resource Utilization. These outcomes demonstrate that the Android-based courseware serves as a highly practical learning medium for enhancing the understanding of electrical circuits. The integration of Android-based technology in the educational environment has proven to be effective and beneficial. These findings offer valuable insights for educators, instructional designers, and stakeholders to enhance modern learning environments. Future research can further investigate the impact of Android-based courseware on learning outcomes and explore additional practical dimensions to comprehensively evaluate its effectiveness.

KEYWORDS

Android-based courseware, practicality, electrical circuit proficiency, vocational students

1 INTRODUCTION

In the Industry 4.0 era, information and communication technology (ICT) has significantly transformed education. Vocational education necessitates an innovative and effective approach to delivering course materials to students in the context

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of mastering electrical circuits [1]–[3]. The abstract nature of electrical circuit topics often poses challenges for students in understanding the subject matter. To address this issue, the integration of high-quality and adaptive learning media with technological advancements becomes crucial to enhance vocational students' comprehension of electrical circuit concepts [4]–[6]. Among the promising technologies, Android-based courseware stands out as an Android application specifically designed as a learning medium, tailored to the needs and characteristics of electrical circuit courses. Android-based courseware is equipped with a range of features and interactive content to enhance students' understanding of electrical circuits [7], [8].

In response to the demands of education in the Industry 4.0 era, the integration of technology in learning has become an increasingly prominent trend [9], [10]. Numerous innovations have been made in the development of Android-based learning media [11]–[13]. Recent studies have demonstrated the effectiveness of Android-based learning media in enhancing student mastery and engagement in learning electrical circuits [7], [14], [15]. This application offers interactive features, simulations, and multimedia content that improve conceptual understanding and motivate students in their learning process. Previous research has also provided evidence of how Android-based learning media facilitates independent and collaborative learning, expands learning accessibility, and increases student involvement and interest in studying electrical circuits [1], [15]. However, despite the mentioned advantages, a comprehensive evaluation of the practicality of Android-based courseware still needs to be conducted. Practicality refers to the extent to which a specific tool, method, or intervention can be effectively utilized or practically implemented in a real-world context according to its intended function [16], [17]. In this study, practicality pertains to the degree to which the Android-based courseware can be efficiently used by vocational students in electrical circuit courses. This evaluation is crucial to understand its practicality and sustainability as a learning medium in vocational education. Previous studies have not thoroughly investigated this practicality aspect, highlighting the significance of this research in addressing the existing knowledge gap. Hence, a distinctive advantage of this research lies in its specific evaluative approach toward assessing the practicality of Android-based courseware within the context of vocational education, particularly in comprehending abstract concepts related to electrical circuits. The Android-based courseware being studied is an Android-based application learning specifically developed for learning media in electrical circuit courses, taking into consideration the characteristics of learning materials in vocational education.

This study addresses the research question, "Is the Android-based courseware practical for enhancing mastery of electrical circuits, as assessed through the perspectives of vocational education students who are its users?" Therefore, the main objective of this research is to evaluate the practicality of Android-based courseware as a learning medium in improving vocational students' mastery of electrical circuits. Specifically, this study aims to achieve the following objectives: (1) Analyze the availability and accessibility level of Android-based courseware as a medium for learning electrical circuits; (2) Measure the performance and responsiveness of Android-based courseware in supporting the understanding and mastery of electrical circuit materials; (3) Assess the compatibility and completeness of the content on Android-based courseware in providing comprehensive and appropriate electrical circuit materials; (4) Evaluate the functionality and resource utilization of Android-based courseware as a learning medium for electrical circuits; and (5) Identify the

overall practicality level of Android-based courseware as a learning medium in improving vocational students' mastery of electrical circuits.

The results of this study are expected to yield significant benefits and contributions within the realm of vocational education and the integration of technology in learning. These include: (1) Providing comprehensive insights into the practicality of Android-based courseware as a learning medium for electrical circuits; and (2) Stimulating the development of modern and adaptive learning environments. By leveraging the potential of Android-based courseware, educational institutions can incorporate technology, thus enhancing student interest and motivation in studying electrical circuits; (3) Offering guidance to educators and instructional designers in selecting appropriate instructional media; (4) Serving as a foundation for future research on the utilization of Android-based courseware and the evaluation of its effectiveness within the context of vocational education.

