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ICT-based social science learning management with Nearpod application in primary education

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ABSTRACT

The integration of technology into education enhances learning experiences, one of which is through the use of Nearpod. The objectives of this study are to (1) describe ICT-based social science learning management through the use of the Nearpod application in primary education and (2) describe the participation of primary education students in social science learning and their responses to the use of the Nearpod application. This qualitative research involved a social sciences teacher and seventh-grade students at YSKI Christian Middle School Semarang. Data were collected through observations, interviews, and documentation and validated using triangulation techniques. The findings reveal that Nearpod-based learning management includes careful planning with lesson plans and interactive activities, implementation through apperception, interactive videos, and PowerPoint slides, and evaluation using game features like Matching Pairs and Time to Climb. Students responded positively, highlighting Nearpod's ease of use, engaging activities, and real-time feedback, though some faced time constraints. This study contributes to the utilization of Nearpod in ICT-based social studies learning, increasing student engagement, and providing insight into the effectiveness of Learning Management Systems (LMS) in elementary education in Indonesia. Further research is recommended to explore Nearpod's effectiveness across subjects and educational levels to enhance teaching methods and student engagement.

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INTRODUCTION

Social sciences is a field of science that studies the interaction between individuals and individuals, individuals and groups, and groups and groups (Rofiq et al., 2020). This relationship is based on the nature of humans, who cannot live without other people because they are social creatures. The abilities that students are expected to achieve in social science learning are being able to think wisely by considering various problems and social dimensions that occur in life through the development of 4C, which includes communication, collaboration, critical thinking and problem-solving, and creative and innovative (Tiwan & Ningsih, 2022).

Conceptual and contextual integration in social science learning needs to be a special study material for teachers to create learning conditions for students. This is because the study aspects of

social studies subjects include humans, the environment, social systems, culture, economics, and welfare (Rofiq et al., 2020). So, teachers must be able to direct students' thinking with direct experience in the surrounding environment.

The main problem that is often encountered in social science learning is that students often feel bored because the teachers who teach tend to apply traditional teaching models, such as lectures that seem monotonous (Hopeman et al., 2022; Sari & Hasanah, 2019). According to Nafisah & Ghofur (2020), social science subjects are predominantly descriptive, narrative, and conceptual, which demands teachers rely heavily on lecture methods, requiring students to listen, memorize, and recall the material. This approach often leads students to perceive social science as a dull subject. Teachers frequently focus on concepts from textbooks without relating them to real-life applications. In fact, with advances in science and technology and changes in educational paradigms, teachers should be able to adopt more varied approaches to utilize technology and create a real atmosphere and experience in learning.

One way teachers can address this problem is by developing ICT-based learning, which is considered an innovative tool to enrich learning experiences, increase student engagement, and facilitate more interactive learning. Creswell (1998) explains that ICT-based learning involves the use of computers or similar devices to present material, allowing students to actively participate and respond to all activities. Similarly, Dewi & Hilman (2018) highlight that ICT-based learning sources and media include computers, PCs, LCDs, the internet, PowerPoint presentations, and other software. Moreover, Achmad & Mulyati (2023) emphasize that the proper use of ICT can help develop the digital competencies students need to face the challenges of the digital era.

In integrating ICT into learning, one essential application is the Learning Management System (LMS), a technology-based platform designed to manage, deliver, and facilitate the learning process. According to Gunawan et al., (2024), LMS serves as a tool that enables effective interaction between educators and students within a digital learning environment. Bradley (2021) highlights that LMS provides an inclusive online classroom, supporting academic progress through collaborative groupings, professional training, discussions, and seamless communication among users. Additionally, the flexibility of LMS allows users to access it anytime and anywhere via various devices such as PCs, tablets, or smartphones (Fitriani, 2020). With these features, LMS effectively helps teachers manage learning more efficiently and enhances the overall educational experience.

One type of LMS that can be used for learning is Nearpod, a cloud-based application that can be accessed using a computer, PC, mobile phone, or other smart device and can be used synchronously or asynchronously (Amelia et al., 2024; Oktafiani & Mujazi, 2022). Nearpod is a web-based educational application designed to strengthen teaching by creating interactive spaces and lessons enriched with videos, images, audio, and even virtual reality experiences to deepen learning (Carrillo-Yalán et al., 2023; Hakami, 2020). It is a versatile platform that facilitates and controls interactivities during learning sessions and can be seamlessly integrated with video conferencing tools to effectively engage students in synchronous online classrooms (Nabilah, 2024; Vinolo-Gil et al., 2022). Easily accessible via smartphones or laptops through the Play Store or Google search, Nearpod can also be accessed for free at https://nearpod.com/ (Anggoro et al., 2022; Burton, 2019).

Nearpod is a cloud-based learning application that provides various interactive features to help teachers create engaging and effective learning experiences. Burton (2019) explains that teachers must first register to access these features, such as designing their presentation slides or uploading existing PowerPoint files using a drag-and-drop tool. In the Add Content section, teachers can utilize diverse interactive elements, such as rotating 3D images through the Nearpod 3D feature, building simulations with the PHET Simulation feature, creating graphs with the Graphing Calculator, and incorporating panoramic images using the Field Trip feature. Additional tools include BBC videos, Sway, a PDF Viewer, and live-streaming capabilities. The Add Web Content feature enables teachers to add URLs relevant to the lesson material, immersing students in a Virtual Learning Environment (VLE). Similarly, the Add Activity section supports interactive tasks like quizzes, matching pairs, drawing exercises, fill-in-the-blank activities, and memory tests, with customizable time limits for each activity (Pramesti et al., 2023).

Nearpod offers flexibility for synchronous or asynchronous learning, depending on the teacher's preference. Teachers can provide an access code for students to join sessions via their devices after registering as participants. At the end of the session, student activity reports are automatically generated and can be sent via email in PDF format. According to Měkota & Marada (2020) and Pupah & Sholihah (2022), there are four fundamental steps to using Nearpod: first, downloading and creating interactive multimedia presentations by integrating tasks such as quizzes, polls, or open-ended questions. Second, sharing the presentation with students and controlling the flow of learning through live participation, where students can only view the slide shown by the teacher. Third, the material should be presented engagingly to promote interaction. Finally, monitoring and assessing students' work is efficient since the results are automatically recorded. With its wide array of features, Nearpod not only simplifies the teaching process but also fosters active student engagement (Burton, 2019; Měkota & Marada, 2020).

The use of the Nearpod application in education can have a positive impact on the quality of learning and students' development. Research conducted by Oktafiani & Mujazi (2022) reveals that the use of the Nearpod learning platform has a positive and significant effect on students' learning motivation. This study also demonstrates that the implementation of Nearpod can enhance both students' motivation and their overall learning outcomes (Oktaviani & Nurhamidah, 2023). Moreover, research by (2024) shows that Nearpod significantly impacts students' critical thinking skills and academic performance. Thus, the use of the Nearpod application has been proven to effectively help students foster their motivation, achieve better learning outcomes, and develop critical thinking skills more effectively.

Based on the results of an interview with a social studies teacher at YSKI Semarang Christian Middle School, he revealed that in the era of revolution 4.0, it is very important for a teacher to integrate the use of ICT in learning. By looking at the phenomenon of all students in their schools who are very comfortable using mobile phones at every opportunity, this needs to be directed to use in learning as a positive effort in building students' digital literacy skills, which are very necessary in this era. Regarding the use of the Nearpod application, he admitted that he had only used it for a few months on his initiative because he was motivated to provide meaningful learning during the COVID-19 pandemic. Initially, he studied autodidactically via YouTube and then deepened his knowledge by attending various webinars. He also said that he would continue to use the Nearpod application even though there is a face-to-face policy because this application is very helpful in presenting interesting learning, fostering student enthusiasm and activeness, and maximizing the usefulness of mobile phones to be more positive.

Currently, the Nearpod application is not yet widely popular in Indonesia's education sector compared to other LMS platforms, particularly in social science learning. Therefore, this research was developed to provide information regarding the use of the Nearpod application through social science learning at YSKI Semarang Christian Middle School, a school that has used it. So, the objectives of this research are: (1) to describe ICT-based social science learning management through the use of the Nearpod application in primary education and (2) to describe the participation of primary education students in social science learning and their responses to the use of the Nearpod application. This study contributes to the utilization of Nearpod in ICT-based social studies learning, increasing student engagement, and providing insight into the effectiveness of LMS in elementary education in Indonesia. Moving forward, it is recommended that broader research be conducted to explore the effectiveness of Nearpod across various subjects and educational levels, as well as to promote its integration into Indonesian classrooms to enhance learning experiences and outcomes. It is also recommended that teachers, particularly in the social studies field, consider experimenting with the Nearpod application to enrich their teaching methods and engage students more effectively.

METHOD

This research uses a qualitative approach with descriptive methods. According to Sugiyono (2017), the descriptive method used in research functions to describe and explain the state of the

object being studied, as it is based on the conditions and situations in which the research process was carried out. This research was carried out in online learning using the Nearpod application synchronously and also integrated via Zoom cloud meetings in social studies learning at YSKI Christian Middle School Semarang, located at Jl. East Sidodadi No. 23, Karangtempel, East Semarang, Semarang City, Central Java, Indonesia. The subjects of the study are one social studies teacher and 32 students from class VII C at YSKI Christian Middle School in Semarang.

Data collection techniques use observation, interviews, and documentation. Observations were carried out to listen to and see social studies learning activities carried out by teachers and students. Interviews were conducted with teachers and several students to find out their responses to implementing and using the Nearpod application in learning. Also, documentation is carried out to collect data in the form of pictures and writings related to the learning preparations that have been carried out by the teacher during the learning process. Test the validity of the data using technical triangulation and source triangulation. Data analysis techniques are carried out using data reduction, data presentation, and data verification. At the data reduction stage, researchers carry out sorting to produce relevant data. At the data presentation stage, the researcher presents the data from the findings and communicates them with the results of relevant previous research. Meanwhile, at the data verification stage, the researcher draws conclusions based on the data presented.

RESULTS AND DISCUSSION

Results

Social Sciences Learning Management by Implementing the Nearpod Application

This study uses a qualitative approach with interviews, classroom observations, and document analysis to explore data on the management of social science learning using the Nearpod application. The findings of this study are described based on three main aspects: planning, implementation, and evaluation of the learning process applied by the teacher.

Planning Stage

At the planning stage, the results of the interview with the teacher revealed that the teacher carefully prepared the lesson plan, integrating the use of the Nearpod application. The teacher stated that Nearpod enabled them to provide interactive learning materials that aligned with curriculum demands. In the interview, the teacher said, "*I can design more engaging and varied lessons with Nearpod, such as adding interactive videos and live quizzes*." As part of the preparation, the teacher also ensured that each student had two devices: a phone to access Nearpod and a laptop to attend the Zoom session.

Documentation collected during the planning stage includes the lesson plan (RPP), which shows the learning objectives aligned with the features in Nearpod, such as interactive videos and game-based evaluations. Additionally, the teacher prepared the Zoom link, which was shared via a WhatsApp group to facilitate the virtual meeting, and this was recorded in the documentation as part of the communication preparation.

Implementation Stage

At the implementation stage, classroom observations indicated that the teacher effectively managed the learning process using Nearpod. The teacher began the lesson with apperception, displaying images related to the topic of "Human Needs" (see Figure 1) and asked students questions via Zoom. Observations showed that students were very active in answering the questions posed by the teacher. In the interview, the teacher explained, "*I try to make the apperception interesting so that students are more focused on the material to be taught*." During the learning activity via Zoom, there was noticeable active interaction between the teacher and students at this stage.

Figure 1. Apperception Display

Next, the teacher used an interactive video presented through Nearpod to explain the "Different Types of Human Needs" (see Figure 2). This video was accompanied by questions that students had to answer directly. Observations revealed that students were very enthusiastic about following the video and responded well to the questions. The teacher explained, "*With the interactive video, I can see how well the students understand the material*."

Figure 2. Interactive Video Display

Additionally, the teacher used PowerPoint slides in Nearpod to continue explaining human activities in meeting needs (see Figure 3). During this process, students continued to participate in discussions and answered the teacher's questions, demonstrating high levels of engagement.

Figure 3. PowerPoint Slide Show

Evaluation Stage

At the evaluation stage, the teacher used game features available in Nearpod, such as "Matching Pairs" and "Time to Climb," to assess students' understanding of the material taught (see Figure 4). Observations indicated that students enjoyed the game-based evaluation, which made them more excited to participate. The teacher stated in the interview, "*This game-based evaluation makes the students more enthusiastic because they feel like they are playing, even though they are learning*."

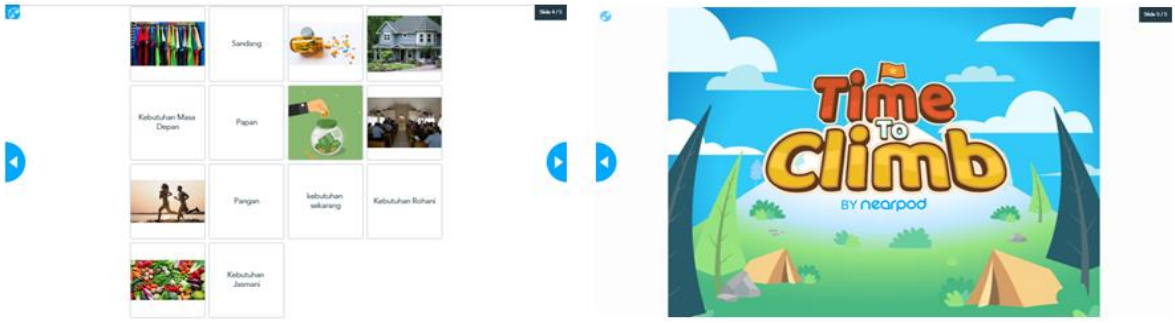

Figure 4. Game Matching Pairs and Time to Climb Display

Documentation of the evaluation results, taken directly from Nearpod report features, showed that the teacher could easily view students' work in a clear and structured format. These reports made it easier for the teacher to assess students' understanding immediately after each evaluation activity, allowing the teacher to follow up promptly if needed. The display of evaluation results through matching pairs and time-to-climb game activities is presented in Figure 5.

