

E-NOTES Mobile App for Interactive Multimedia Learning in TVET Education

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Abstract—The rapid advancement of digital technology has transformed teaching and learning practices, especially in Technical and Vocational Education and Training (TVET). However, conventional learning methods are still less interactive and unable to fully engage students in the learning process. Therefore, this study aims to develop and evaluate the effectiveness of the E-NOTES mobile application as an interactive digital learning platform for TVET education. This study applied the ADDIE model consisting of analysis, design, development, implementation, and evaluation phases. The application integrates multimedia elements and real-time annotation features to support flexible and student-centered learning. A total of 30 Information Technology students participated as respondents in this study. Data were analyzed using descriptive statistics, paired sample t-test, and Cohen's d effect size analysis. The findings revealed significant improvements in students' interest, understanding, and interaction after using the application ($p < 0.001$). The effect size also indicated a very large practical impact on student engagement. Overall, E-NOTES has strong potential to support technology-enhanced learning and digital transformation in TVET education aligned with Industry 4.0 and 21st-century learning needs.

Keywords: Mobile Learning; TVET Education; Interactive Multimedia; Student Engagement; Digital Learning

1. INTRODUCTION

The rapid development of digital technology has significantly transformed the educational landscape worldwide. The integration of mobile technology in education has introduced new learning approaches that are more flexible, interactive, and student-centered. In line with the Industrial Revolution 4.0 (IR4.0), educational institutions are encouraged to integrate digital learning tools to improve learning quality and develop graduates equipped with technological competencies relevant to industry demands. Technical and Vocational Education and Training (TVET) institutions play a crucial role in producing skilled graduates capable of supporting technology-based industries. However, one of the major challenges faced in TVET education is maintaining students' engagement during teaching and learning sessions, especially in technical and practical subjects. Traditional teaching approaches that rely heavily on printed notes and one-way instruction are often unable to attract students' attention effectively.

Previous studies have shown that mobile learning environments can improve flexibility and accessibility in education. Behnamnia et al. (2020) stated that mobile learning applications support self-directed learning and increase student participation through flexible learning environments. Similarly, Nikolopoulou et al. (2020) found that students demonstrated positive acceptance toward mobile technologies when the applications were easy to use and aligned with learning needs.

In addition, multimedia integration has become one of the important elements in enhancing students' understanding. Kalogiannakis et al. (2021) explained that multimedia learning environments involving audio, video, and visual graphics can stimulate multiple senses simultaneously and improve cognitive processing. Nascimento and Oliveira (2022) also highlighted that visual and interactive learning materials can significantly improve students' engagement and motivation.

Despite the rapid growth of educational applications, many existing applications still focus only on static content delivery and lack interactive annotation features. This limitation reduces active interaction between students and learning materials. Furthermore, most applications do not integrate multimedia and annotation functions comprehensively within a single mobile platform. Another issue identified in TVET education is the limited availability of learning platforms specifically designed to support practical learning activities and collaborative learning environments. Students often face difficulties reviewing practical procedures and technical content independently outside classroom hours. Therefore, there is a strong need for a flexible mobile learning platform that supports multimedia integration and interactive learning activities.

To address these challenges, this study developed the E-NOTES mobile application, which integrates multimedia elements and real-time annotation functions in a single platform. The application allows students to upload and access PDF learning materials, perform annotations directly on digital notes, and interact with multimedia contents such as videos, audio, and graphics. This research contributes to the field of technology-enhanced learning in several ways. First, it integrates multimedia and annotation features into a single mobile learning application specifically designed for TVET education. Second, the study applies the ADDIE instructional design model systematically to support structured application development. Third, the effectiveness of the application is evaluated using inferential statistical analysis and effect size measurement, providing empirical evidence on its practical impact on student engagement.

Furthermore, this study supports the conference theme, "Strengthening Technology-Based Industries to Support Inclusive and Sustainable Economic Development," by contributing toward digital transformation in TVET education.

The integration of *technology-enhanced learning* applications in *TVET* institutions can help produce digitally competent graduates equipped with self-directed learning skills and technological adaptability required in modern industries.

TVET institutions are increasingly encouraged to adopt digital learning technologies to strengthen students' technological competencies and industry readiness. The use of *mobile learning* platforms in *TVET* education can support flexible learning environments, improve accessibility to learning resources, and enhance students' digital literacy skills. Furthermore, technology-enhanced learning environments are essential in preparing future graduates capable of adapting to *Industry 4.0* and sustainable economic development.

2. RESEARCH METHODS

2.1 Research Framework

This study employed a quantitative research design using a pre-test and post-test approach to evaluate the effectiveness of the E-NOTES mobile application. The study was conducted at Kolej Komuniti Arau involving 30 Information Technology students. The development of the application was based on the ADDIE instructional design model consisting of five phases: Analysis, Design, Development, Implementation, and Evaluation.

The analysis phase focused on identifying students' learning needs and challenges faced during *TVET* teaching and learning sessions. Observations and reflections from teaching experiences revealed that students had difficulties understanding technical concepts using traditional learning materials.

During the design phase, the application interface and system flow were designed to ensure usability and user-friendly interaction. Wireframes and interface layouts were created to support interactive learning experiences.

The development phase involved integrating the main features of the application, including:

- a. PDF upload and sharing
- b. Interactive annotation tools
- c. Multimedia integration (video, audio, graphics)
- d. Mobile accessibility

The application was tested to ensure functional stability and usability before implementation. The application was implemented in real classroom learning sessions involving students as active users. Students were provided with guidance on how to use the application effectively. Next the effectiveness of the application was evaluated using questionnaires based on a 5-point Likert scale. Data collected were analyzed using descriptive statistics, Cronbach's Alpha reliability analysis, paired sample t-test, and Cohen's d effect size.