2 LITERATURE REVIEW

2.1 Android-based courseware

Android-based courseware refers to a learning application specifically developed as a medium for Android-based learning. This courseware is designed to provide an interactive learning experience, enabling students to engage with materials related to the concept of electrical circuits, which are inherently abstract, through their Android devices [10], [15], [18]. Abstract materials in the context of the electrical circuits course encompass intellectual and mathematical concepts lacking tangible physical forms. An illustrative instance pertains to the topic of Ohm's Law, a fundamental principle within electric circuits that correlates electric current, potential difference (voltage), and resistance within a conductor. Ohm's Law stipulates that electric current maintains direct proportionality with voltage and inverse proportionality with resistance. While these concepts hold significance, their constituents remain beyond direct observability. Thus, the employment of pedagogical tools capable of elucidating these principles through tangible instances or graphical depictions is instrumental in enhancing students' comprehension of these associations. Abstract learning materials often pose challenges for students in grasping concepts without the aid of innovative and interactive learning media. Android-based courseware is specifically tailored and developed to align with the characteristics of electrical circuit learning materials [19], [20]. It offers innovative features such as simulations, multimedia content, and interactive exercises, which enhance student understanding and engagement in the learning process [21]. With an intuitive and responsive interface, students can study independently, review challenging topics, and assess their comprehension through various activities and tests [15], [21]. Moreover, Android-based courseware ensures wider accessibility as it can be accessed from a variety of commonly used Android devices [10], [22], [23]. These advantages make Android-based courseware an appealing and effective solution for enhancing electrical circuit learning for students.

Android-based courseware consists of six main menus: (1) Basic Competencies and Competency Achievement Indicators; (2) Learning Materials; (3) Simulation; (4) Evaluation; (5) Instructions for Use; and (6) Developer Profile, as illustrated in Figure 1.

Fig. 1. Main menu in Android-based courseware for electrical circuit course

Basic competency and competency achievement indicators. This menu offers explanations of the basic competencies and competency achievement indicators for electrical circuit courses. It aims to provide students with a clear understanding of the basic competencies, competency achievement indicators, learning objectives, and criteria they need to fulfill after studying the materials provided in this courseware.

Learning materials. This menu provides comprehensive and well-structured course materials and a summary of the course materials, which are divided into three major groups of electrical circuit concepts. The learning material menu assists students in comprehending important concepts in electrical circuits through interactive explanations and simulations that facilitate the concretization of abstract materials. The layout of the learning material menu is presented in Figure 2.

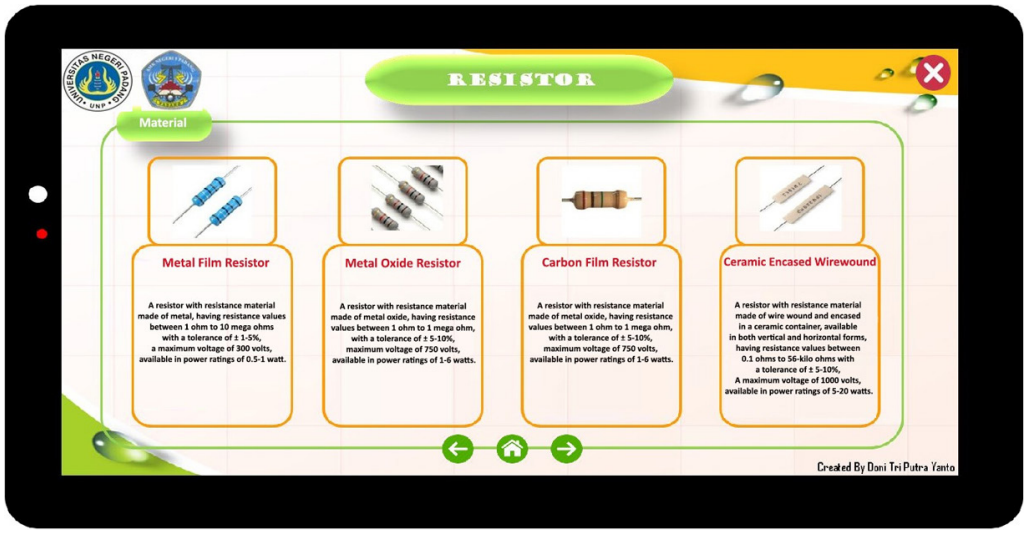

Fig. 2. The layout of the learning material menu

Simulation. This menu provides interactive simulations that enable students to engage in virtual experiments and observe the effects of altering electrical circuits. These simulations play a crucial role in enhancing students' comprehension of abstract electrical circuit concepts. An example of one of the simulations in this Android-based courseware is presented in Figure 3.