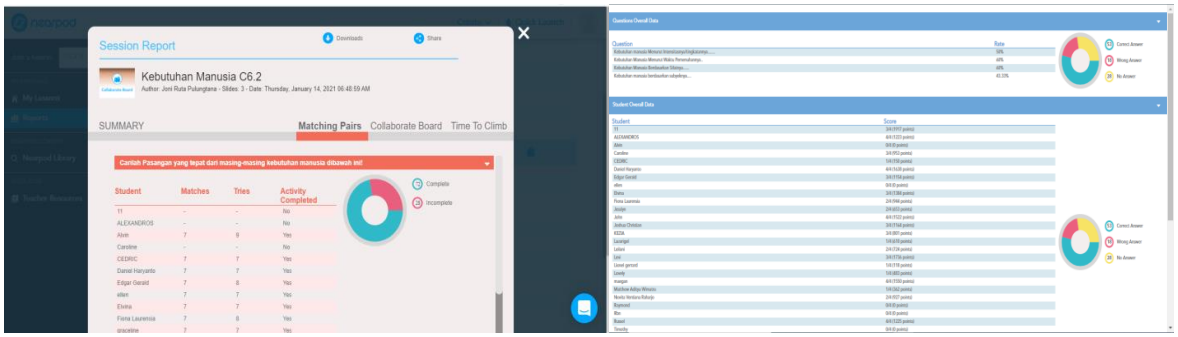

Figure 5. The Results of Matching Pairs and Time to Climb Game Display

Student Participation and Response to Social Science Learning using the Nearpod Application

The classroom observation results show that the student participation rate in each activity is 78% for those who answered and 22% for those who skipped (see Figure 6). The 22% who skipped the activity did not mean they were not involved; most likely, they ran out of time to complete the tasks. Since activities in Nearpod are time-limited, students need to manage their time well to avoid missing tasks. The reports generated by the Nearpod application provide detailed data on student participation, offering insights into both individual and collective engagement in the learning process.

Figure 6. Student Participation Display

The results of interviews with seventh-grade students from YSKI Christian Middle School Semarang revealed a positive response to the use of Nearpod. The students felt happy and motivated because the application is easy to use and presents fun, interactive activities. "*Learning*

with Nearpod is more interesting and helps me understand the material better," said one student. The students also felt more engaged because they could interact directly with the questions and videos provided.

The flexibility of the Nearpod application also received positive feedback. "*I feel freer to learn in a fun way, with videos and questions that make it more engaging*," said another student. However, some students complained about unstable Internet connections, which could disrupt their participation in activities. "*If the connection is bad, I miss some activities*," added one student. Despite the challenges related to internet connection, the students felt that using Nearpod increased their learning motivation. The interactive nature of the learning, along with immediate feedback, was seen as more engaging compared to traditional learning methods.

Discussion

The findings of this study reveal that implementing the Nearpod application in the management of Social Science learning significantly transforms the learning process into a more interactive and participatory experience. At the planning stage, the teacher meticulously prepared the lesson plans, integrating Nearpod features such as interactive videos, quizzes, and educational games. This aligns with Aulia & Baalwi (2022), who stated that Nearpod helps teachers design engaging and easy-to-understand learning materials. Additionally, thorough preparation, including ensuring device readiness and communication tools like WhatsApp for Zoom meetings, highlights the importance of classroom management skills in successfully initiating learning (Oktafiani & Mujazi, 2022).

The implementation stage demonstrates a more dynamic and engaging learning environment facilitated by Nearpod's interactive features. Activities such as video presentations, live quizzes, and discussions actively involved students and enhanced their focus on the material. McClean & Crowe (2017) explain that Nearpod provides a more dynamic and collaborative learning experience compared to conventional methods, where students are encouraged to interact more actively with the content. The accessibility of Nearpod across various devices, including smartphones, tablets, and laptops, further supports student participation and engagement (Feri & Zulherman, 2021; McClean & Crowe, 2017). This active involvement also reflects Nearpod's effectiveness in fostering student motivation (Měkota & Marada, 2020) and promoting interactive discussions.

During the evaluation stage, the teacher utilized game-based features like Matching Pairs and Time to Climb, creating an enjoyable and less monotonous assessment process. This is consistent with Halnanelis & Ulyanti (2023), who confirmed that Nearpod significantly increases student motivation, while Banjarnahor & Tarigan (2023) emphasized its effectiveness in improving student learning outcomes. Moreover, Nearpod's ability to generate real-time structured reports allows teachers to monitor students' understanding and provide immediate feedback, enhancing the overall learning process (Burton, 2019; Mastura et al., 2023).

From the students' perspective, learning with Nearpod was seen as more engaging and motivating, offering a fun and well-structured learning experience. Ahmed & Elmubark (2022) highlighted that Nearpod promotes better interaction between students and teachers, encourages collaboration, and enhances student performance. Features such as interactive videos and quizzes not only support content comprehension but also develop students' critical and creative thinking skills (Siswati et al., 2023; Wulandari et al., 2023). Students also expressed a sense of freedom to learn in an enjoyable atmosphere, as the application provides a more organized and engaging learning process (Afif & Zulherman, 2022; Naumoska et al., 2022).

Nevertheless, challenges such as unstable internet connections remain a limitation in the use of Nearpod. Despite this, the benefits of Nearpod significantly outweigh the drawbacks. Putri & Amini (2023) emphasized that the application effectively facilitates interactive reinforcement between teachers and students, offering a more meaningful learning experience compared to traditional methods. Thus, Nearpod serves not only as a solution to enhance student participation but also as a tool to support innovative, adaptive, and engaging teaching in the digital era (Sarginson & McPherson, 2021; Syahrir et al., 2023)

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CONCLUSION

Based on the research findings, several conclusions can be drawn: (1) Social science lessons using the Nearpod application at YSKI Christian Middle School in Semarang were conducted synchronously, allowing the teacher to directly control the slides and manage learning activities. Students used two devices: mobile phones for managing the Nearpod application and laptops for virtual meetings via Zoom, enabling the teacher to oversee the learning process more effectively. The learning management process began with the teacher preparing the lesson plan and slides and designing various activities in the Nearpod application. The implementation phase started with apperception using the image feature, followed by material presentation through interactive videos and PowerPoint slides, and evaluation using the 'Matching Pairs' and 'Time to Climb' game features. (2) Nearpod can provide reports on student participation. The participation rate of YSKI Salatiga Christian Middle School students in each activity, according to Nearpod data, was 78% for responses and 22% for skipped activities. The missed percentage was due to students running out of time to complete each task. The students' response to using Nearpod was positive; they felt happy, motivated, and enthusiastic about learning, as Nearpod is easy to use, offers a variety of interesting and interactive activities, and provides immediate feedback. However, it is important to ensure a stable internet connection to support the effective use of the application. Looking ahead, it is recommended that broader research be conducted to assess the effectiveness of Nearpod across various subjects and educational levels and to promote its integration into Indonesian classrooms to enhance learning experiences and outcomes. Additionally, it is suggested that teachers, particularly those in the social studies field, consider experimenting with the Nearpod application to enrich their teaching methods and engage students more effectively.

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Integrating Publuu technology into interactive teaching materials as a strengthening of evaluation material learning in the Teacher Professional Education Program (PPG)

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ABSTRACT

Learning in the digital era requires innovative interactive media to improve educational effectiveness, including learning evaluation. The main challenge is low student engagement due to conventional evaluation methods. Publuu, an interactive digital platform, offers a solution by providing interesting teaching materials. This study developed and tested Publuu-based interactive materials for learning evaluation courses in the Teacher Professional Education (PPG) program. Using the ADDIE-based Research and Development (R&D) method, data were collected through initial trials and final trials on two groups: the experimental group (30 students using Publuu) and the control group (30 students using conventional methods). Normality and homogeneity tests ensured statistical validity, followed by paired sample t-tests. The results showed that Publuu materials significantly improved student learning outcomes, with a significance value (Sig.) <0.05. In addition, these materials increased student motivation and engagement. Thus, Publuu-based interactive learning materials are suitable for PPG programs, improving the quality of evaluation learning. This study provides practical benefits of interactive tools in improving learning effectiveness and student active participation. Future developments may include more interactive features to increase the appeal and effectiveness of the material.

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INTRODUCTION

Education in the digital era of the 21st century faces significant challenges due to technological transformations that fundamentally change the way knowledge is acquired and delivered. This technological advancement adds complexity to the evaluation of students' learning outcomes, where evaluation methods must now encompass critical, creative, and collaborative thinking skills in addition to traditional cognitive achievements. In Indonesia, this challenge is increasingly felt due to the gap in technology access between urban and rural areas, which widens the disparity in the quality of education. As expressed by Richardo et al., (2023) and Candra (Ranti et al., 2024), educators need

to ensure that evaluation methods remain relevant and capable of motivating students to learn innovatively in a rapidly evolving information environment. For example, in urban areas, teachers are beginning to utilize e-learning platforms and artificial intelligence (AI) to evaluate students dynamically and in real time. Conversely, in rural areas, limited digital infrastructure hinders the implementation of technology-based evaluations, so traditional approaches remain dominant (Supa, 2023). Therefore, as stated by Subroto et al., (2023), A refresh is needed in the learning approach, where technological innovations are adapted to local conditions in Indonesia through teacher training and improved access to technology that is more equitable. Initiatives like "Merdeka Belajar" launched by the government are expected to bridge this gap by promoting flexibility in contextual and inclusive learning and evaluation methods (Tanuwijaya et al., 2024; Wuisan & Mariyanti, 2023).

One of the main obstacles in evaluating learning outcomes today is the low level of student engagement in the learning process (Maimunah et al., 2021). Researchers Kang et al., (2023) stated that factors such as lack of interest, minimal active participation, and static evaluation methods contribute to the limited effectiveness of the learning experience. In Indonesia, this challenge often arises because the learning methods are still lecture-oriented and rely on written exams, making students passive recipients (Amien & Hidayatullah, 2023; Widaningsih, 2019). Observation studies on PPG Malang State University students still find a lot of learning using conventional teaching materials, so students now tend to get bored. To address this issue, innovation is needed to enhance student interaction and engagement in the learning process. One relevant approach is the use of interactive learning media, such as technology-based digital modules, which allow students to interact with the material directly and dynamically (Tianyi, 2024). Thus, the application of interactive media in learning evaluation can create a more dynamic and in-depth learning experience where students are actively engaged (Han, 2024). One of them is interactive media, namely Publuu.

Publuu itself is a digital platform that facilitates the conversion of PDF files into interactive publications that can be accessed through various devices. This platform is very suitable for creating interactive teaching materials due to its user-friendly and flexible interface (Rahmadani & Bungawati, 2023). In the context of educational evaluation for the PPG program, Publuu enables the presentation of interactive modules, visualizes performance assessment rubrics, and provides relevant scenario-based exercises (Agustina et al., 2022). Prospective teachers can understand the concept of evaluation more comprehensively and can apply it in teaching practice.

In the context of developing interactive learning materials based on Publuu for evaluation materials in Teacher Professional Education (PPG), this platform offers flexibility in presenting interactive and multimedia-based evaluation modules. Publuu allows educators to create teaching materials that visualize assessment rubrics and provide scenario-based exercises, which effectively help prospective teachers understand educational evaluation concepts more deeply (Kao & Lin, 2023). Li et al., (2024) note that the use of multimedia interactions in teaching materials allows students to explore complex concepts more intuitively and engagingly. This creates a more inclusive learning environment and motivates students to explore the learning material actively. Thus, the implementation of interactive learning materials based on Publuu in PPG evaluations can enhance the teaching quality of prospective teachers while also inspiring them to apply innovative evaluation methods in their teaching practices.

Integrating digital teaching materials into the learning process not only creates a more dynamic learning experience but also allows learners to interact with the learning material more deeply. Recent research shows that the use of interactive educational technology can enhance student engagement and their understanding of the material being taught (Kalyani, 2024). In addition, learners are no longer passive spectators; they are empowered to explore complex concepts through various interactive media, including videos, simulations, and educational games, which have been proven to improve learning outcomes significantly (Festiyed et al., 2023). The use of multimedia interactions in education also facilitates more personalized learning, where students can learn at their own pace and according to their individual learning styles. This encourages students to become more engaged in the learning process, which in turn enhances their intrinsic motivation to understand the material in depth (Mayer, 2019). Furthermore, a more interactive learning environment, such as that achieved through multimedia technology, enables collaborative learning experiences where learners

can share ideas, ask questions, and work together more effectively (Rahayu et al., 2022). Integrating platforms like Publuu into learning can improve interaction between educators and learners through more dynamic and interactive material delivery, which can increase student engagement and encourage better collaboration in the classroom (Aulia et al., 2024).

Several studies support the use of interactive teaching materials in education. Research by Utami et al., (2022) about the use of Schoology shows that interactive teaching materials are worth implementing and are very engaging for students. Similarly, the research by Sholikhah et al., (2024) regarding Edpuzzle shows the effectiveness of teaching materials and interactive videos in increasing student participation. A study by Febrianto & Puspitaningsih (2020) about the development of teaching materials for learning evaluation also obtained results that indicate feasibility for use in the learning process. Although previous studies have shown the effectiveness of various interactive teaching material platforms such as Schoology, Edpuzzle, and general evaluation teaching materials, this study offers a new approach by using Publuu in the learning evaluation course, an innovative platform that allows the presentation of teaching materials in an interactive format that resembles digital publications in the form of a website. Therefore, the researchers identified a research gap in this context, with the development of interactive learning materials based on Publuu integrated with a website for evaluation materials in PPG, in line with these findings, the research contribution brings the advancement of interactive teaching materials by integrating Publuu technology, offering an innovative approach to improving evaluation materials in the Teacher Professional Education Program (PPG) at the Postgraduate Program of State University of Malang. The research provides practical implications for improving the effectiveness of learning evaluation, equipping educators with cutting-edge tools to encourage active engagement and comprehensive understanding among PPG students.

