Hybrid Learning Media Innovation: Optimization of an Interactive Digital Historical Map Application for History Education Students

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ABSTRACT

The development of digital technology encourages the need for innovation in history learning to be more interactive, contextual, and relevant to the needs of the 21st century generation. This study aims to develop and test the feasibility and effectiveness of *Interactive Digital History Map Application in* supporting history-based learning/hybrid *learning for* students of the History Education study program. The research method used is *Research and Development*(R&D) Borg & Gall model involving the stages of needs analysis, design, development, expert validation, limited trials, and field trials. The instruments used included expert validation sheets, student perception questionnaires, and learning outcome tests in the form of pre-tests and post-tests. The validation results showed that the application was very feasible to use, with the highest scores in the content and user interface aspects. Student perceptions were also very positive towards visual appearance, navigation, and content relevance. Quantitatively, the use of the application significantly improved student learning outcomes, with an average pre-test score of 61.23 increasing to 81.98 in the post-test and a score of *Normalized Gain*of 0.53. In conclusion, this application is effective in improving the quality of history learning, strengthening students' digital literacy, and is relevant to the demands of learning in the Industrial Revolution 4.0 and Society 5.0 eras.

I. Introduction

In the rapidly evolving digital era, technology has become an inseparable part of the educational landscape. The shift from conventional learning to technology-based learning is increasingly evident as the internet and educational software advance (Aggarwal et al., 2024; Bandara & Jayaweera, 2024; Miliou & Angeli, 2021; Nizami et al., 2023). One approach that is increasingly gaining attention is hybrid learning, a method that combines online and offline learning to create a more flexible and practical learning experience. In the context of history education, the main challenge often faced is how to present complex historical material in a way that makes it more interesting, interactive, and easier for students to understand (Adlemo et al., 2023; Amirova et al., 2024; Lee & Ramasamy, 2024; Tolstykh et al., 2023).

History education requires learning methods that bring past events to life for students. The lecture method, which is still widely used in history learning, is sometimes less effective at attracting students' interest (Hassan & Dietze-Schirdewahn, 2024; Reyes et al., 2024; Sembiring et al., 2024). Therefore, innovations in learning media are needed that not only present historical facts textually, but also combine various visual and interactive elements. One solution that can be implemented is the use of Interactive Digital History Maps in a hybrid learning system.

Maps are an essential tool for learning history because they provide a visual representation of historical events that occurred in different places and times. However, in practice, the use of maps in learning history remains limited to conventional forms, such as printed maps or static two-dimensional images. With the development of digital technology, it is now possible to develop historical maps in digital form that are more interactive and support hybrid learning processes.

The Interactive Digital History Map application is designed to optimize the use of technology in history learning (Menze et al., 2025; Talpur et al., 2024; Y. Zhang et al., 2024). This application integrates features such as dynamic maps, infographics, videos, and interactive quizzes that can help students understand historical concepts more comprehensively (Giachelle et al., 2024; Manke, 2022; Toktamysov et al., 2023). By using this application, students can explore historical events in

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greater depth and actively participate in the learning process.

This study focuses on the innovation of learning media in a hybrid learning system, optimizing the use of the Interactive Digital History Map application for students in history education. This study aims to explore the application's effectiveness in improving students' understanding and analytical skills of historical events. Moreover, this study will also examine the extent to which this application can improve students' learning motivation and their involvement in the learning process.

The hybrid learning method used in this study combines face-to-face meetings with digital technology to enrich students' learning experiences. In offline meetings, students can participate in discussions and critically analyze digital historical maps, while in online sessions, they can access additional materials and work on application-based exercises independently (Matkovič, 2024; Parellada & Carretero, 2022; Vetrivel & Mohanasundaram, 2024).

The advantage of this hybrid learning model is its flexibility in accommodating various student learning styles (Kurniawan et al., 2022; Liste et al., 2025; Mei & Balsiri, 2024; Ruiz, 2023). Those who are more comfortable with a visual approach can take advantage of the application's graphics and animations. At the same time, those who prefer to learn by reading can access various written sources integrated into the application. Thus, this approach is expected to increase student involvement in understanding history more comprehensively.