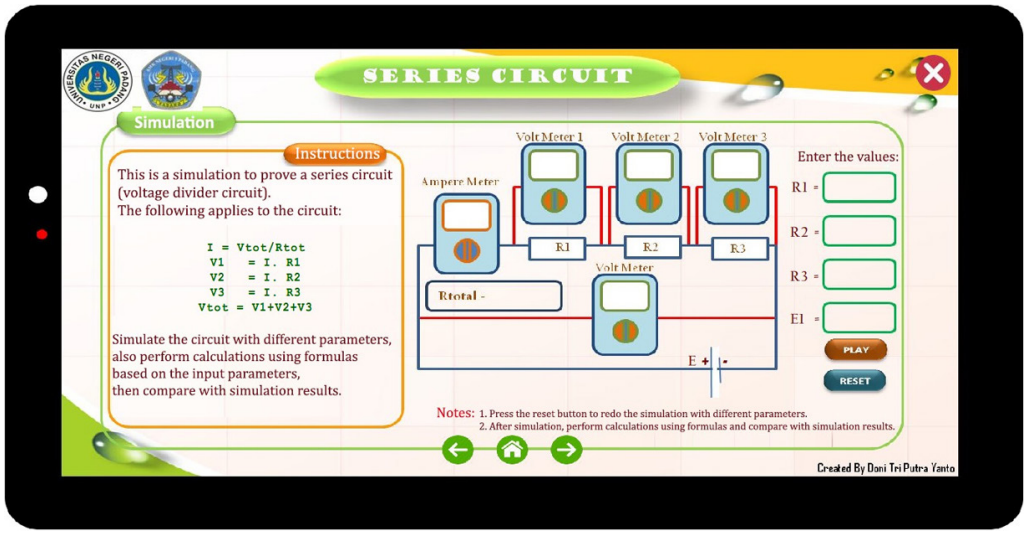

Fig. 3. The simulations in this Android-based courseware

Evaluation menu. This menu is specifically designed to assess students' understanding through a variety of questions and exercises. Students can gauge their progress and receive immediate feedback through this menu. An example of one of the evaluations in this Android-based courseware is presented in Figure 4.

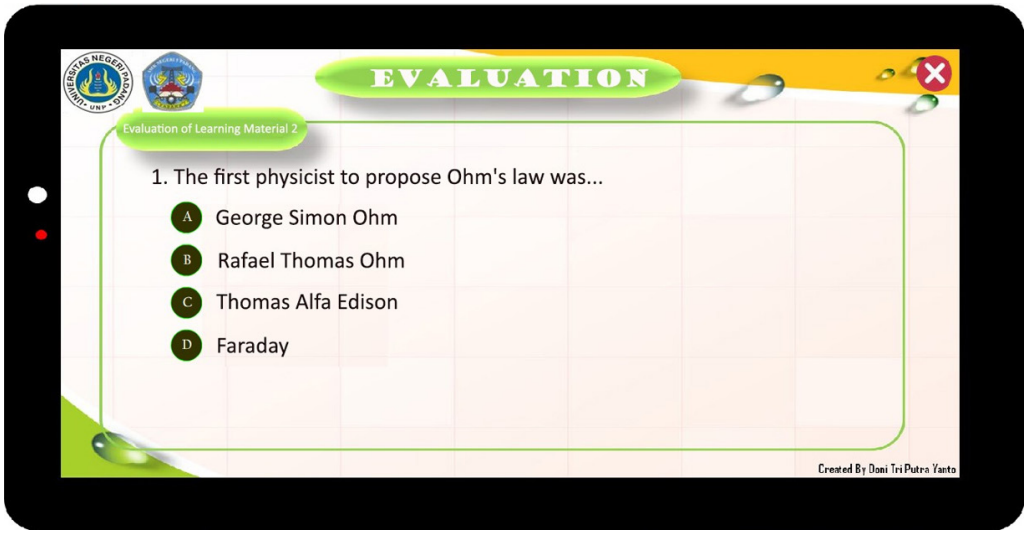

Fig. 4. The evaluations in this Android-based courseware

Instructions for use. This menu offers clear and detailed guidance on how to effectively utilize the application, enabling students to make the most of its features.