METHOD

This research uses a Research and Development (R&D) approach with the ADDIE design to develop interactive teaching materials based on Publip on the topic of Learning Evaluation in the Teacher Professional Education program (PPG) (Agustianti et al., 2024). The researchers chose the ADDIE design because it is easy to understand, and its research procedures are systematically organized as shown in Figure 1. This approach helps in producing teaching materials that meet the needs and characteristics of the learners (Sakdiyah & Triwahyudianto, 2022).

Qualitative and quantitative data were collected directly from the research subjects. The subjects in this research and development were 60 PPG postgraduate students at Malang State University, with 30 experimental classes and 30 control classes. The research instruments used to collect data include validation questionnaires, student response questionnaires, and multiple-choice tests (see Table 1 and Table 2).

Table 1. Needs Analysis Instrument

No.	Questions	Yes	No
1	I feel that the Teaching Materials for the Learning Evaluation Course Used in the PPG Program are not Interactive Enough		
2	I feel that the Existing Teaching Materials for Learning Evaluation Courses have not Optimally Facilitated Students' Learning Needs		
3	I feel that New Teaching Materials are Needed to Improve the Quality of Learning Evaluation in the PPG Program		
4	I Feel the Need for Interactive Teaching Materials that can Help Students Better Understand the Evaluation Material		
5	Visually Appealing Teaching Materials to Increase My Interest in Learning		
6	Technology-based Interactive Teaching Materials can Help Make the Learning Process More Efficient in Learning Evaluation Courses		
7	I Often Find it Difficult to Access Learning Evaluation Materials with the Current Media		
8	Current Teaching Materials do not Provide Enough Support for Independent Learning Outside the Classroom in Learning Evaluation Courses		

No.	Questions	Yes	No
9	I Agree that Publuu-Based Learning Media is Effective Compared to Conventional Media		
10	I Prefer Technology-Based Teaching Materials to Support Learning in Learning Evaluation Courses		
11	I feel that Publuu-Based Teaching Materials will Facilitate Access to Learning Materials		
12	I feel that I Often Use Digital Learning Media in My Daily Learning Process		
13	I feel that Publuu-based Teaching Materials can Provide a More Interesting Learning Experience than Conventional Media		
14	I feel that Interactive Features such as Quizzes or Videos in Publuu-based Teaching Materials can Help understand Learning Evaluation Materials		
15	I am More in Favor Of Developing Publuu-based Teaching Materials for Independent Learning		
16	I Need More Guidance or Tutorials on How to Use Publuu-based Teaching Materials		
17	It Should be Accessible Through Various Devices, Such as Laptops or Mobile Phones, to Increase Learning Convenience		
18	Interactive Features Such as Easy Search or Navigation can Make it Easier to Find Certain Information in Publuu-based Teaching Materials		
19	The Content of Current Learning Evaluation Teaching Materials is Difficult to Understand		
20	Publuu-based Teaching Materials will Help Improve Learning Outcomes in Learning Evaluation Courses		

Table 2. Instrument Pretest dan Posttest

No.	Pretest Questions	Posttest Questions
1	Formative Assessments are often Conducted to Monitor Student Progress During the Learning Process. Explain the main Purpose of Formative Assessments and how Teachers can Use the Results of these Assessments to Improve Learning.	After Conducting a Formative Assessment, the Teacher Realizes that most Students have Difficulty Understanding Certain Material. As a Follow-up Step, What should the Teacher do to Ensure All Students can Achieve the Learning Objectives?
2	Validity is an Important Principle in Assessment. When an Assessment has High Validity, what are the Implications for Measuring Student Ability?	When Using Rubrics as Assessment Instruments, what are their main Benefits in Ensuring Fair and Objective Assessment?
3	The Principle of Fairness Demands that all Students have Equal Opportunities to Demonstrate their Competence. How can Teachers Ensure that the Principle of Fairness is Applied in Classroom Assessments?	Diagnostic Evaluation is Conducted at the Beginning of Learning to Identify Students' Abilities and Needs. How can the Results of this Diagnostic Evaluation be used to Design more Effective Learning Strategies?
4	What Distinguishes Authentic Assessment from Traditional Assessment? Explain by giving Examples of the Application of Authentic Assessment in Learning.	The Holistic Assessment Paradigm Asks Teachers to Assess Students as a whole, Including Aspects of Attitude, Knowledge, and Skills. How can the Implementation of Holistic Assessment Support Students' Competency Development?
5	Feedback is an Important Part of Formative Assessment. Why should Feedback be Specific, Timely, and Actionable?	Teacher Technology-based Assessment uses an Online App to give Short Quizzes Every Week. What are the Advantages of this Approach Compared to Conventional Methods?
6	Feedback given to Students should Use a Constructive Approach to Help them Improve their Learning Outcomes. How can a Teacher Provide Feedback that Supports a Growth Mindset?	Teachers Often Use Different Types of Instruments Such as Projects, Exams, and Portfolios. What is the Best Way to Integrate the Results from these Different Types of Instruments?
7	One of the Key Principles in Assessment is Transparency. How can this Principle be Applied in Classroom Assessment Practices?	One of the Main Purposes of Diagnostic Evaluation is to Help Teachers Understand Students' needs Before Learning Begins. What is a Concrete

No.	Pretest Questions	Posttest Questions
		Example of Implementing a Diagnostic Evaluation in the Classroom?
8	In Authentic Evaluation, Students are Asked to Complete a Project that is Relevant to Real Life. What are the main Benefits of Authentic Evaluation Compared to Traditional Evaluation?	The Principle of Inclusivity in Assessment Emphasizes the Importance of Considering the Different needs of Students. What can Teachers do to Ensure that the Assessments they use are Inclusive?
9	The Principle of Relevance in Assessment Emphasizes that Assessments should be in line with the Learning Objectives. How to Ensure that the Assessments Used are Relevant?	When Developing Assessment Questions, Teachers must Ensure that the Questions have Varying Levels of Difficulty. Why is this Variation in Difficulty Important?
10	Teachers can use a Variety of Methods to Gather Information on Student Progress. Which of the Following is most Suitable for Formative Assessment?	Project-based Assessments often Require Students to Work in Groups. What are the main Benefits of this Approach?

These instruments consist of open-ended questionnaires that yield qualitative data in the form of critiques and suggestions from validators and students, as well as closed-ended questionnaires that produce quantitative data regarding the assessment of the developed product (Yu et al., 2021). Data analysis in the research is conducted through validity analysis and statistical analysis. Validity analysis uses Formula 1.

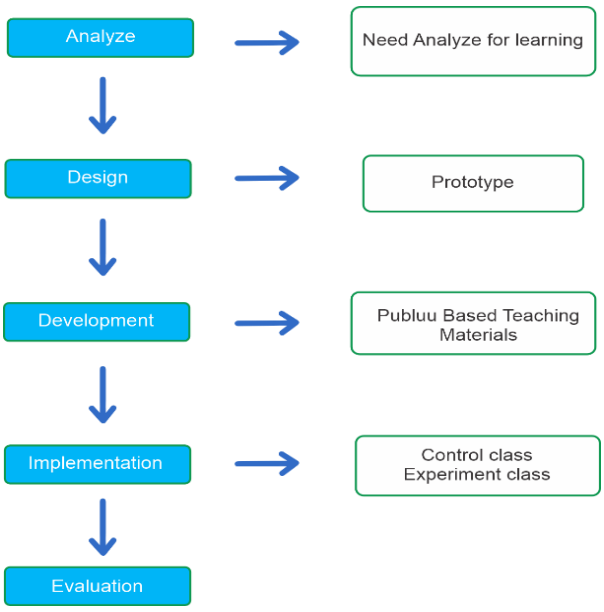

Figure 1. Methods ADDIE

$$Average\ Score = \frac{Total\ Score}{Number\ of\ questions} \quad (1)$$

The scores obtained from the respondents' assessments are quantitative data that will subsequently be interpreted into qualitative data by referring to the qualification range (Sumartini et al., 2020) in Table 3 below.

Table 3. Criteria and Content Eligibility

No.	Explanation	Class
1	0%-20%	Very Unqualified (STL)
2	21%-40%	Unqualified (KL)
3	41%-60%	Doubtful (R)
4	61%-80%	Qualified (L)
5	81%-100%	Very Qualified (SL)

Data analysis in this study uses pretest and posttest scores from postgraduate PPG students at Malang State University as research subjects. Before conducting the paired sample t-test, normality and homogeneity tests were performed to ensure the data met the necessary statistical assumptions. The pretest and posttest results were then analyzed using the paired sample t-test to test the research hypothesis. Next, the results of this t-test are compared with the predetermined significance level.

RESULTS AND DISCUSSION

Results

Analysis

The previous analysis was used as a guideline and consideration in developing interactive learning materials based on Publip for the Learning Evaluation material in the Teacher Professional Education (PPG) program. The analysis conducted includes complexity analysis and user needs analysis. The complexity analysis aims to identify and categorize the issues faced in the PPG program related to the material and types of learning materials. This analysis includes the review of core competencies and basic competencies, as well as the analysis of material concepts.

An interview with a PPG lecturer revealed that traditional teaching methods, such as lectures using textbooks or handouts, are still predominantly used, emphasizing teacher-centered learning. Lecturers also highlighted that the choice of teaching materials has a significant impact on students' interest and motivation to learn. The interview results also indicate that there are materials that are difficult for students to conceptualize, particularly in the learning outcome evaluation module. Additionally, students tend to get bored quickly if the learning process relies solely on PowerPoint presentations or text materials. To increase enthusiasm and motivation for learning and reduce boredom, innovative teaching materials that effectively support the learning process are needed.

User needs analysis is conducted to determine the types of learning materials required by students to improve the quality of education. The needs analysis questionnaire was distributed online using Google Forms, chosen for its efficiency and wide reach. The questionnaire was distributed to postgraduate PPG students at Malang State University. Based on the results displayed in Figure 2 as a follow-up to the analysis of student needs, it can be interpreted that although lecturers have utilized teaching materials, they are generally still in the form of textbooks or handouts. This indicates the need for the use of other more innovative teaching materials that can enhance student motivation and interest in learning, as well as improve learning outcomes during lecture sessions.

Previous research by Anggela et al., (2021) explains that critical thinking skills and student learning outcomes improve with the use of creative and innovative media. Therefore, the development of interactive learning materials based on Publuu can be tailored to the needs of the students. Research supporting this has been conducted by Sagala (2024), who developed a Website-Based E-Module for the Choir Course with Publuu.

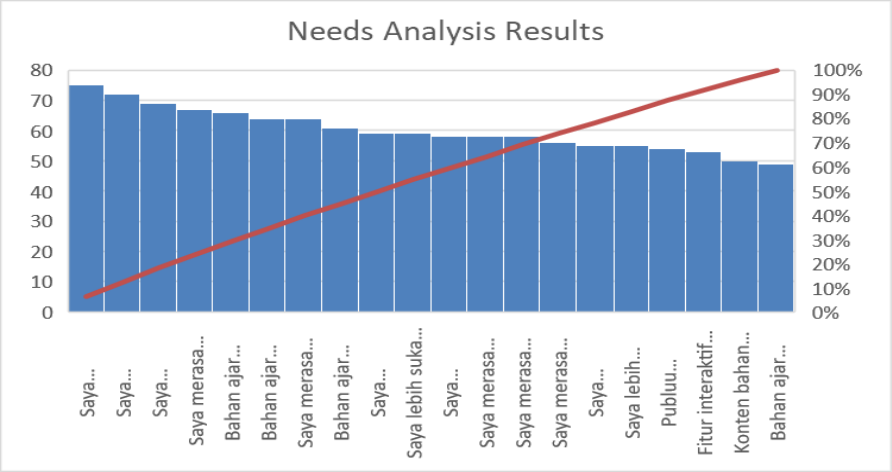

Figure 2. Needs Analysis Result

Design

Based on the needs identified in the analysis stage, interactive learning materials based on Publuu were developed to meet the needs of students. The design process begins with selecting appropriate media to be transformed into effective learning resources that enhance the learning experience. A storyboard was then created as the initial blueprint and design framework for this interactive learning material. The storyboard played an important role in designing the interface, from the initial page to the evaluation section. Content is organized by identifying core and basic competencies, determining the types of learning materials to be used, and selecting learning resources as references. The final product is developed in the form of a Publuu-based website.

Development

This development stage involves the creation of products and the feasibility testing of interactive teaching materials based on Publuu for Learning Evaluation materials in the Teacher Professional Education (PPG) program. The development process begins with formulating learning objectives, preparing materials according to the syllabus, developing interactive teaching materials based on the designed storyboard, and conducting evaluations that include practice questions. This interactive learning material based on Publuu has several display menus, including the initial page, as shown in Figure 3, the material menu in Figure 4, and the quiz page in Figure 5. This stage produces a structured interactive learning material product by the established competencies, along with a questionnaire sheet to measure the validity of the media, material, and user responses.