The use of technology in history learning also has the potential to overcome the limitations of space and time in delivering material (Liste et al., 2025; Parellada & Carretero, 2022). Through the Interactive Digital History Map application, students not only rely on lecturers' explanations in class, but can also access materials anytime and anywhere according to their needs. This aligns with the concept of student-centered learning, in which students are encouraged to become active and independent learners (Giachelle et al., 2024; Manke, 2022).

In addition to improving cognitive understanding, this innovation is expected to develop students' critical thinking skills. By presenting various perspectives on a digital historical map, students can analyze cause-and-effect relationships in a historical event, compare historical sources, and develop a more objective interpretation of history.

In the era of globalization, digital literacy is a skill that students need. The implementation of the Interactive Digital History Map in hybrid learning is not only aimed at improving historical understanding but also at developing students' technological skills. Thus, students will be better prepared to face the challenges of an increasingly technology-based world of work (Nikolakopoulou et al., 2022; Toktamysov et al., 2023).

Through this research, it is expected to identify a more effective and relevant hybrid-based history learning model as times develop. Innovation in history learning is very much needed so that this course is no longer considered boring, becomes an interesting one, and provides a meaningful learning experience.

Not only that, but the Interactive Digital History Map application also has the potential to be further developed in various other subjects that require strong visual representation, such as geography, anthropology, and other social sciences. Thus, this research also opens opportunities for the development of similar innovations in the broader field of education.

In the long term, the use of digital technology in history learning can be one strategy in facing the challenges of the Industrial Revolution 4.0 in education. Universities as higher education institutions need to continue to innovate in creating learning methods that are more adaptive to technological developments to remain relevant to the needs of the times.

This research is also part of an effort to improve the quality of history education in Indonesia. By providing a more interactive and contextual learning experience, it is hoped that students will not only understand history as a collection of facts but also connect it to the current social, political, and cultural context.

In conclusion, the innovation of hybrid learning media based on the Interactive Digital History Map is a strategic step in improving the quality of history learning in higher education. The use of technology in learning is not only intended to facilitate access to information but also to increase the appeal and effectiveness of material delivery.

With this application, history education students can have a richer and deeper learning experience. More than just reading textbooks, students can explore history in a more dynamic and participatory way.

This research contributes to the development of a more innovative, technology-based, and student-oriented model of history learning. With an optimal hybrid learning approach, it is hoped that students will be more interested and involved in learning history, so that they can understand history more critically and apply it in everyday life.

II. Method.

A. Development Models and Procedures

This research adopts a *Research and Development* (R&D) approach, drawing on the development model by Borg and Gall (2003). This model was chosen because it is well-suited to producing innovative digital learning media that can be systematically validated, tested, and

refined. The seven main stages in this study include: (1) needs analysis, (2) initial product design planning, (3) application prototype development, (4) validation by material and media experts, (5) stage I product revision, (6) limited trials (small group trial), and (7) field trials and final revisions.

B. Research Subjects and Setting

The research was conducted at STKIP Budidaya Binjai, with a focus on the History Education Study Program. The limited trial subjects involved 10 fourth-semester students who took the course, History of Indonesia During the Revolution for Independence. The field trial was conducted in a broader group of 30 students from the same class. In addition, two material experts (history lecturers) and two digital learning media experts were involved in the validation stage to assess the quality of the application's content and technical aspects. The selection of participants was carried out purposely, considering active involvement in the online learning process and basic skills in using digital devices.

C. Data Collection Techniques and Instruments

Data collection was conducted using three main techniques: expert validation, student perception questionnaires, and learning outcome tests. Validation was performed using a 5-point Likert scale-based assessment sheet, which includes two aspects: (1) material aspects to assess the suitability of application content to the curriculum, accuracy of historical data, completeness of substance, and depth of topic; and (2) media aspects to assess user interface (UI) design, navigation, multimedia integration, and visual appeal. The student perception questionnaire also used a 5-point Likert scale to assess indicators of application ease of use, digital learning experience, quality of historical content, and visual aesthetics. To determine the application's effectiveness in improving learning outcomes, pre- and post-test instruments were used, comprising 20 multiple-choice questions that had undergone content validation by experts and reliability testing. These questions were arranged based on learning achievements in the material on Indonesian history during the independence revolution and were developed to measure students' conceptual understanding and historical thinking skills.