Profile. The developer presents information about the development team responsible for creating this app, including their qualifications and contact details.

This Android-based courseware provides students with a highly interactive and engaging learning experience. By integrating all the necessary features into a single application, students can conveniently access learning materials, engage in simulations, assess their understanding, and receive guidance. This significantly enhances learning efficiency and facilitates deeper comprehension of electrical circuit concepts.

Nevertheless, Android-based courseware does have some limitations. However, these shortcomings can be addressed and mitigated through proper identification

and prompt resolution. Firstly, limitations in accessibility on certain Android devices and compatibility issues with different Android versions may pose barriers for some students [15], [21]. Nonetheless, maintaining accessibility and compatibility can be achieved by establishing minimum specification requirements and regularly updating the application. Secondly, while the interactive and simulation features of Android-based courseware offer an engaging learning experience, more complex concepts in electrical circuits may require a more detailed approach or additional explanations [18], [24]. However, this can be overcome by integrating supplementary support modules or resources into the courseware, such as video tutorials or reading references. Thirdly, certain students might not have access to an Android device. As a result, educators should ascertain that all students possess Android devices before fully implementing Android-based learning media. By addressing these limitations and implementing appropriate corrective measures, Android-based courseware can effectively enhance vocational students' learning of electrical circuits.

2.2 Electrical circuit course

The electrical circuit course holds significant importance for vocational students in the field of industrial electrical engineering. Its objective is to provide a comprehensive understanding of the fundamental principles, components, and analysis of electrical circuits utilized in diverse industrial applications. Vocational students require a strong grasp of electrical circuits, as they will be involved in the installation, maintenance, and troubleshooting of electrical systems within industrial sectors [25]–[27]. However, due to the predominantly abstract nature of the course material, students may encounter difficulties in grasping these concepts without the aid of effective learning processes and resources [19], [27]. The significance of Android-based courseware in electrical circuit courses lies in its interactive, visual, concrete, and adaptable simulation capabilities [18], [24]. By utilizing Android-based courseware, students can engage in self-directed learning, accessing course materials at their convenience. This courseware provides realistic and interactive simulations, enabling students to conduct virtual experiments with electrical circuits and observe real-time outcomes. Such features enhance the learning experience, promoting active student engagement and understanding. In conclusion, Android-based courseware plays a crucial role in facilitating vocational students' comprehension of electrical circuit concepts. Its interactive and flexible nature, coupled with visual simulations, contributes to a more effective and immersive learning environment.

3 METHOD

3.1 Research design

This research is classified as a non-experimental, explanatory, and descriptive study, employing a quantitative approach [10], [21]. A survey-based quantitative research design is utilized to gather data from respondents who have utilized Android-based courseware as a learning medium for studying electrical circuits. Surveys serve as a research method capable of providing descriptive insights and investigating inter-variable influences [18], [21], [28]. By systematically collecting information by a predetermined design, the accuracy of the obtained information is ensured. This research design enables comprehensive data collection regarding the practicality of the courseware.

3.2 Research subject

This research involved 97 sophomore vocational students enrolled in the Industrial Electrical Engineering study program at the Faculty of Engineering, Universitas Negeri Padang, Indonesia. All of these students participated in both the lecture and survey phases of this study. These students utilized Android-based courseware as a learning medium during their electrical circuit courses. After the semester, the students were requested to assess the practicality level of the Android-based courseware based on their firsthand experience using it as a learning medium.

3.3 Research instrument

The instrument utilized in this study is the Practicality Assessment Instrument, which has been previously developed. The Practicality Assessment Instrument is a specialized questionnaire designed to evaluate the feasibility of a specific tool, method, or intervention, based on user feedback [16], [17]. This questionnaire gathers data regarding the practicality of a given product, device, method, or intervention from users. This instrument can make practicality-level judgments based on direct user assessments. In this study, the Practicality Assessment Instrument was a questionnaire employed to gather assessments from vocational education students regarding the level of practicality of the Android-based courseware for the electrical circuit course. This instrument comprises a set of questions employing a Likert scale, with a minimum score of "1" indicating "Strongly Disagree" and a maximum score of "5" indicating "Strongly Agree". The instrument is employed to gauge respondents' perceptions regarding the practical aspects of Android-based courseware, encompassing factors such as availability and accessibility, performance and responsiveness, content compatibility, and completeness, as well as functionality and resource usage. Table 1 presents the specific details of these aspects.