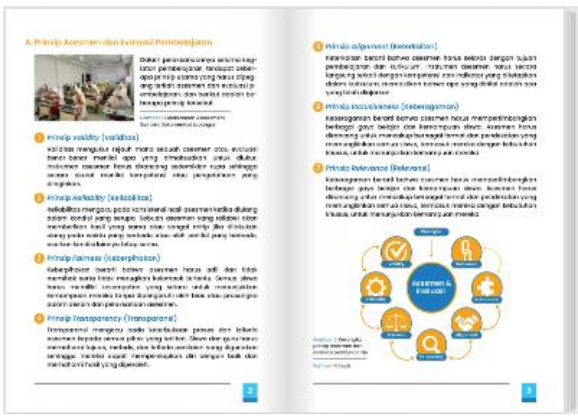

Figure 3. The Front Display of Publuu

Figure 4. Teaching Material Evaluation

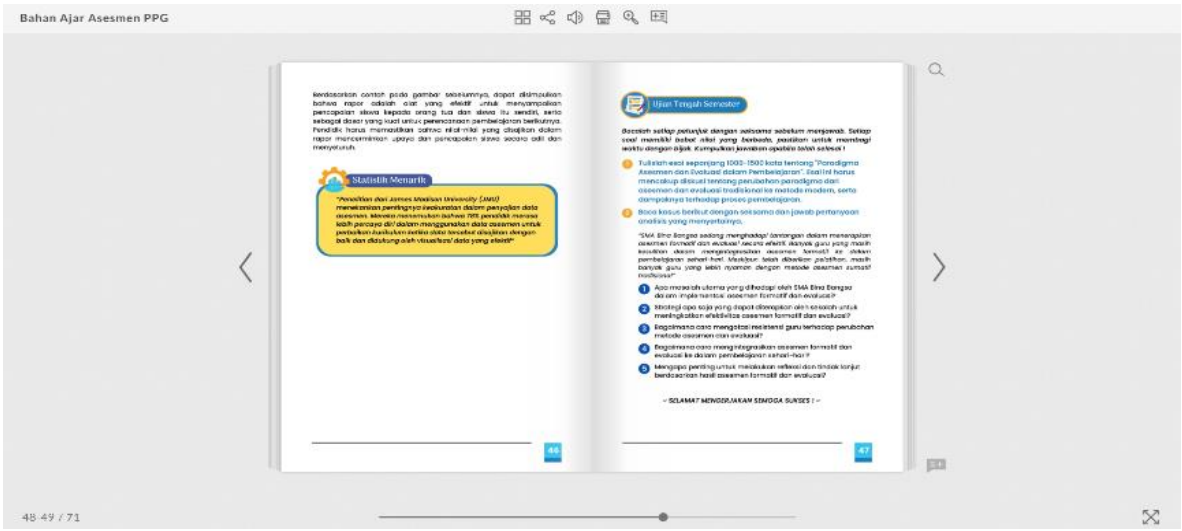

Figure 5. Quiz Page for Evaluation-Based Learning Materials on Publuu

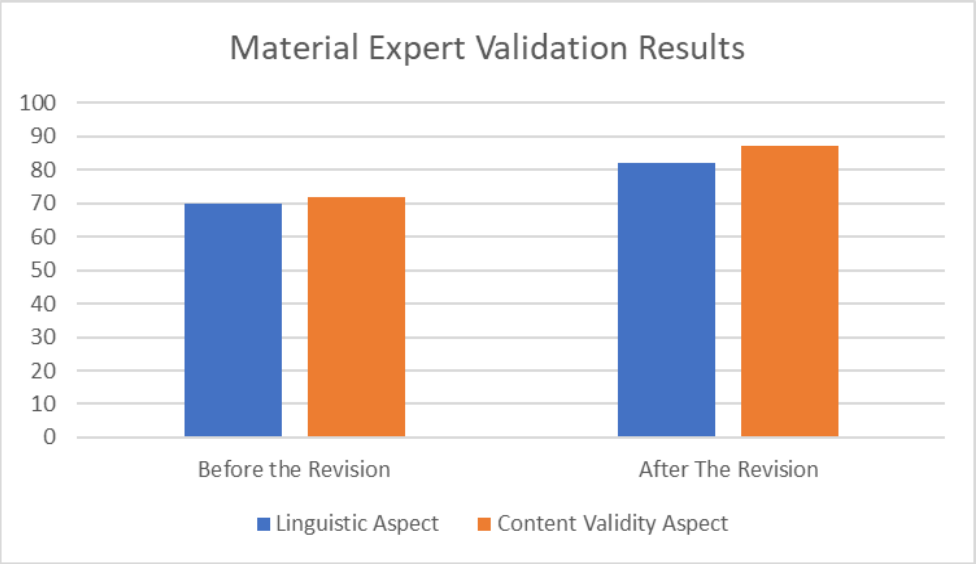

Figure 6. Material Expert Validation

Based on the data presented in Figure 6, the material aspect received a percentage of 90% after revision. This percentage indicates that the material in the interactive learning resources based on Publuu meets the feasibility criteria with the designation "very feasible." This signifies that the material has been compiled in detail, clearly, and by the needs of the students. Thus, the presentation of material through interactive learning materials based on Publuu can help students understand the material more optimally. As a medium of delivery in the classroom learning process, the presence of effective teaching materials is essential. Without the use of appropriate teaching materials, the delivery of the material will be abstract, and students' understanding of the material will decrease because they cannot visualize what is being taught (Setiawan et al., 2023). These findings indicate that the material is suitable for use in interactive teaching materials based on Publuu and is ready to be tested with educational practitioners and students. However, several improvements need to be made to the material before the trial implementation.

The media validation process was carried out using a questionnaire consisting of 20 statements, along with a comments and suggestions section. The assessment includes several important aspects, such as visual design, language use, learning strategies, and software engineering.

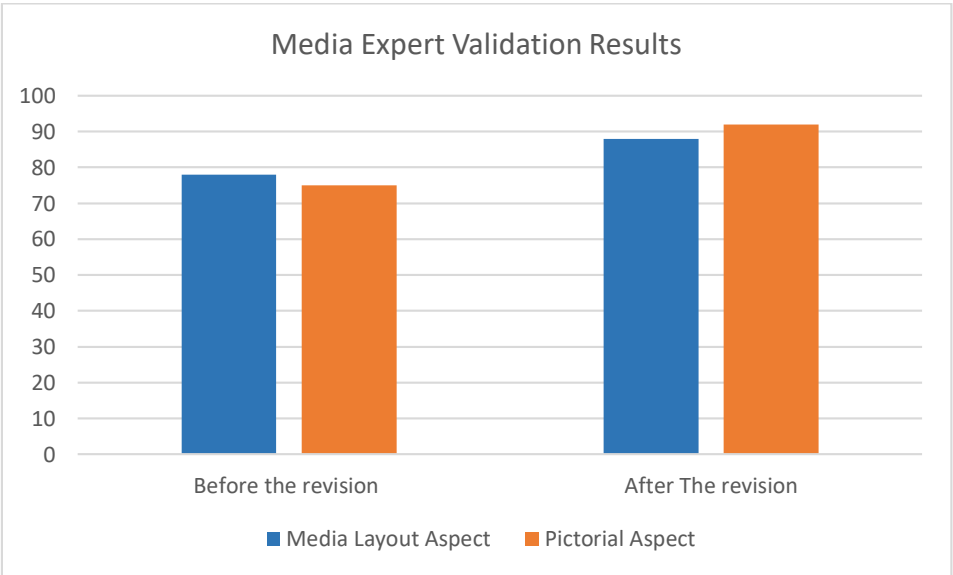

Figure 7. Media Expert Validation Result

The percentage of the suitability of the interactive learning materials based on Publuu reached 84.5%, as shown in Figure 7. This figure indicates that the learning materials have met the eligibility criteria as "very suitable," thus ready for testing. This interactive learning material offers a deeper learning experience through the visualization of symbols, allowing students to understand the learning evaluation material through relevant images. Referring to Edgar Dale's cone of experience theory, learning that involves the five senses can be effectively implemented in the teaching and learning process (Anwar et al., 2022).

The use of interactive learning materials based on Publuu will enhance the effectiveness of classroom learning and provide a more concrete experience for students. With the help of realistic visualizations, students can grasp the material better compared to just through concepts or text (Nurandari & Triatmanto, 2023). Interactive features such as quizzes in this learning material encourage students to be more active in developing their understanding and enhancing their skills and knowledge. This teaching material is designed to encourage students to learn independently, while the role of the instructor is as a facilitator who supports the learning process. In the constructivist theory, facilitators have the responsibility to help students achieve effective learning outcomes (Sayaf, 2023). Based on validation, this interactive learning material based on Publuu is ready to be tested with education practitioners and PPG students.

Implementation

Interactive learning materials based on Publuu are implemented for users after being validated by experts during the development stage. This implementation stage involves lecturers as education practitioners and 30 postgraduate PPG students as the experimental group. Education practitioners conducted the trial to evaluate educators' responses. The assessment is performed using a questionnaire consisting of 20 statements regarding the components of teaching materials, along with a comments and suggestions column. The aspects evaluated include language use, Publuu-based teaching material components, material structure, and overall presentation.

The purpose of this stage is to measure user responses to interactive learning materials based on Publuu, particularly in enhancing students' understanding of learning evaluation materials in the PPG program. The learning materials being tested also emphasize the presentation of interactive visuals relevant to students' needs, facilitating the learning process. The implementation of this teaching material not only supports a deeper understanding of students but also strengthens the role of lecturers as facilitators who help enhance students' learning independence through the constructivist approach.

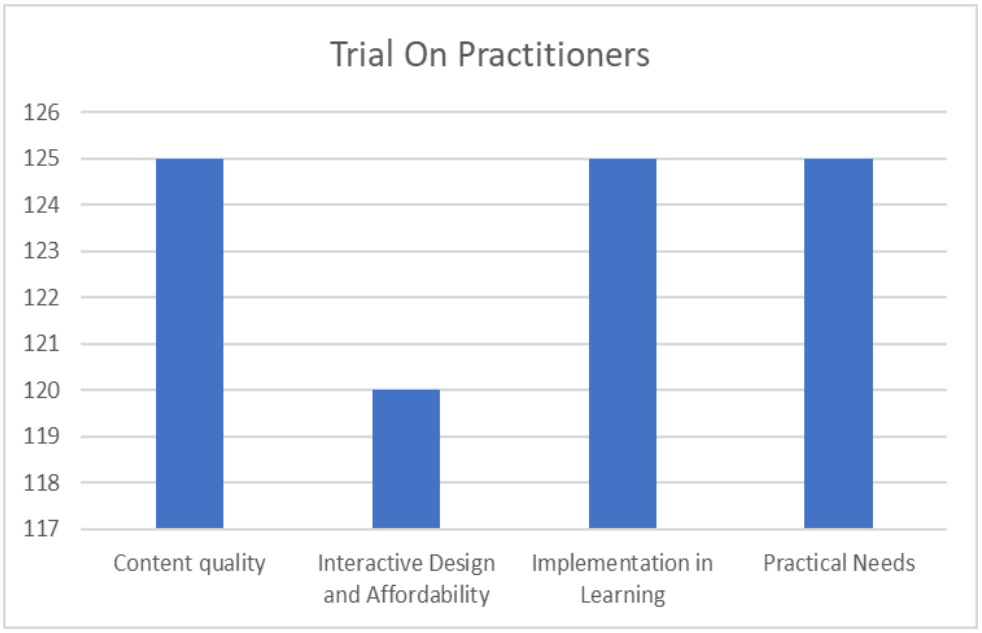

Figure 8. Graph of Test Results for Education Practitioners

The results of the trial conducted by education practitioners, as shown in Figure 8, indicate a percentage of 99%. This figure suggests that the interactive learning materials based on Publuu meet the "very feasible" criteria and can be further tested. Based on these test results, these learning materials are ready to be implemented for students.

The data collection process was conducted during offline learning activities and took place in three sessions guided by PPG lecturers. Before the trial was conducted, students were asked to download and access the interactive learning materials based on Publuu through their respective devices. Next, this teaching material is used by the learning evaluation material that has been prepared in the activity plan. After the learning session is over, students fill out a questionnaire containing statements to collect data on the feasibility and effectiveness of the tested teaching materials.

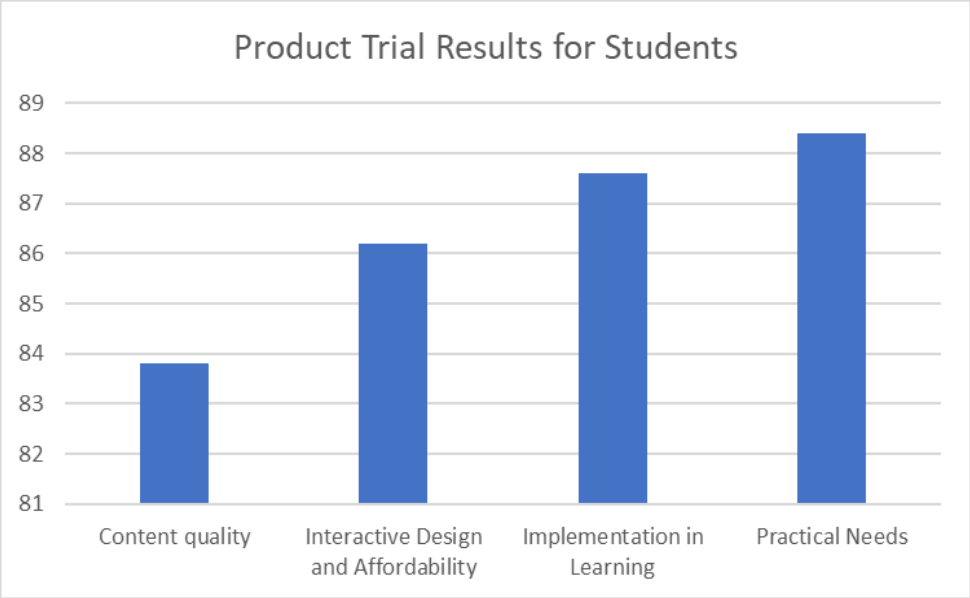

Figure 9. Graph of Student Responses to Publuu-based Teaching Materials

Based on the data displayed in Figure 9, the interactive learning materials based on Publuu show an average feasibility level of 85%. This figure indicates that the learning materials in the trial usage phase have met the "very feasible" criteria. Responses from students suggest that this teaching material is very interesting and can enhance learning motivation. Students feel that understanding the material and its application has become easier. Thus, this interactive learning material based on Publuu is very suitable for implementation in the learning process, especially in the evaluation of learning materials in the Teacher Professional Education program. (PPG).