D. Data Analysis Techniques

Data from expert validation and questionnaires were analyzed descriptively and quantitatively by calculating the average score for each indicator and category of eligibility. Student learning outcome data were analyzed using the test pairs (paired sample t-test) to determine the significance of the difference between pre-test and post-test scores, with a confidence level of 95% ($p < 0.05$). In addition, the effectiveness of improving learning outcomes is measured using the Normalized Gain (N-Gain) formula developed by Hake (1999), which is classified into low ($g < 0.3$), medium ($0.3 \leq g \leq 0.7$), and high ($g > 0.7$) categories.

III. Result And Discussion

A. Needs Analysis Stage

This study began with a needs analysis of the use of the Interactive Digital History Map Application in hybrid learning for History Education students. The results of observations and interviews with students showed that mobile device-based learning (smartphones) has high appeal and makes it easier for students to learn independently anytime and anywhere. In addition, students expressed that visual-based learning media, such as videos, interactive maps, and practice questions, are needed to improve their understanding of Spatial History material. Therefore, this study develops an application that integrates these elements in a hybrid learning system.

B. Product Design Stage (Design)

At this stage, the initial design of the Interactive Digital History Map Application was developed with two main aspects in mind: the front-end (the user interface for students) and the back-end (the dashboard for lecturers). The main features of this application include:

- Home History Material: structured historical narrative summary
- Interactive Historical Maps: spatial exploration of territories and events
- Thematic Educational Videos: visual explanations of history with narrators
- Interactive Quiz: HOTS-based practice questions
- Online Discussion Forum: for synchronous and asynchronous hybrid learning
- Visual History Gallery: historical documents, archives, and images

After completing the analysis and creation stages of the World History Map Application, the next step is to design the application. The initial design of this Android-based application is divided into two parts: the front-end design for users (students taking the World History course) and the back-end design for administrators (lecturers), which updates the application as needed. The initial description of the application design is shown in Figures 1 and 2.

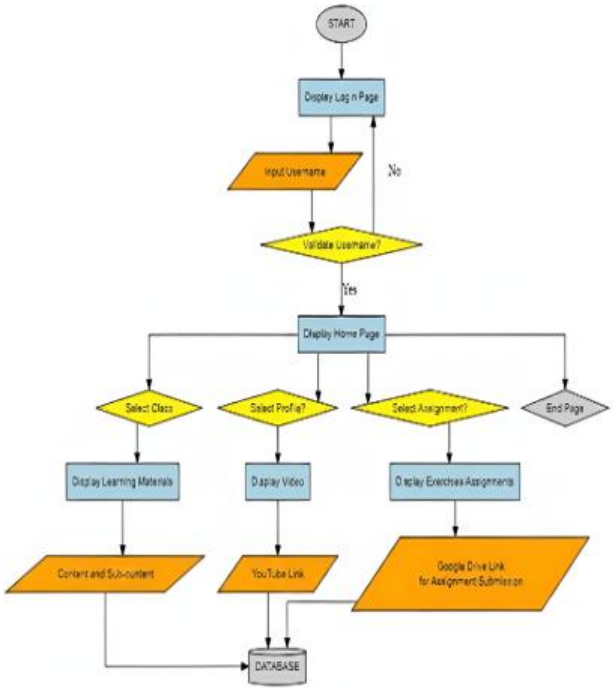

Fig. 1. Initial design of the application for the Front-end (User)