Table 1. Dimensions and indicators of research instrument

Dimensions	Theoretical Framework	Indicator
Availability and Accessibility	[14], [23]	AA.1. This application can be easily downloaded and installed. AA.2. This application can be accessed easily without significant obstacles. AA.3. This application can be accessed through various types of Android devices. AA.4. This application has an intuitive and clear installation process.
Performance and Responsiveness	[10], [18]	PR.1. This application functions flawlessly without any serious bugs or technical issues. PR.2. This application provides a fast response to user input. PR.3. This application offers a smooth and seamless user experience. PR.4. This application has satisfactory graphics and visual quality.
Content Compatibility and Completeness	[10], [18], [28]	CC.1. This application effectively supports various types of content (text, images, audio, and video). CC.2. This application presents learning content engagingly and interactively. CC.3. This application provides a sufficient variety of content to support the learning process. CC.4. This application presents content with a clear and easily understandable layout.
Functionality and Resource Usage	[10], [18]	FR.1. This application provides features that facilitate managing your study schedule. FR.2. This application utilizes Android device resources (battery, memory) efficiently. FR.3. This application offers the option to store and access content offline. FR.4. This application includes features that foster collaboration and interaction among users.

Before utilization, this research instrument underwent testing with 30 students who were not part of the main research subjects. Subsequently, the research instrument underwent analysis to assess its validity and reliability. Validity was assessed through Pearson Product Moment Correlation analysis, while reliability was evaluated using Cronbach's Alpha reliability analysis. The results of the validity analysis revealed that the r-count value for all indicators exceeded the r-table value (> 0.361) at a degree of freedom (DF) of 28, with significance values below 0.05. This suggests that all indicators within this research instrument were deemed valid. The Cronbach's alpha analysis yielded a value of 0.815, surpassing the threshold of 0.60 (0.815 > 0.600), indicating that the research instrument can be considered reliable.

3.4 Data analysis techniques

The collected data will be initially analyzed using Partial Least Squares (PLS) analysis to ascertain the validity and reliability of each indicator within the variables [29], [30]. Subsequently, the data will undergo statistical analysis employing descriptive analysis techniques. The practicality assessment results for each aspect will be calculated as percentages and classified into various categories based on the practicality criteria table presented in Table 2 [10], [18]. The data analysis process will yield a comprehensive overview of the practicality level of Android-based courseware in the context of learning electrical circuits, derived from student evaluations as users.

$$P = \frac{X}{Y} \cdot 100\% \tag{1}$$

Note:

P = Practicality Score (%)

X = The score obtained from the Practicality Assessment Instrument results (1–5)

Y = The Maximum Practicality Score from the Practicality Assessment Instrument results (5)

Table 2. Practicality criteria

No	Practicality Score (%)	Criteria
1	81–100	Very Practical
2	61–80	Practical
3	41–60	Pretty Practical
4	21–40	Less Practical
5	0–20	Impractical

4 RESULTS

4.1 Partial least square analysis

PLS analysis is employed to assess the validity, reliability, and extent to which each indicator accurately represents the variable [29], [30]. The collected data obtained from the Practicality Assessment Instrument is then examined to ensure

that it fulfills the assumptions and prerequisites for the analysis. Specifically, the VIF (Variance Inflation Factor) value is utilized to determine if there is any multicollinearity issue present. The results of the Indicator VIF Values analysis are presented in Table 3. As shown in Table 3, all VIF values for each indicator are below 5 (VIF < 5), indicating the absence of multicollinearity problems.