Evaluation

Evaluation is the final stage in the ADDIE development model, which aims to assess whether the interactive learning materials based on Publuu for the Learning Evaluation subject in the Teacher Professional Education (PPG) program have achieved the desired objectives. This evaluation ensures that every step of the development process runs according to plan. At the analysis stage, after the complexity and needs analysis of the students is conducted, the supervisor evaluates the obtained results to ensure that the developed teaching materials are relevant and meet the needs of PPG students. Subsequently, the evaluation at the design stage is carried out through the review of learning objectives formulation, material development, questionnaire instrument design, tests, and the storyboard of Publuu-based teaching materials to ensure that all design elements support the effectiveness of learning. At the development stage, expert validators assess the suitability of the teaching materials using a questionnaire and identify weaknesses such as typographical errors, image mismatches, and a lack of materials that support higher-order thinking. At the implementation stage, the questionnaire is filled out by education practitioners and PPG students who have used the

teaching materials. Education practitioners provided a positive response regarding the effectiveness of the teaching materials but recommended incorporating variations in their application. Students also stated that the Publuu-based teaching materials helped their understanding of the learning evaluation material. However, there were still shortcomings, such as the absence of sound in the videos and images that could not be enlarged. This evaluation is conducted at every stage of development to ensure that the interactive learning materials based on Publuu for the Learning Evaluation material for PPG are developed according to the ADDIE model and can produce effective learning materials that meet the needs of students.

Analysis of the Effectiveness of Publuu-based Teaching Materials

This effectiveness test aims to measure the success level of developing educational evaluation teaching materials based on Publuu in improving students' learning outcomes in the Teacher Professional Education Program. (PPG). Effectiveness analysis is conducted through the implementation of pretests and posttests on two groups of students, namely, the experimental group and the control group. The pretest is performed to measure the initial abilities of the students before the treatment in the form of using Publuu-based teaching materials. Meanwhile, the post-test is used to assess the learning outcomes after the use of these teaching materials.

The implementation of Publuu-based teaching materials was carried out in three sessions. In the first session, students were given a pretest to evaluate their understanding of educational evaluation material before using Publuu-based teaching materials. In the second session, students in the experimental group followed the learning process with Publuu-based teaching materials, while the control group used conventional methods based on printed teaching materials. In the third session, both groups of students were given a post-test to assess the improvement in learning outcomes and understanding after the learning process using Publuu-based teaching materials in the experimental group and conventional methods in the control group.

Table 4. Normality Test

No.	Treatment	Sig.
1	Pretest Experiment	0.945
	Pretest Control	0.140
2	Posttest Experiment	0.051
	Pretest Control	0.200

The results of the students' pretest and posttest were analyzed using normality (see Table 4) and homogeneity tests (see Table 5). The normality test shows that the pretest value of the experimental group has a significance (Sig.) value of 0.945, while the posttest has a (Sig.) value of 0.051. In the control group, the pretest value shows a (Sig.) of 0.140 and the posttest (Sig.) of 0.200. Based on the results of the Kolmogorov-Smirnov normality test, the pretest and posttest data in both groups show (Sig.) values > 0.05, indicating that the data are normally distributed.

Table 5. Homogeneity Test

	Levene Statistic	df1	df2	Sig.
Publuu Effectivity	0.024	1	67	0.878

Next, the homogeneity test on the pretest and posttest data of students from both groups shows a significance value (Sig.) of 0.878. Since this value is greater than 0.05, the pretest and posttest data are considered heterogeneous, as presented in Table 2. With the normal data distribution and the existing heterogeneity, a paired sample t-test can be conducted to test the previously formulated hypothesis related to the development of this Publuu-based teaching material.

Based on the results of the paired sample t-test conducted using the SPSS application with a significance level of 0.046, a two-tailed significance (Sig) value was obtained, indicating $e \leq 0.05$. These results suggest that the null hypothesis (H0) is rejected, and the alternative hypothesis (H1) is accepted, meaning there is effectiveness in the use of Publuu-based educational evaluation teaching materials in improving the learning outcomes of PPG students. Thus, Publuu-based teaching

materials are effective for use in educational evaluation learning for students of the Teacher Professional Education Program (PPG).

Discussion

Learning media, such as interactive teaching materials based on Publuu for the Learning Evaluation material in the Teacher Professional Education (PPG) program, have proven to be an effective solution to address various issues in the learning process, including the lack of innovation and variation in media usage. This condition often makes students quickly feel bored, lose motivation, and decrease their interest in studying (Harsel et al., 2019). The use of technology-based media, as explained by Knaus (2023), can encourage active student engagement, increase enthusiasm, and improve learning outcomes. Daud et al., (2024) also revealed that public learning can significantly enhance students' motivation and academic achievement.

Research supporting interactive learning materials based on Publuu emphasizes the importance of learning materials. According to Dolasinski & Reynolds (2020), Microlearning with websites is useful for reflecting on the knowledge that has been learned and integrating it into microlearning. This approach is highly relevant in the subject of Learning Evaluation, where students must deeply understand the concept of evaluation and apply it practically. Besides that, Satriawati et al., (2023) should mention that websites with geometry materials can make learning more interactive and enjoyable, which ultimately reduces boredom and helps in understanding complex concepts.

Based on these findings, the development of interactive learning materials based on Publuu is not only effective in reducing boredom but also in significantly enhancing student motivation and learning outcomes. In addition, this teaching material is capable of creating a more interactive and engaging learning experience where students can actively participate in the learning process. Thus, the development of this teaching material is consistent with previous research that supports web-based learning as an innovative and effective teaching method.

CONCLUSION

Based on the findings of this study, the development of interactive learning materials based on Publuu for Learning Evaluation content in the Teacher Professional Education (PPG) program has aligned with the complexity analysis and user needs conducted by the researcher. The results of the statistical analysis with the paired sample t-test show a two-tailed Sig. value of $0.000 < 0.05$, which means the alternative hypothesis (Ha) is accepted, and the null hypothesis (H0) is rejected. This shows that the use of interactive learning materials based on Publuu is effective in improving the learning outcomes of PPG students. These learning materials significantly succeeded in enhancing students' learning achievements, as evidenced by the difference in pretest and posttest scores between the experimental class and the control class, where the experimental class showed a greater improvement.

Some suggestions that emerged regarding the development of this teaching material include constraints in technology access, such as students' limited ability to access the Publuu application, as well as time constraints that could affect the smoothness of the learning process. To overcome these obstacles, the researchers recommend using an LCD projector as an alternative for presenting interactive teaching materials in the classroom. In addition, the researchers also provided additional devices to students who had difficulty accessing learning materials. The limitations of this research include the scope of the material, which only covers one sub-topic, the testing of teaching materials in only one experimental class, and the lack of interactive features such as scoreboards or leaderboards. Recommendations for further development include adding more material, integrating innovative technologies such as AR (Augmented Reality), enhancing quiz features with higher difficulty levels, and adding other interactive elements to make the teaching materials more engaging and suitable for the needs of PPG students.

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Audience engagement in practice tests and instructional videos on YouTube

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ABSTRACT

As a digital video-sharing platform, YouTube has vast resources for sharing educational content. It is an accessible, open educational resource to assist the audience in gaining information and knowledge for educational needs. The research explored audience engagement and viewing patterns between two types of educational videos- instructional videos and practice test videos on a single Indonesian educational YouTube channel. It employed a quantitative descriptive approach to identify audience engagement and viewing patterns for both categories of videos. The data is collected through YouTube analytics with a population of 218 educational videos. The sample used is 139 videos chosen from the two video categories using proportional random sampling, ensuring each category is represented. The finding reveals that instructional videos have high numbers in view and shares metrics, while practice test videos topped in likes, watching duration, and average view duration metrics. This research provides insight to teachers, educational content creators, and those involved in the educational field, optimizing content strategy for digital learning resources in video formats. Further research can explore audiences' motivations for watching educational content and other metrics related to watching long or short videos that can affect audience engagement, which can provide broader insights regarding learning preferences in online video platforms.

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INTRODUCTION

Digital education has transformed significantly since the COVID-19 pandemic, changing the perspectives and educational paradigm from traditional methods to online learning. This impacts students who usually learn collectively in conventional class settings to a more personalized environment by accessing learning resources online for knowledge construction (Goel & Rastogi, 2024). Consequently, the extreme disruption of education because of COVID-19 has affected the urgency to integrate technology and learning materials to create optimized digital learning systems (UNESCO, 2024). In other words, UNESCO emphasizes the immediate need for learning access-based technology to provide sustained and inclusive education and equitable learning opportunities.

One of UNESCO's strategies to improve education practices after the global pandemic is providing Open Educational Resources (OER), defined as teaching-learning resources in any format

and medium, including videos under public domains for public use (Elango & Kumaravel, 2022). Online video platforms have indeed become essential resources for learning and gaining information to master knowledge and skills in the education sector (Cihangir & Coklar, 2021). One of the OER formats in online video platforms is YouTube, which has become a medium for providing educational content since its establishment in 2005 (Hussain et al., 2024). YouTube has emerged as a powerful educational resource with a global impact on video-sharing platforms, providing a broad educational ecosystem (Guilherme et al., 2024). It also serves as a medium for providing educational content since it has evolved into a robust educational tool for students to get a better learning experience (Chalkias et al., 2023; Quintero-Rodríguez & Colás-Bravo, 2024).

Students are loyal users of YouTube, and they explore the platform for various purposes, including learning (Roy, 2023). Given YouTube's performance as a flexible learning resource, it provides expansive educational content that is readily accessible, from instructional videos to practice test videos. Instructional videos help learners understand conceptual knowledge and critical thinking and master their studying (Beheshti et al., 2018), while practice tests, also known as practice exam videos, help students prepare for the actual examination. Despite the widespread watching of these two academic video formats on YouTube, little is revealed about how the audience engaged with each video category. The phenomenon regarding audience preferences for different educational videos is paramount to gaining exploration since there is a growing focus on engagement analytics and educational data mining to identify student engagement with learning resources for better knowledge retention (Walsh et al., 2021). Because students turn to YouTube as part of their learning journey, understanding how audiences engage with different educational videos becomes crucial.

Understanding audience engagement between instructional and practice test videos is pivotal not only for strategic content design purposes but also for improving more meaningful learning experiences. Ilin (2022) emphasizes that making decisions about creating content, as well as what, when, and how they learn, are important considerations if we want to improve the learning experience. Getting insight into engagement with learning materials is needed to understand learning behaviors, adapt instructional strategies, and address engagement declines with required interventions (Adnan et al., 2021; Seo et al., 2021). Moreover, as it has a significant role in enhancing the overall learning experience, engagement is pivotal to be understood in education and online networking platforms (Shen et al., 2022). Therefore, by exploring audience engagement for instructional videos and practice test videos, we will gain more understanding regarding audience preferences for which learning videos are preferred most and what instructional strategies can be embarked on to optimize the learning experience in the shared educational resources.

Previous studies have established perspectives regarding audience engagement in learning materials through the YouTube platform. Yang et al., (2024) studied the YTCommentQA (Question Answering) dataset to address question answerability in instructional videos. Their work highlights the challenging multimodal inputs in Video QA that still need more development. Lijo et al., (2024) analyzed the performance of STEM educational videos versus their version in an informative format on a YouTube channel, suggesting that educational videos significantly surpass the other kinds regarding engagement metrics. Meanwhile, Saurabh & Gautam (2019) studied how YouTube is used for educational purposes by exploring the author's YouTube analytics, revealing that the everyday view number aligned with the seasonal pattern, showing that viewership skyrocketed during the semester and dropped during the semester break. Walsh et al., (2019) also conducted a similar study on viewing patterns by showing 17 videos over two years, suggesting that students spent more time watching videos with related learning topics during exam periods. The studies that have been referenced have comparable highlights regarding methods to optimize instructional videos, the popularity of educational videos, and audience preferences in watching educational videos, which are more intense during the semester than during study breaks. However, there is a lack of research on how audiences watch instructional videos compared to practice test videos measured with engagement metrics. Specifically, little is known about exploring audience engagement regarding views, watching hours, likes, shares, the timing, and frequency of uploading videos throughout regular school days and exam periods. In addition, the difference from this study is that it utilizes data from the owner's YouTube Analytics to examine audience engagement, providing a quantitative perspective on user engagement for over 100 educational videos. Therefore, this study aims to

explore the engagement patterns related to practice test videos and instructional videos in one of the open educational resources, YouTube.

Understanding audience engagement from online video platforms provides educators and content creators valuable insights into developing a strategy and plan to produce quality and effective digital educational content (Jayavardhini et al., 2023). Besides, it extends to transferring awareness of the current learning dynamic, such as helping the learning media developers and education institutions as one of their references in academic programs that establish teaching and learning resources between conceptual understanding and practical exercises through online video platforms.

METHOD

This study utilized a quantitative descriptive approach, as the goal is to explore audience engagement with instructional and practice test videos on an educational YouTube channel. The approach is suitable for identifying audience preferences without intending to test specific hypotheses, giving insights into audience needs (Cohen et al., 2018; Fraenkel & Wallen, 2019). By leveraging this approach, the study provides a nuanced understanding of audience engagement within the educational videos on the observed YouTube channel.

This study utilized data from the YouTube channel owner @lulu's_learning. This channel was selected because the accessibility of data from the channel owner provided a more comprehensive analysis than what could be achieved with publicly available data (Saurabh & Gautam, 2019). The channel has a YouTube Studio, a channel-specific tool that content creators use to manage, edit, and evaluate the performance of their videos (Sweatt, 2023). The data collected on YouTube Analytics are for these metrics: Views, Watching Time, Likes, Shares, and Average View Duration. Identifying the Watch Time shows the effectiveness of students watching the video, and it indicates the extended time they spent viewing it (Walsh et al., 2019). Besides, Views, Likes, Comments, Shares, and Sharing to external platforms are the metrics that impact actions, expressions, and effects based on the four-level framework by Aldous et al., (2019). However, the Comment metric is eliminated in this study because YouTube has labeled the two types of videos as "made for kids" and "not made for kids" videos on the owner's YouTube channel, impacting the comment feature for the "made for kids" videos as unavailable due to YouTube Policy.