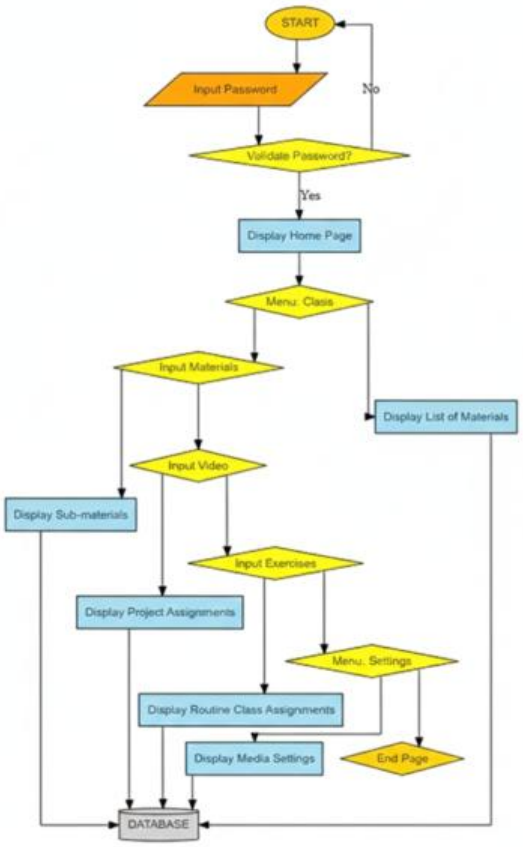

Fig. 2. Initial design of the application for the back-end

C. *Product Development Stages*

Application development is done based on the designed design. The content collection process involves using various sources, such as e-books, academic sites, and digital media platforms like YouTube. The application is developed using Android-based technology with mobile application developer software. After the initial version of the application is complete, the development team conducts initial testing (alpha testing) to ensure that all features function properly before entering the next trial stage. Figures 3 and 4 show the web section of the historical map that was developed.

Fig. 3. Homepage of the World History Map Application

Fig. 4. World History Map Application View

Each feature is designed responsively and can be used on Android devices with a minimum operating system of 9.0. This application was tested as an APK file through a 3-week hybrid learning program.

D. Product Trial Phase

Before being implemented in learning, the Interactive Digital History Map application was validated by two experts, a material expert and a learning media expert. Validation was carried out across three aspects: content suitability, media display, and interactive functionality, using a 1–5 Likert scale (1 = very inappropriate; 5 = very appropriate).

Table 1. Expert Validation Results for the Application

Rated aspect	Subject Matter Expert	Members of the Media	Rate-rate	Category
Conformity of Historical Content	4,8	–	4,8	Very Suitable
Interactive Features Eligibility	4,6	4,7	4,65	Very Suitable
UI View and Navigation	–	4,9	4,9	Very Suitable
Relevance to Learning Objectives	4,7	4,6	4,65	Very Suitable
Eligibility for Hybrid Learning	4,8	4,7	4,75	Very Suitable

The assessment of the Interactive Digital History Map application by material experts and media experts yielded very positive results, with an average score consistently falling into the very appropriate category. The suitability of the historical content received the highest score of 4.8 from material experts, confirming its validity and accuracy. The suitability of interactive features and their relevance to learning objectives each received an average score of 4.65, indicating that the existing features effectively support the learning process and align with learning targets. The appearance and navigation of the user interface (UI), assessed by media experts, received the highest score of 4.9, indicating that the application design is highly user-friendly and easy to use. In addition, the application's suitability for hybrid learning was assessed as very good, with an average score of 4.75, reinforcing its suitability for flexible learning models. Overall, this assessment indicates that the application meets high academic and technical quality standards, making it suitable for use as a history learning medium in a hybrid learning context.

E. Small Group Trial Results

Initial trials were conducted with 10 students over 5 days, focusing on ease of use and initial perceptions of the features.

Table 2. Average Assessment of Small Group Students

Application Usage Aspects	Average Score	Category
Ease of Access and Installation	4,6	Very Suitable
Navigation between Menus	4,4	Very Suitable
Clarity of Content and Tasks	4,5	Very Suitable
Visual Appeal and Graphics	4,2	In accordance
Historical Map Responsiveness	4,3	In accordance

The results of the application usage aspect showed an average score in the very appropriate-to-appropriate category, indicating that users generally received the

Interactive Digital History Map application well. Ease of access and installation received the highest score of 4.6, indicating that the application's download and installation went smoothly without significant obstacles. Navigation between menus with a score of 4.4 was also considered very appropriate, allowing users to move between features easily and efficiently. Clarity of content and tasks received a score of 4.5, indicating that the instructions and materials in the application were presented clearly and easily understood. Meanwhile, the visual and graphic appeal and responsiveness of the historical map each received a score of 4.2 and 4.3, which were still within the appropriate category. However, they showed potential to improve the interactive map's aesthetics and response speed, enhancing the overall user experience. Thus, this application has met the standards of good use, but improvements in several technical aspects can further improve the quality of application services. However, two technical issues were found: the file size is quite large (80 MB), and the "zoom in" map button is less responsive on one device. The development team immediately compressed and improved the Zoom function before the field trial.