Table 3. The indicator VIF values analysis

Indicators	VIF	Indicators	VIF	Indicators	VIF	Indicators	VIF
AA.1	1.618	PR.1	1.129	CC.1	1.458	FR.1	1.773
AA.2	1.167	PR.2	2.177	CC.2	2.762	FR.2	2.556
AA.3	2.174	PR.3	2.364	CC.3	2.776	FR.3	2.445
AA.4	3.561	PR.4	2.543	CC.4	1.998	FR.4	1.776

The analysis of indicators in PLS is referred to as the Outer Model Analysis. This analysis involves assessing indicators for convergent validity, construct reliability, average variance extracted (AVE), discriminant validity, cross-loading, and unidimensionality models [29], [30]. The indicators' ability to measure their respective variables is evaluated through Internal Consistency Reliability, which is measured using Cronbach's Alpha. Table 4 displays that Cronbach's Alpha values for each tested variable are > 0.6, indicating that all tested variables are reliable [29], [30]. Unidimensionality tests are also conducted to ensure that there are no measurement issues. According to Table 4, all constructs meet the requirements for unidimensionality as the composite reliability value exceeds 0.7. Additionally, all tested variables are deemed valid and meet the criteria for convergent validity [29], [30]. This is demonstrated by the AVE values for each variable, which are greater than 0.50, as presented in Table 4.

Table 4. The results of indicator analysis

	Cronbach's Alpha (> 0.7)	rho_A (> 0.7)	Composite Reliability (> 0.7)	AVE (> 0.5)	Internal Consistency Reliability	Undimensionalitas Model	Convergent Validity
AA	0.877	0.891	0.891	0.693	Reliable	Reliable	Valid
PR	0.790	0.819	0.879	0.701	Reliable	Reliable	Valid
CC	0.890	0.733	0.811	0.680	Reliable	Reliable	Valid
FR	0.901	0.875	0.897	0.676	Reliable	Reliable	Valid

4.2 Android-based courseware practicality analysis

The findings of the study demonstrate that Android-based courseware is highly practical in enhancing vocational students' mastery of electrical circuit concepts. In terms of Availability and Accessibility, the results indicate a score of 90.19% in the "very practical" category. This implies that the application can be easily downloaded and installed, and students can access it without significant obstacles. Consequently, learning the concepts of electrical circuits becomes more convenient. Regarding Performance and Responsiveness, the Android-based courseware achieved a score of 89.88% in the "very practical" category. This indicates that the application operates

smoothly without any major bugs or technical issues. It also exhibits fast response times to user input, enhancing efficiency and convenience during the learning process. In terms of Content Compatibility and Completeness, the results show a score of 86.96% in the "very practical" category. This demonstrates that the application adequately supports various types of content, such as text, images, audio, and video. The learning content is presented engagingly and interactively, increasing student interest and involvement in studying electrical circuits. Moreover, the content covers essential aspects of the course, ensuring comprehensive material delivery to students. In About Functionality and Use of Resources, the scores obtained were 90.06% in the "very practical" category. The application offers features that facilitate students in managing their study schedules. It also utilizes the resources of Android devices, such as battery and memory, efficiently without imposing an excessive burden on the user's device. Furthermore, the application provides storage and offline access capabilities, enabling students to access learning content without an Internet connection. Collaborative and interactive features among users are also significant additions that enhance the learning of electrical circuits. The Android-based courseware has been meticulously designed with interactive features to foster collaborative student engagement within the learning process. This interaction is facilitated through the question-and-answer feature embedded in the post-learning material discussions. Within this application, students can actively take par in online discourse revolving around educational content. They are empowered to pose inquiries, offer clarifications, and exchange insights on intricate concepts covered in the curriculum. This cultivates an environment conducive to the interchange of ideas and mutual support among peers, thereby enabling the exploration of diverse perspectives that contribute to the enhancement of collective comprehension. The results of the practicality evaluation analysis for each indicator are presented in Table 5.

Table 5. The results of the practicality evaluation analysis

Dimensions	Indicators	Mean of Practicality Score (%)	Total Mean (%)	Criteria
AA	AA.1	90.75	90.19	Very Practical
	AA.2	89.50		
	AA.3	91.50		
	AA.4	89.00		
PR	PR.1	88.50	89.88	Very Practical
	PR.2	89.50		
	PR.3	91.50		
	PR.4	90.00		
CC	CC.1	85.00	86.96	Very Practical
	CC.2	86.75		
	CC.3	89.50		
	CC.4	86.60		
FR	FR.1	89.75	90.06	Very Practical
	FR.2	88.75		
	FR.3	91.25		
	FR.4	90.50		

5 DISCUSSION

These findings indicate that Android-based courseware holds significant potential in enhancing vocational students' mastery of electrical circuit concepts. The obtained high scores for practicality in various aspects underscore the effectiveness of this application in terms of accessibility, performance, and content comprehensiveness. The interpretation of this study emphasizes the success of Android-based courseware in improving vocational students' understanding of electrical circuit concepts. The high practicality scores across multiple aspects demonstrate the application's efficacy in providing practical and efficient learning experiences. Its easy availability and accessibility enable students to effortlessly access and utilize the courseware, without encountering significant barriers. This flexibility empowers students to learn electrical circuit concepts at their convenience, anytime and anywhere.