Data collection from YouTube analytics is generated by filtering the specific date range. The date range is from August 31, 2022 (since the channel was created) to March 15, 2024, used for data collection. The procedures involved identifying the population of 218 videos, which consist of 167 Instructional Videos and 51 Practice Test Videos. Data were collected from YouTube Analytics by filtering the data between August 31, 2022, and March 15, 2024. Still, in the Date Picker, the four metrics were chosen for the sample videos: views, watching time, likes, and shares, as well as for the average view duration.

The sampling technique used is the proportional random sampling. Proportional random sampling is the sampling of identified sub-groups represented in the same proportion in the population where they exist (Mertler, 2019). It is used to describe the representativeness of each video category. The sample numbers were determined based on the sample size table developed by Isaac and Michael, which has a margin error of 5%. As we know, the Formula 1 for the sample size is as follows.

$$S = \frac{\lambda^2.N.P.Q}{d^2.(N-1) + \lambda^2.P.Q} \quad (1)$$

λ^2 Chi-square value with 95% confidence level
P = Q = 0,5
N = Population size
D = 0,05
S = Sample size

Based on Table 1 in Sugiyono (2013), the population of 218 is nearly 220, with a margin error of 5%, which requires a 135-sample size. However, this study chose 139 videos as the samples to

increase the representative numbers. Since there are 167 instructional videos and 51 practice test videos, the proportion is determined as follows: Instructional videos = $\frac{167}{218}$ x 100% = 76.61%, and Practice test videos = $\frac{51}{218}$ x 100% = 23.39%. Therefore, a total of 106 instructional videos and 33 practice test videos were included in the sample of 139 videos.

Table 1. Proportion of Video Types

No.	Video Type	Video Population	Percentage	Video Sample
1	Instructional Videos	167	76.61%	106
2	Practice Test Videos	51	23.39%	33
Total		**218**	**100%**	**139**

RESULTS AND DISCUSSION

Results

Below are the results of audience engagement between instructional videos and practice test videos in terms of video uploading frequency, general audience engagement, duration of viewer watching in hours, average view duration, and audience engagement during exam periods.

The Frequency of Uploading Instructional and Practice Test Videos

Table 2. Video Upload Frequency (Instructional Videos)

No.	Month	Instructional Video (IV)	Total Video
1	August 2022	IV1	1
2	September 2022	IV2, IV3, IV4, IV5, IV6, IV7	6
3	October 2022	IV8, IV9, IV10, IV11, IV12, IV13, IV14, IV15, IV16	9
4	November 2022	IV17, IV18, IV19	3
5	December 2022	IV20, IV21, IV22, IV23, IV24	5
6	January 2023	IV25, IV26, IV27, IV28, IV29, IV30, IV31, IV32, IV33, IV34	10
7	February 2023	IV35, IV36	2
8	March 2023	IV37, IV38, IV39, IV40, IV41, IV42	6
9	April 2023	IV43, IV44, IV45, IV46, IV47, IV48, IV49, IV50	8
10	May 2023	IV51, IV52, IV53	3
11	June 2023	IV54, IV55, IV56, IV57, IV58, IV59, IV60	7
12	July 2023	IV61, IV62, IV63, IV64, IV65, IV66	6
13	August 2023	IV67, IV68, IV69, IV70, IV71	5
14	September 2023	IV72, IV73, IV74, IV75	4
15	October 2023	IV76, IV77, IV78, IV79, IV80, IV81	6
16	November 2023	IV82, IV83	2
17	December 2023	IV84, IV85, IV86, IV87	4
18	January 2024	IV88, IV89, IV90, IV91, IV92, IV93, IV94, IV95, IV96, IV97, IV98, IV99, IV100	13
19	February 2024	IV101, IV102	2
20	March 2024	IV103, IV104, IV105, IV106	4
Total Video			**106**

From August 31, 2022, to March 15, 2024, the uploading schedule for instructional videos showed significant variation each month. Noticeably, despite how many times videos are uploaded in a week, in January 2023, 10 instructional videos were uploaded. Meanwhile, the most frequent video upload occurred in January 2024, with 13 instructional videos.

Table 3. Video Upload Frequency (Practice Test Videos)

No.	Month	Practice Test Video (PT)	Total Video
1	October 2022	PT1	1
2	November 2022	PT2, PT3, PT4, PT5, PT6,	5
3	December 2022	PT7, PT8	2

No.	Month	Practice Test Video (PT)	Total Video
4	February 2023	PT9, PT10, PT11, PT12, PT13	5
5	March 2023	PT14, PT15, PT16	3
6	May 2023	PT17, PT18	2
7	August 2023	PT19, PT20, PT21, PT22	4
8	September 2023	PT23, PT24, PT25	3
9	November 2023	PT26, PT27, PT28, PT29, PT30	5
10	February 2024	PT31, PT32, PT33	3
Total Video			**33**

Meanwhile, the uploading schedule for the practice test videos follows an identical pattern, indicating that they are uploaded based on the specific moment, especially during the school exam periods. The time intervals are 1, 1, 2, 1, 2, 3, 1, 2, 3 (in months), with an average interval of 16/9 = 1.77 months. The video upload interval in the period above is 1.77 months, which means that practice test videos are uploaded every two months.

Audience Engagement Between Instructional and Practice Test Videos

Table 4. Audience Engagement

No.	Video Types	Total View	Total Watching Time	Total Likes	Total Shares
1	Instructional	262.774	10.117	2.993	3.950
2	Practice Test	239.842	17.186.88	3.046	3.291
Total		**502.616**	**27.304**	**6.039**	**7.421**

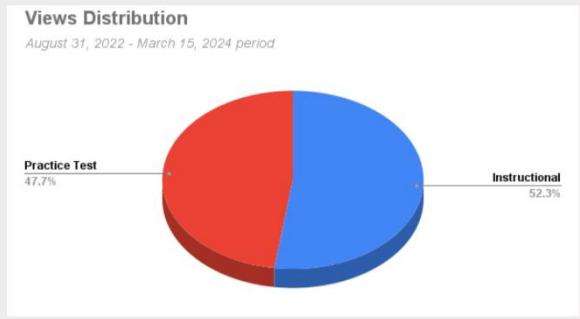

Figure 1. View Distribution

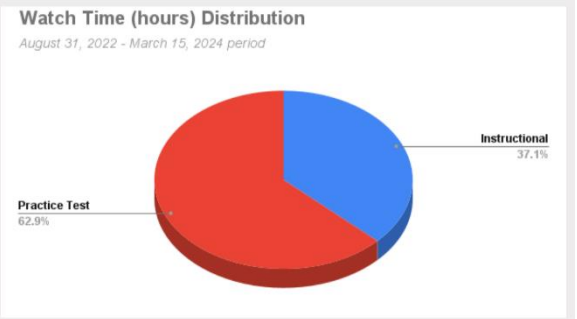

Figure 2. Watch Time Distribution

There are considerable differences between the practice test and instructional videos. Instructional videos topped the viewership with a slight difference from the practice test videos. In contrast to the viewer metrics, the watch time metrics show a significant proportion between the two types of videos. Despite the instructional videos gaining more viewers, the practice test videos exceeded the watching time proportion with 17.186 watching hours in 33 videos, while the instructional videos exceeded threefold the number of practice test videos gained less watching duration. This noticeable distinction suggests that audiences spend more time watching practice test videos than instructional videos.

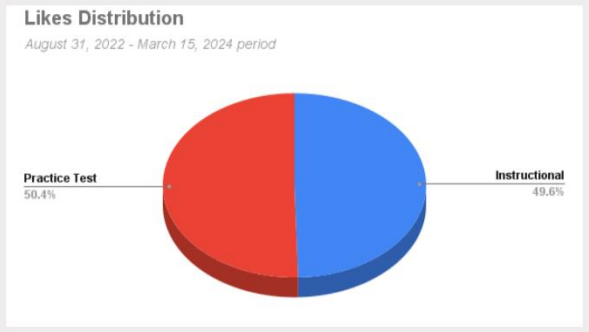

Figure 3. Likes Distribution

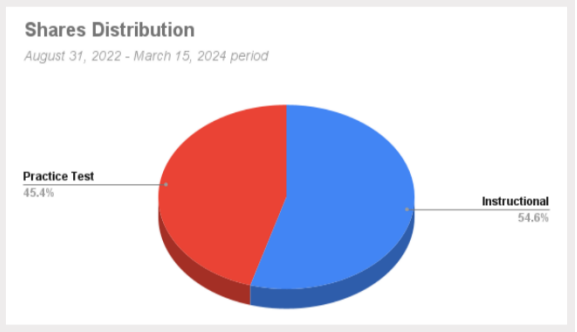

Figure 4. Shares Distribution

Furthermore, practice test videos still get more likes numbers than instructional videos, although the difference is slightly narrow. However, when the two video categories were compared regarding the distribution of shares, instructional videos gained a more noticeable increase. It was 9.2% higher than practice test videos.

Duration of Viewers Watching the Instructional and Practice Test Videos

Table 5. Instructional Videos

No.	Publish Time	Watch Time	Video	Total Video
1	2022-Aug	<100 Hours	IV1	1
2	2022-Sep	<100 Hours	IV2, IV3, IV4, IV5, IV6	5
3	2022-Sep	100-250 Hours	IV7	1
4	2022-Oct	<100 Hours	IV8, IV9, IV10	3
5	2022-Oct	100-250 Hours	IV11, IV12, IV13, IV14, IV15, IV16	6
6	2022-Nov	<100 Hours	IV17, IV18	2
7	2022-Nov	100-250 Hours	IV19	1
8	2022-Dec	<100 Hours	IV20	1
9	2022-Dec	100-250 Hours	IV21, IV22, IV23	3
10	2022-Dec	500-750 Hours	IV24	1
11	2023-Jan	<100 Hours	IV25, IV26, IV27, IV28, IV29	5
12	2023-Jan	100-250 Hours	IV30, IV31, IV32, IV33	4
13	2023-Jan	250-500 Hours	IV34	1
14	2023-Feb	<100 Hours	IV35	1
15	2023-Feb	100-250 Hours	IV36	1
16	2023-Mar	<100 Hours	IV37, IV38, IV39, IV40	4
17	2023-Mar	100-250 Hours	IV41, IV42	2
18	2023-Apr	<100 Hours	IV43, IV44, IV45, IV46, IV47, IV48, IV49	7
19	2023-Apr	100-250 Hours	IV50	1
20	2023-May	<100 Hours	IV51, IV52, IV53	3
21	2023-Jun	<100 Hours	IV54, IV55	2
22	2023-Jun	100-250 Hours	IV56, IV57, IV58	3
23	2023-Jun	250-500 Hours	IV59	1
24	2023-Jun	500-750 Hours	IV60	1
25	2023-Jul	<100 Hours	IV61, IV62	2
26	2023-Jul	100-250 Hours	IV63, IV64, IV65, IV66	4
27	2023-Aug	<100 Hours	IV67, IV68	2
28	2023-Aug	100-250 Hours	IV69, IV70	2
29	2023-Aug	250-500 Hours	IV71	1
30	2023-Sep	<100 Hours	IV72, IV73, IV74	3
31	2023-Sep	100-250 Hours	IV75	1
32	2023-Oct	<100 Hours	IV76, IV77, IV78	3
33	2023-Oct	100-250 Hours	IV79, IV80, IV81	3
34	2023-Nov	<100 Hours	IV82	1
35	2023-Nov	100-250 Hours	IV83	1
36	2023-Dec	<100 Hours	IV84, IV85, IV86, IV87	4
37	2024-Jan	<100 Hours	IV88, IV89, IV90, IV91 IV92, IV93, IV94, IV95, IV96, IV97, IV98	11
38	2024-Jan	100-250 Hours	IV99, IV100	2
39	2024-Feb	<100 Hours	IV101, IV102,	2
40	2024-Mar	<100 Hours	IV103, IV104, IV105, IV106	4
Total Video				**106**

Table 6. Practice Test Video

No.	Publish Time	Watch Time	Video	Total Video
1	2022-Oct	100-250 Hours	PT1	1
2	2022-Nov	<100 Hours	PT2, PT3, PT4	3
3	2022-Nov	100-250 Hours	PT5	1
4	2022-Nov	250-500 Hours	PT6	1
5	2022-Dec	250-500 Hours	PT7	1

No.	Publish Time	Watch Time	Video	Total Video
6	2022-Dec	500-750 Hours	PT8	1
7	2023-Feb	<100 Hours	PT9, PT10	1
8	2023-Feb	>1000 Hours	PT11, PT12	1
9	2023-Feb	100-250 Hours	PT13	1
10	2023-Feb	500-750 Hours	PT14	1
11	2023-Feb	750-1000 Hours	PT15	1
12	2023-Mar	<100 Hours	PT16	1
13	2023-Mar	100-250 Hours	PT17, PT18	2
14	2023-May	250-500 Hours	PT19	1
15	2023-May	500-750 Hours	PT20	1
16	2023-Aug	>1000 Hours	PT21	1
17	2023-Aug	100-250 Hours	PT22	1
18	2023-Aug	500-750 Hours	PT23	1
19	2023-Aug	750-1000 Hours	PT24	1
20	2023-Sep	100-250 Hours	PT25, PT26	2
21	2023-Nov	>1000 Hours	PT27	1
22	2023-Nov	100-250 Hours	PT28	1
23	2023-Nov	250-500 Hours	PT29	1
24	2023-Nov	500-750 Hours	PT30	1
25	2023-Nov	750-1000 Hours	PT31	1
26	2024-Feb	100-250 Hours	PT32, PT33	3
Total Video				**33**

During the 19 months, the audience watched 66 instructional videos under 100 Hours, distributed about every month. This indicates that 62,3% of instructional videos were watched in less than one hundred hours. Meanwhile, 35 instructional videos, or approximately 33.02%, were watched within 100-250 hours, which is longer than the earlier watch time range. This means that most videos are watched for shorter durations, while only a few videos are watched for more extended periods.