F. Student Perception Questionnaire Results

After revision, 30 students used the application in hybrid lectures. Students' perceptions of the application were collected using a 1–5 scale questionnaire.

Table 3. Average Student Perception of Application

Assessment Indicators	Average Score	Category
User Friendly Interface	4,5	Very Suitable
Conformity of Historical Content	4,7	Very Suitable
The Attraction of Visual Media	4,6	Very Suitable
Student Engagement	4,3	In accordance
Suitability for Hybrid Learning	4,6	Very Suitable

The results of measuring students' perceptions of the Interactive Digital History Map application showed very positive acceptance, with average scores in various aspects in the very appropriate category. The user-friendly interface (4.5) facilitates navigation and an intuitive learning experience. At the same time, the suitability of the historical content (4.7) ensures that the material is relevant and accurate in accordance with curriculum standards. The attractiveness of visual media (4.6) increases student motivation and understanding, while student engagement (4.3) is good, although it can still be improved through additional interactive features. The app's suitability for hybrid learning (4.6) confirms its flexibility and effectiveness for use both online and offline. Overall, these findings confirm that this application has succeeded in meeting students' expectations as a hybrid history learning medium, thanks to development that focuses on user needs, content validation, and optimal interface design.

G. Learning Outcome Test Evaluation Results

To assess the application's effectiveness in understanding historical concepts, a pre-test and post-test were conducted. The questions consisted of 20 HOTS multiple-choice items with historical thinking indicators.

Table 4. Effectiveness of the Application Based on Pre-Test and Post-Test Results

Indicator	Mark
Installment-installment Pre-test	61,23
Post-test rate	81,98
Rata-rata N-Gain Score	0,53
t-statistic	25,515
p-value	0,00000
Significance ($\alpha = 0.05$)	Significant

Based on the analysis results, the average pre-test score for students was 61.23, indicating an initial level of understanding in the category *"Enough"*. After the hybrid-Based on the learning process using the application, the average post-test score increased to 81.98, placing it in the *good category*.

This increase is also reflected in the N-Gain Score, which reaches 0.53, placing it in the *medium–high category*. This indicates that the application makes a significant contribution to helping students understand historical materials more deeply and in context.

Furthermore, the test results yield a t-statistic of 25.515 with a p-value of 0.00000 ($p < 0.05$), indicating that the difference between the pre-test and post-test scores is statistically significant. In other words, the use of the Interactive Digital History Map application has a real effect on improving student learning outcomes.

These findings reinforce the application's superiority as a supporting medium for learning history in the hybrid learning model, especially in helping students build a stronger understanding of the spatial and temporal relationships among historical events.

Based on the research results, the implementation of the Interactive Digital History Map Application in the model hybrid learning proved effective in improving the quality of student learning. This application combines synchronous (face-to-face) and asynchronous (online, independent) learning in a balanced way, creating a flexible, adaptive learning experience that meets student needs. This hybrid learning model aligns with educational approaches that increasingly emphasize flexibility in time, place, and learning rhythm and can accommodate diverse learning styles (Leinonen & Mäkelä, 2023; Prananosa, 2022). Synchronous learning provides space for direct interaction with lecturers and classmates. In contrast, asynchronous learning allows students to explore the material independently and in depth (Adisel & Prananosa,

n.d.; Simonova & Poulova, 2016). In the context of learning history, the use of digital tools such as interactive maps greatly supports spatial and temporal understanding, which is often difficult to achieve through conventional methods (Degbelo et al., 2023; Lampropoulos et al., 2023). The spatial visualization offered by this application not only increases students' motivation but also strengthens their involvement in the active learning process (Malysheva et al., 2022; Moseikina & Toktamysov, 2024).

The effectiveness of this application is also reinforced by expert validation results showing that this media has met high academic and technical standards. Validation by material experts yields a historical content suitability score of 4.8, indicating that the application's content aligns with the curriculum and relevant learning objectives (López et al., 2023; Zihlmann & Mazzaia, 2022). Meanwhile, media experts gave a score of 4.9 on the appearance and navigation of the interface, indicating that this application has been designed with attention to the principles of effective user interface (UI) and user experience (UX) design (Albaghli et al., 2024; Chaganti et al., 2023; Singh et al., 2023). The design of this application draws on user-centered design (UCD) and heuristic evaluation, approaches shown to improve ease of use and user comfort in educational contexts (Al-Sa'di & McPhee, 2021; Then & Surja, 2024). The combination of intuitive visual aspects, efficient navigation, and fast interface response allows students to focus on the learning substance without being distracted by technical constraints. This also reflects the principal learning experience design(LXD), which emphasizes the importance of digital interactions that align with cognitive psychology and pedagogical goals (Fayez et al., 2023; Sousa & Martins, 2021).