2.2 Research Hypotheses

The following hypotheses were tested in this study:

H1: There is a significant difference in students' interest before and after using E-NOTES.

H2: There is a significant difference in students' understanding before and after using E-NOTES.

H3: There is a significant difference in students' interaction before and after using E-NOTES.

2.3 Research Instrument

The questionnaire instrument consisted of three main constructs:

- a. Interest
- b. Understanding
- c. Interaction

The questionnaire used a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

2.4 Sampling Technique and Ethical Consideration

Purposive sampling was used in this study because the respondents were selected based on their involvement in *TVET* learning courses and accessibility to mobile learning activities. The selected students had prior experience using digital learning tools and mobile devices in educational settings. The questionnaire instrument was reviewed and validated by subject matter experts in educational technology and *TVET* learning before implementation. Ethical considerations were also emphasized throughout the research process. Participation was voluntary, and all respondents were informed regarding the objectives of the study. Confidentiality and anonymity of respondents were maintained to ensure ethical compliance.

2.5 Data Analysis

Data analysis was conducted using:

- a. Descriptive statistics
- b. Cronbach's Alpha reliability test
- c. Shapiro-Wilk normality test
- d. Paired sample t-test
- e. Cohen's d effect size analysis

3. RESULTS AND DISCUSSION

3.1 Descriptive Analysis

The descriptive analysis showed a significant increase in students' engagement after using the E-NOTES application.

Table 1. Mean Scores Before and After Using E-NOTES

Construct	Before	After
Interest	1.40	5.00
Understanding	1.43	4.83
Interaction	1.40	4.83

The overall mean score increased from 1.41 to 4.89, indicating a very high level of acceptance toward the application. The findings suggest that the application successfully enhanced students' engagement during learning sessions. Students were more interested in participating actively due to the multimedia and annotation features integrated into the application.

3.2 Reliability Analysis

Cronbach's Alpha analysis was conducted to evaluate the reliability of the questionnaire instrument.

Table 2. Reliability Analysis

Variable	Cronbach's Alpha
Before	0.577
After	0.750

The findings indicated that the instrument had acceptable to good reliability values.

3.3 Paired Sample t-Test

Paired sample t-test analysis was conducted to determine whether there were significant differences before and after using the application.

Table 3. Paired Sample t-Test Results

Construct	t	p
Interest	39.573	<0.001
Understanding	33.063	<0.001
Interaction	30.037	<0.001

The results showed significant improvements in all constructs after using the application.

3.4 Effect Size Analysis

Table 4. Cohen's d Effect Size

Construct	Cohen's d	Interpretation
Interest	7.225	Very Large
Understanding	6.036	Very Large
Interaction	5.484	Very Large

The effect size analysis demonstrated that the E-NOTES application had a very strong practical impact on students' engagement and learning experiences.

3.5 Discussion

The findings of this study revealed that the E-NOTES mobile application significantly improved students' interest, understanding, and interaction in TVET learning environments. The integration of multimedia elements such as videos, graphics, and interactive annotations made learning sessions more engaging and student-centered. The results are consistent with previous studies by Behnamnia et al. (2020) and Kalogiannakis et al. (2021), which emphasized that multimedia-supported mobile learning environments can improve student motivation and cognitive engagement. Similarly, Nouri et al. (2023) highlighted that students' experiences with mobile learning applications are highly influenced by usability and interactivity. The implementation of annotation functions also supported active learning and independent revision among students. Students were able to highlight important information, add notes, and interact directly with learning materials. This feature is particularly beneficial in TVET education where practical and technical understanding is essential. In addition, the application supported collaborative learning through digital sharing and interaction among students. The findings suggest that technology-enhanced learning applications can improve not only learning effectiveness but also digital learning readiness among TVET students. Although the normality test indicated that the data were not fully normally distributed, the very high t-values and large effect sizes demonstrated strong evidence

regarding the effectiveness of the application. Overall, the study supports the importance of integrating interactive multimedia technologies in *TVET* education to strengthen digital learning ecosystems aligned with *Industry 4.0* requirements. The integration of annotation features enabled students to interact directly with learning materials, which promoted active learning behavior and increased engagement during learning sessions. This finding is consistent with previous research highlighting that interactive learning environments improve students' motivation and independent learning practices. In the context of *TVET* education, multimedia-supported mobile learning applications are particularly important because technical and practical subjects require visual and procedural understanding. Therefore, E-NOTES can serve as a practical digital learning solution that supports both theoretical and practical learning activities. The findings also demonstrate the importance of integrating *technology-enhanced learning* applications within *TVET* institutions to support sustainable digital transformation and strengthen industry-oriented education systems.

4. CONCLUSION

This study successfully developed and evaluated the E-NOTES mobile application for *TVET* education using the ADDIE instructional design model. The findings demonstrated significant improvements in students' interest, understanding, and interaction after using the application. Statistical analyses, including paired sample t-test and Cohen's d effect size, confirmed that the application had a significant and very large practical impact on student engagement. The integration of multimedia and annotation features within a single mobile platform contributed toward more interactive, flexible, and student-centered learning experiences. The application also supported independent and collaborative learning practices among students. The study contributes to the development of technology-enhanced learning applications in *TVET* institutions and supports digital transformation aligned with *Industry 4.0* and sustainable educational development. Future research may involve larger respondent samples, additional learning features, and integration with institutional learning management systems to further improve the effectiveness of the application. Despite the positive findings, this study has several limitations including the relatively small sample size and limited implementation scope involving only one institution. Future studies are recommended to involve multiple *TVET* institutions and incorporate additional features such as quizzes, analytics dashboards, and Learning Management System (*LMS*) integration to enhance learning effectiveness further.

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