The distribution of watching time is relatively even among all 33 videos for the practice test category. Five practice test videos have been watched for less than 100 hours, with the publishing time mainly in the earlier phases. Meanwhile, 36.36% of the videos were watched for 100-250 hours. The most extended watching number is more than 1000 hours the audience spends watching four practice test videos. Compared to the instructional videos, when the highest watching time is 500-750 hours, the practice test videos have a greater number beyond 1000 hours on several practice test videos.

Average View Duration

Table 7. Instructional Videos

No.	Publish Time	View (Average)	Instructional Video	Total Video
1	2022-Aug	< 2 Minutes	IV1	1
2	2022-Sep	2-4 Minutes	IV2, IV3, IV4, IV5, IV6, IV7	6
3	2022-Oct	< 2 Minutes	IV8, IV9, IV10, IV11	4
4	2022-Oct	2-4 Minutes	IV12, IV13, IV14, IV15, IV16	5
5	2022-Nov	< 2 Minutes	IV17	1
6	2022-Nov	2-4 Minutes	IV18, IV19	2
7	2022-Dec	2-4 Minutes	IV20, IV21, IV22, IV23, IV24	5
8	2023-Jan	< 2 Minutes	IV25, IV26, IV27, IV28	4
9	2023-Jan	2-4 Minutes	IV29, IV30, IV31, IV32, IV33, IV34	6
10	2023-Feb	< 2 Minutes	IV35	1
11	2023-Feb	2-4 Minutes	IV36	1
12	2023-Mar	< 2 Minutes	IV37, IV38, IV39, IV40	4
13	2023-Mar	2-4 Minutes	IV41, IV42,	2
14	2023-Apr	< 2 Minutes	IV43,	1
15	2023-Apr	2-4 Minutes	IV44, IV45, IV46, IV47, IV48, IV49, IV50	7
16	2023-May	< 2 Minutes	IV51, IV52, IV53	3

No.	Publish Time	View (Average)	Instructional Video	Total Video
17	2023-Jun	< 2 Minutes	IV54, IV55	2
18	2023-Jun	2-4 Minutes	IV56, IV57, IV58, IV59, IV60	5
19	2023-Jul	< 2 Minutes	IV61, IV62	2
20	2023-Jul	2-4 Minutes	IV63, IV64, IV65, IV66	4
21	2023-Aug	< 2 Minutes	IV67, IV68, IV69, IV70	4
22	2023-Aug	2-4 Minutes	IV71	1
23	2023-Sep	< 2 Minutes	IV72, IV73	2
24	2023-Sep	2-4 Minutes	IV74, IV75	2
25	2023-Oct	2-4 Minutes	IV76, IV77, IV78, IV79, IV80, IV81	6
26	2023-Nov	2-4 Minutes	IV82, IV83	2
27	2023-Dec	< 2 Minutes	IV84, IV85, IV86	3
28	2023-Dec	2-4 Minutes	IV87	1
29	2024-Jan	< 2 Minutes	IV88, IV89, IV90	3
30	2024-Jan	2-4 Minutes	IV91, IV92, IV93, IV94, IV95, IV96, IV97, IV98, IV99, IV100	10
31	2024-Feb	< 2 Minutes	IV101, IV102,	2
32	2024-Mar	< 2 Minutes	IV103, IV104, IV105, IV106	4
Total Video				**106**

Table 8. Practice Test Videos

No.	Publish Time	View (Average)	Practice Test Code Video	Total Video
1	2022-Oct	< 2 Minutes	PT1	1
2	2022-Nov	2-4 Minutes	PT2, PT3, PT4, PT5	4
3	2022-Nov	4-6 Minutes	PT6	1
4	2022-Dec	6-8 Minutes	PT7, PT8	2
5	2023-Feb	2-4 Minutes	PT9, PT10	2
6	2023-Feb	4-6 Minutes	PT11, PT12, PT13	3
7	2023-Mar	2-4 Minutes	PT14, PT15	2
8	2023-Mar	6-8 Minutes	PT16	1
9	2023-May	2-4 Minutes	PT17, PT18	2
10	2023-Aug	2-4 Minutes	PT19	1
11	2023-Aug	4-6 Minutes	PT20, PT21, PT22	3
12	2023-Sep	2-4 Minutes	PT23, PT24	2
13	2023-Sep	4-6 Minutes	PT25	1
14	2023-Nov	4-6 Minutes	PT26, PT27, PT28, PT29 PT30	5
15	2024-Feb	2-4 Minutes	PT31, PT32	2
16	2024-Feb	4-6 Minutes	PT33	1
Total Video				**33**

The average view duration in Table 7 and Table 8 is derived from the selected date range in YouTube Analytics. It can be noticed from Table 7 that the duration of watching instructional videos is under 4 minutes. From the total viewers of 262.774 with 10,117 watching time (in hours), the audience spent an average of 2-4 minutes watching 65 instructional videos. 41 videos were watched for less than 2 minutes, which means 38.6% of the instructional videos remained on the lower end.

Meanwhile, the practice test videos experience a higher duration for getting audience engagement towards average view duration; despite its total views being 239.842, the hours spent are 17.187. Only one video was watched in under 2 minutes, 15 videos were watched in the range of 2 to 4 Minutes, and 4 to 6 minutes were spent watching 14 practice test videos. The top three videos have been watched for an average of between 6 and 8 minutes. In light of this, both types of videos are still watched in under 10 minutes. Despite that, the practice test videos still topped instructional videos, as the duration spent watching practice test videos is higher than that of instructional videos.

Audience Engagement Proportion During Exam Periods

Audience engagement fluctuates during exams due to academic pressure, study priorities, and limited free time. The results are presented in Table 9.

Table 9. Engagement Proportion

No.	Metrics	Instructional	Practice Test	Total	Proportion Instructional	Proportion Practice Test
1	Views	62.342	151.019	213.361	29.22%	70.78%
2	Watching	2.563.30	11.015.10	13.578.40	18.88%	81.12%
3	Likes	675	2.050	2.725	24.77%	75.23%
4	Shares	1.041	2.130	3.171	32.83%	67.17%

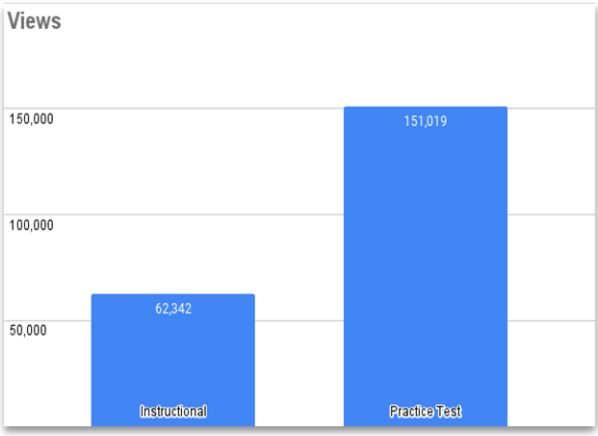

Figure 5. View Numbers

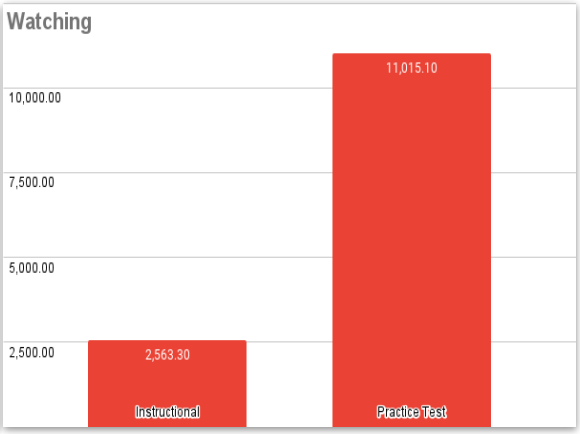

Figure 6. Watching Time Numbers

Two different types of videos are compared during the exam periods with the four engagement metrics: Views, Watching Time, Likes, and Shares. During the exam periods, the audience engaged more with the practice test videos rather than instructional videos, topping in all engagement metrics with at least 67% of the total proportion. The most significant distinction can be seen in the chart of watching time. The number of watching time in hours was almost six times higher than instructional videos, getting 2563 hours during the exam periods. This means that the audience spends more time watching practice test videos in the exam sessions, with 81.12% of total videos compared to instructional videos, which get 18.88% of watch time. Views metrics also gained a comparable number, more than twice the instructional videos' viewers.

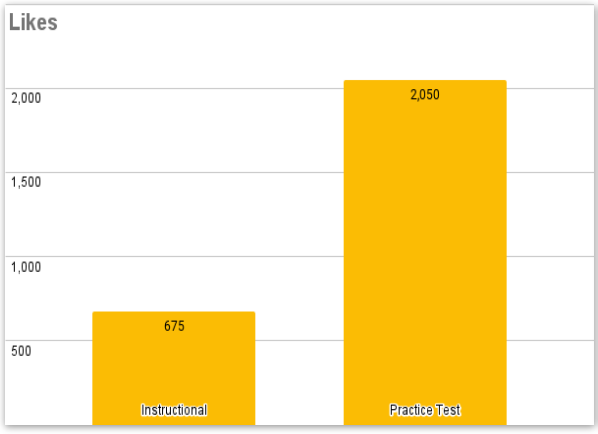

Figure 7. Like Numbers

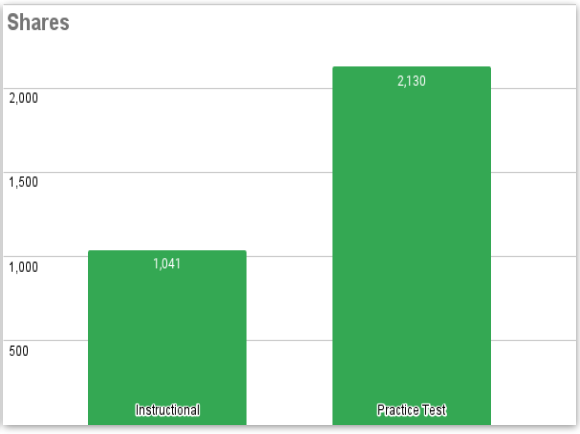

Figure 8. Share Numbers

For the Likes metrics, the audience gives more thumbs up to the practice test videos during the exams than instructional ones that get threefold lower-end thumbs up. As for Share metrics, the practice test videos still get more content sharing outside the YouTube platform, twice the sharing rate than instructional videos. Thus, practice test videos lead to engagement metrics during the exam periods.

Discussion

The frequency of uploading instructional videos in Table 2 is more intense during the selected period, while the practice test videos remain less frequent. These show that the higher upload frequency of instructional videos that lay a foundation of knowledge over time increases the viewership, as shown in Table 4, compared to practice test videos aiming to reinforce concepts tied to specific exam schedules. This is aligned with the study conducted by Saurabh & Gautam (2019) on how video upload frequency influences viewer engagement, suggesting that consistent uploads can retain viewer interest over time. Instructional videos have high viewership due to frequent uploading, meaning consistent educational video uploads boost viewers, which leads to promoting continuous learning.

Foster (2020) highlights that the more views a video gets, the fewer likes or interactions it gains in return. The pattern of these metrics is usually identical; the view count is consistently higher than the like count on a video (Dubovi & Tabak, 2021; Sui et al., 2022). These are not much different from the findings of this study, which show that instructional videos have increased viewership metrics despite the number being lower than that of practice test videos. This provides insights into educational video consumption; although popular videos are in the traffic, basic audience needs are the key, as shown by feedback given through the likes.

Shares are significant in reaching viewers, showing the video's value, increasing the video's visibility, and drawing a larger audience (Hussain et al., 2024). The higher sharing rate of educational videos means the greater educational use of learning materials, aligning with the higher view counts reflecting a consistent pattern of learner engagement (Lijo et al., 2024). This study also found similar conditions where the share metrics for instructional videos get more numbers due to their higher viewers than practice test videos. This finding indicates that instructional videos provide room for massive learning, where disseminated educational materials can promote the construction of knowledge together. It also gives insight into the importance of creating educational content that optimizes its reach and impact on a massive audience.

The proportion of watching durations for each video category is significant in Table 5, which shows that instructional videos were watched on average for less than 750 hours, while several practice test videos can reach more than 1000 hours in Table 6. From this research, it can be confirmed that students watch instructional videos for shorter durations while practice test videos are watched longer. This is a similar condition applied to the study conducted by Firmansyah et al., (2024), which shows that despite explaining videos as a valuable educational resource, it receives low student interest, showing that only 30% of students watch these videos until the end. Students select videos based on their perceived usefulness for acquiring knowledge or improving their academic performance (Dussel & Ferrante, 2023). Besides, the timing of the video's release can impact its success since it is published at optimal times for the targeted audience, who can watch it in full (Jayavardhini et al., 2023). This research confirms that practice test videos published in the intended time for students' exam preparation get more attention to be watched thoroughly.

In terms of the Average Video Duration, the instructional videos perceived less span attention as the viewers stand to watch for an average of under 4 minutes. This is not much different from the study conducted by Guo et al., (2014), who suggested that students watch educational videos for an average of 2-3 minutes, regardless of the length of the video. However, practice test videos have a much greater average view duration in the 4–8-minute range. This is aligned with the research by Dussel & Ferrante (2023), reporting that most students watch videos between 5 and 10 minutes long, as they value the content to be straightforward. The results validate prior studies and provide an awareness of how different educational video formats are used and engaged differently. Audiences are rarely influenced by popularity or external factors when watching a video because they look for the content that matters and supports their educational needs (Foster, 2020; Shoufan & Mohamed, 2022). These findings have proved the distinct average viewing time for different educational videos, which is beneficial for educators and content creators to optimize their video strategies for diverse learning goals.