In addition to the expert validation results, students' responses as end users of this application were also very positive. Based on the questionnaire results, students gave high scores on the aspects of user interface (4.5), suitability of historical content (4.7), and visual appeal (4.6). This application is considered not only visually attractive but also provides cognitive stimulation that encourages active involvement during the learning process. An intuitive and easy-to-use interface enhances user satisfaction and improves access to learning materials (Ofosu-Asare, 2024; Pandita & Kiran, 2023). Attractive visual design, dynamic historical mapping, and the presence of educational icons and images enrich students' learning experiences and increase their appeal to complex materials (Dinç et al., 2023). Not only that, interactive features in the application have been shown to improve focus, information processing, and a deeper understanding of historical concepts (Pesek et al., 2020; Zairon et al., 2025).

Quantitatively, the effectiveness of this application is also evident from the significant increase in student learning outcomes. The average pre-test score of 61.23 increased to 81.98 after students used the application to learn. The Normalized Gain of 0.53, which is in the medium-to-high category, indicates this increase. In addition, the test results were statistically significant ($p < 0.05$), strengthening the evidence that the improvement in learning outcomes was not due to chance. These results indicate that the application significantly improved students' understanding of spatial history concepts. Other studies also support this finding, stating that Android-based educational applications that combine visual and interactive elements can strengthen academic performance and accelerate mastery of learning materials (Patmanthara et al., 2019; Quispe et al., 2018; Shaiakhmetov et al., 2024).

Furthermore, this application also plays an essential role in strengthening students' digital literacy. The activities of exploring digital maps, watching learning videos, and participating in online discussion forums provide students with a learning experience rich in technological skill development, virtual collaboration, and critical thinking. These three skills are the main pillars of 21st-century competencies urgently needed to face the challenges of the Industrial Revolution 4.0 and Society 5.0 eras (Franciskovic & Alvarado, 2022; Tiwari et al., 2023). Students not only absorb historical content but also learn to use technology productively and reflectively, which has been shown to impact academic performance and problem-solving positively (Ding et al., 2024; Johnson, 2020; Tiwari et al., 2023). Discussion forums in the application also strengthen communication and collaboration skills in a digital context, which are the hallmarks of modern learning (McNaughton et al., 2018; J. Zhang & Wu, 2025). This interaction also builds students' ability to reason, evaluate information, and develop creative, critical solutions to historical problems (Miliou & Angeli, 2023; Thiyagarajan & Harish, 2023). This application thus supports the principles of Education 4.0, namely personalized, digital, and sustainable learning (Almela, 2023; Kanqi et al., 2024).

Overall, the integration of the Interactive Digital History Map Application into hybrid-based history learning not only improves students' understanding of history but also strengthens digital competence, increases engagement, and enhances students' readiness to face educational and professional challenges in the digital era. With a collaborative, visual, and technology-based pedagogical approach, this application successfully bridges curricular needs with the demands of the 21st-century world, while creating a contextual, critical, and relevant history learning experience.

IV. Conclusion

The results of this study conclude that the Interactive Digital History Map Application is efficacious in improving the quality of history learning based on hybrid learning, as evidenced by expert validation showing high feasibility in terms of content and technical aspects, as well

as positive student responses to the interface, content, and visual appeal of the application. A significant increase in pre-test to post-test scores, with an N-Gain Score of 0.53, demonstrates the application's real contribution to learning outcomes and to strengthening digital literacy and students' 21st-century skills, including critical thinking, online collaboration, and technology mastery. However, this study has limitations in scope: it is limited to one study program and one short-term learning cycle, and it has not evaluated compatibility across operating systems, such as iOS. Therefore, it is recommended that further development be carried out across courses, involving longitudinal testing, and integrating adaptive features and artificial intelligence, while expanding platform compatibility to strengthen the impact and sustainability of application utilization in the digital learning ecosystem in higher education.

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