The Android-based courseware demonstrates good performance and fast responsiveness, which significantly contributes to enhancing the mastery of electrical circuit concepts. Its minimal bugs and absence of significant technical issues allow students to focus on the learning process without distractions. The high response speed facilitates smooth interaction between students and the application, thereby expediting the understanding of the taught concepts. Additionally, the satisfying graphic and visual quality further stimulates student interest and engagement in learning. The compatibility and completeness of the Android-based courseware's content are instrumental in fostering a deeper understanding of electrical circuits. By accommodating various multimedia formats such as text, images, audio, and video, the courseware offers a diverse and interactive learning experience. The presentation of materials in an engaging and comprehensible manner increases student involvement and comprehension. The wide range of content options enables students to select a study method that aligns with their preferences and learning styles. With a clear and accessible content layout, students can easily grasp complex electrical circuit concepts. By providing practical, efficient, and engaging learning experiences, this courseware effectively aids students in comprehending and mastering the subject matter. The availability of comprehensive content, coupled with its good performance and compatibility across various Android devices, highlights its immense potential in enhancing electrical circuits.

These findings align with previous studies that have examined the utilization of technology in learning electrical circuits [12], [31], [32] These studies have consistently demonstrated a notable improvement in conceptual understanding following the use of such applications [12], [31], [32]. Additionally, some studies have revealed that the implementation of augmented reality can enhance both learning motivation and concept comprehension among students [15], [31]. Despite employing different approaches, these studies yield comparable outcomes, underscoring the engaging and interactive learning experience offered by Android-based courseware [12], [31], [32]. Moreover, research investigating the integration of mobile applications in electrical circuit instruction has yielded significant advancements in both students' conceptual mastery and their level of engagement [3], [10], [15]. This finding corresponds with the outcomes of the present study, which also highlighted an enhanced mastery of concepts and increased student involvement after the utilization of Android-based courseware.

The findings of this study are also relevant to research investigating the utilization of interactive simulations in the learning of electrical circuits. Previous studies have demonstrated that the incorporation of interactive simulations can enhance students' conceptual understanding and practical skills [3], [10], [33]. These findings

are in line with the results of our research, wherein Android-based courseware offers a simulation feature that aids students in comprehending practical aspects of electrical circuits. Furthermore, another study has compared the use of mobile applications with conventional teaching materials in the context of learning electrical circuits [11], [18], [24]. The outcomes of this study indicate that the use of mobile applications leads to a significant improvement in both concept mastery and student motivation. These findings corroborate our research results, demonstrating that Android-based courseware provides a more effective and motivating learning experience for vocational students.

6 CONCLUSION

Based on the findings of this research, it can be strongly concluded that Android-based courseware exhibits a high level of practicality in enhancing vocational students' mastery of electrical circuit concepts. This study successfully demonstrates the significant benefits offered by Android-based courseware, including improved accessibility, responsive performance, compatibility with diverse content, user-friendly functionality, and efficient resource utilization. Through this innovative approach, students can effectively and efficiently learn electrical circuits, enhance their conceptual understanding, and enrich their learning experiences. Consequently, Android-based courseware holds great potential as a practical and relevant learning medium to address educational challenges.

This research exclusively involved vocational students specializing in industrial electrical engineering as participants. Therefore, the generalization of these findings is limited to this specific population and cannot be directly extrapolated to students from other disciplines. The scope of this research solely focuses on the practicality of Android-based courseware in enhancing the mastery of electrical circuit concepts. Exploring other aspects such as learning effectiveness and its influence on student motivation and interest, can serve as intriguing avenues for future research. Furthermore, future studies should consider developing additional features for Android-based courseware, such as an automated assessment system, integration of virtual reality and augmented reality, collaboration functionalities, and a wider range of content options to further enrich students' learning experiences. Additionally, conducting longitudinal research would provide insights into the long-term impact of utilizing Android-based courseware on the mastery of electrical circuit concepts and students' academic achievements.

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