During exam weeks, students are more likely to focus on specific parts of the videos and study efficiently since the content is directly related to their exams (Saurabh & Gautam, 2019; Seo et al.,

2021). Student engagement rises at the end of the class term, indicating that students become concerned as exams approach, driven by the necessity of adequate preparation (Walsh et al., 2021). This research identified a similar situation where the practice test videos gained more attention during the exam period, topping all four metrics examined, especially for the watching hours. The practice test videos during exam season draw the audience's attention immediately so that they can rehearse and familiarize themselves with potential exam questions. Students learn more effectively with educational videos that facilitate active learning and are appropriate for practice (Eamcharoen, 2024). Therefore, with the high engagement in practice test videos, this finding gives insights into providing practice test questions that often appear in the exam, followed by an explanation.

This study significantly contributes to the world of open educational resources by providing insight for educators, content creators, and other stakeholders to understand the learning dynamics in digital platforms. This research is also essential for stakeholders who will build digital content in the field of education. They need to see and read trends related to strategies for uploading digital content, in this case, on the YouTube platform and beyond, to meet the learning objectives and the audience's needs. The present study has only investigated one YouTube channel regarding audience engagement with four metrics between two video types during the selected periods, which restrains the dimension of long-term trends. Also, there is still a limitation to knowing audiences' motivations for watching educational content and other metrics related to watching long or short videos that can affect their engagement.

CONCLUSION

Based on the study described in this article discussing audience engagement between instructional and practice test videos in a single YouTube channel, the instructional videos gained high views and shared metrics. In contrast, the practice test videos topped in likes, watching duration, and average view duration metrics, especially in the exam periods. This finding presents an educational phenomenon of audience preferences in the digital learning ecosystem; therefore, the implications can provide references to teachers, educational content creators, and those in educational sectors when designing and producing learning resources in video format. Further research can explore audiences' motivations for watching YouTube educational videos. It is also an area of exploration to other metrics with long-term trends, as well as whether long or short videos can affect audience engagement, which can provide broader insights regarding audience engagement in YouTube educational videos.

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From logs to insights: A comprehensive framework for data-driven learning insights

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ABSTRACT

This study develops a theoretical framework for learning analytics utilizing data from the Moodle Learning Management System (LMS). Despite Moodle's extensive use in educational settings, its potential for learning analytics remains underutilized. This research aims to design a predictive framework for identifying learning difficulties through Moodle's internal analytics, incorporating various data points such as activity completion, attendance logs, social interactions, and learner habits. The study employs a research and development methodology with three main stages: (1) needs analysis and learning component identification, (2) theoretical framework design, and (3) validation through focused group discussions with learning experts. The framework integrates predictive modeling for learning retention, task load analysis, and personalized learning style assessments based on the VARK model. Results demonstrate that the framework effectively uses Moodle's default logs for analyzing learner behavior, although it is limited to online interactions within the LMS. Validation confirms its alignment with Moodle's architecture and online learning theories, with minor adjustments for task load components. The framework offers a scalable solution for institutions managing large student populations and varied learning models, serving as a foundation for early intervention and improved learning outcomes. Future studies could expand the framework's scope to include offline and face-to-face interactions.

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INTRODUCTION

Moodle has become the choice of many learning organizations, from primary education to higher education. The implementation of Moodle LMS also varies, initially as a tool for organizing online learning (Irawan & Surjono, 2018), to hybrid learning (Nugroho, et al., 2024; Nugroho, et al., 2024; Siswanto et al., 2023). The variety of topics taught also varies, ranging from language (Rokhmah et al., 2022) and science (Irawan & Surjono, 2018; Rizki & Daniamiseno, 2019) to vocational learning (Kusumaningrum & Marpanaji, 2014). These various implementation scenarios also illustrate that Moodle has become a reliable LMS that can be implemented in various scenarios (Gunawan et al., 2024).

Although there have been many implementations of learning with various innovative scenarios (Saputra & Putra, 2021), the potential of Moodle as a Learning Management System (LMS) is still not fully explored. The use of Moodle is still limited to facilitating learning to support distance learning and independent learning. Moodle holds various potentials, such as an activity completion feature that can track learners' activities towards the content in Moodle, an attendance plugin that tracks learners' attendance, chat with peers through Moodle, public discussion on learning forums, to system log records that track and store all activities and behaviors of LMS users (Molins & García, 2023; Peraić & Grubišić, 2022; Verdú et al., 2021).

One form of advanced implementation of Moodle is in the development of a learning analysis system. By default, Moodle has a feature that can send alerts to teachers if there are students who have the potential to not pass a lesson. This feature is less flexible and cannot be customized without having to make changes to the main Moodle source code. The implementation of learning analytics has been done in many higher education institutions, and various results have been obtained such as recommendations for improving courses in the LMS, variables that affect learner achievement, and visualization of learner behaviors (Einhardt et al., 2016; Mwalumbwe & Mtebe, 2017; Yassine et al., 2016).

There have been many studies on Moodle. Molins & García (2023) utilize Moodle as a learning environment that promotes learning regulation ability. In promoting learning regulation, a learning design is developed that can be personalized according to the learners' wishes. The result of the personalization is used in learning analysis. The process of monitoring learning is done through monitoring the completeness of learners' learning activities. In addition, the research with the theme of social interaction, which was conducted by Verdú et al., (2021), demonstrates the capability of Moodle as a system that can seamlessly connect learning in virtual and non-virtual environments. This research also provides insight for educators into the learning process of learners through the aspect of communication both with peers and with learning content.

This study aims to develop an analytical framework for learning based on the components within a learning management system (LMS). In prior research conducted by various scholars, the assembly process among learning component variables was primarily based on gaps identified in empirical studies. However, no comprehensive framework has yet been established to fully integrate all variables and LMS components into a cohesive learning analytics system. The expected outcome of this research is a theoretical framework that can serve as a guideline for designing evaluation techniques for learning conducted through LMS platforms.

METHOD

This study is a research and development type with a product in the form of a theoretical framework intended to predict learning difficulties based on various data points sourced from Moodle LMS and other brand LMS. In this research, the development model adopted is the circular prototype model because it provides convenience in the process of developing technological designs (Pressman & Maxim, 2020), however, in this research, the circular stage is not carried out in full, but only emphasized on the product development stage of the theoretical framework. This research has three main stages, namely (1) Needs Analysis & Identification of Learning Components, (2) Design of the theoretical framework of the prediction model, and (3) Evaluation of the framework based on scientific literature review. The research procedure overview can be seen in Figure 1.

The stage of Needs Analysis and Component Identification is focused on the availability of learning components supported by internal LMS analytics. The availability of learning components on the LMS can significantly affect the model to be developed. In the theoretical framework design stage, it is the main process in the research stage. At this stage, the output is a draft design of the learning analytics framework that will be evaluated through a literature review. The findings or fundamental errors found in the third stage it is used as a reference in revising the draft that has been made. The flow of the second and third stages is circular. Circular stages open opportunities

to improve and strengthen the developed model so that it can be used as a reference in building applicable products through the model that has been developed.

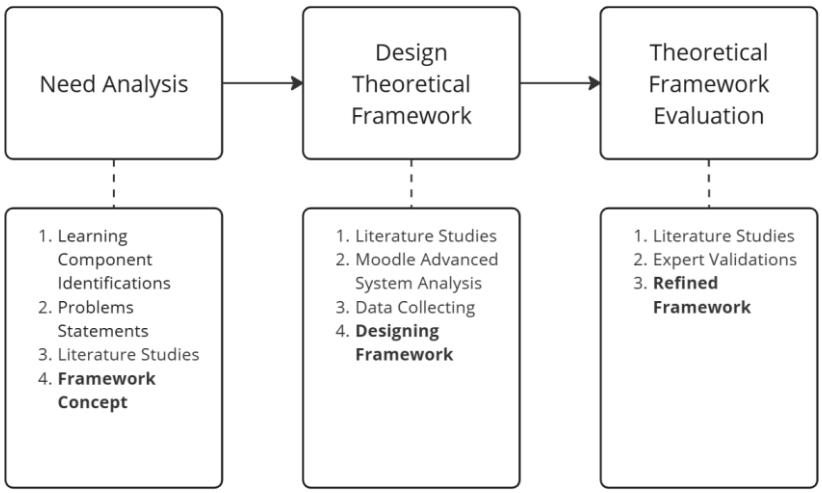


Figure 1. Research Procedure

The validation process for the developed framework is carried out through focused group discussions with a panel of learning experts. The validation process includes assessing the relevance and interconnection of components and aspects based on empirical studies, as well as their alignment with conventional and online learning theories. The panelists are entrusted with the mandate to provide the final decision regarding the accuracy of this framework based on the outcomes of discussions among researchers and participants.

The data sources used in this research are primary and secondary data. Primary data is system recording data or logs on SIPEJAR Moodle. Secondary data consists of scientific literature published in open access with topics in the scope of learner habits, learning strategies, learning outcomes, learning styles, use of AI in academic life, social learning relationships, self-determination theory, and self-regulated learning. The system records used in this study are RAW_LOGS data that have not been processed, so a cleaning & normalization process is needed so that it can be used in further research processes.

The final product of this research is a learning analysis construct model that can be used as an early warning system by institutions that have a massive number of students with various models of learning conducted in LMS.

RESULTS AND DISCUSSION

Results

Needs Analysis & Identification of Learning Components Stage

At the stage of analyzing learning needs and components, findings were obtained on the learning process at the State University of Malang through the SIPEJAR LMS. In general, the learning delivery process is carried out face-to-face and online. Face-to-face delivery of material is conducted in the classroom, while digital delivery is through SIPEJAR. However, few lecturers conduct asynchronous learning, which is fully conducted through SIPEJAR as a medium for delivering material, and students access it on demand through their respective devices at any place and time (Soepriyanto & Kuswandi, 2021).

In analyzing the learning components in the LMS, SIPEJAR supports many data points that can be used as a reference to assess the quality of learning carried out by learners. SIPEJAR supports data points such as duration spent in accessing and interacting with SIPEJAR, learning content downloaded and viewed, delay in collecting assignments, and social relationships between learners through forum discussions and private chats (see Table 1 SIPEJAR Data Point for the

overview. In the context of learning components, SIPEJAR can support accommodating various learning components needed, but unfortunately, not all learners present learning components in SIPEJAR (Adi et al., 2024; Soepriyanto et al., 2021). This happens because the learning process carried out at the State University of Malang runs in a hybrid manner so that some components are presented in face-to-face meetings and the rest are presented in virtual meetings that run asynchronously (Soepriyanto et al., 2022).

Table 1. SIPEJAR Data Point

No.	SIPEJAR Learning Components	Data Points Availability
1	Duration Spent on LMS	Available Through Logs
2	Last Course Access	Available Through Logs
3	Learning Content Views	Available Through Logs
4	Delay in Submit Assignments	Available Through Logs
5	Social Interaction on Course via Forums	Available Through Logs
6	Private Social Interaction	Available Through Logs
7	Applied Learning Models	Not Available
8	Login Frequency	Available Through Logs
9	Presents Rate	Available Through Logs
10	Learning Content Download	Not Available Natively
11	Learning Content Shared	Not Available Natively
12	Work hours	Not Available Natively
13	Grades	Available Through Logs
14	Dropout Prediction	Opt-in Featured Natively

Developing the Learning Analytics Theoretical Framework Stage

The second stage is to develop the framework of the learning analysis system. The core structure used as “information nodes” is extracted from basic Moodle course Moodle logs & activity completion (Mwalumbwe & Mtebe, 2017). The prediction system modeling on learning retention uses data derived from attendance log records, frequency, and time spent on the LMS. The data is used to predict students' habits in accessing the LMS (Ademi et al., 2019). The basic rule used in this prediction is "if a learner does random access without any consistent time pattern, then the learner may be at risk of abandoning the learning process". The prediction model based on this pattern allows the analysis system to use a risk-based approach based on the anomaly or irregularity value of the student's activity. The higher the risk value, the more signals are sent to the "intervention" node.

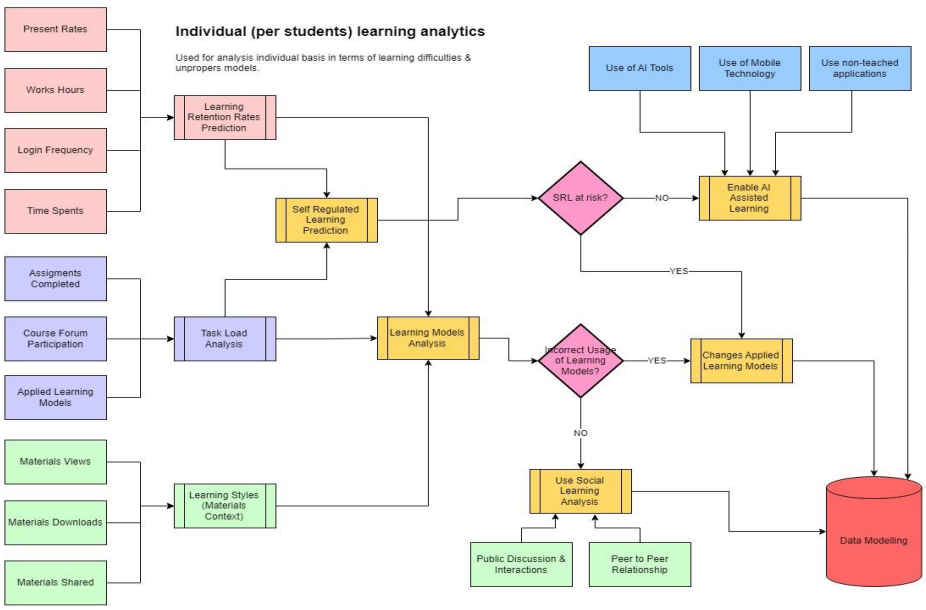


Figure 2. Learning Analytics Frameworks

The information needed in the task load analysis is the tasks completed, participation in learning forums, and learning models used. In the task completion node, the form of tasks, outcomes, and deadlines are significant considerations in determining the task load experienced by learners. The type of task, outcome, and deadline influence students' stress levels (Hidayat et al., 2021; Rahayu & Sari, 2023).

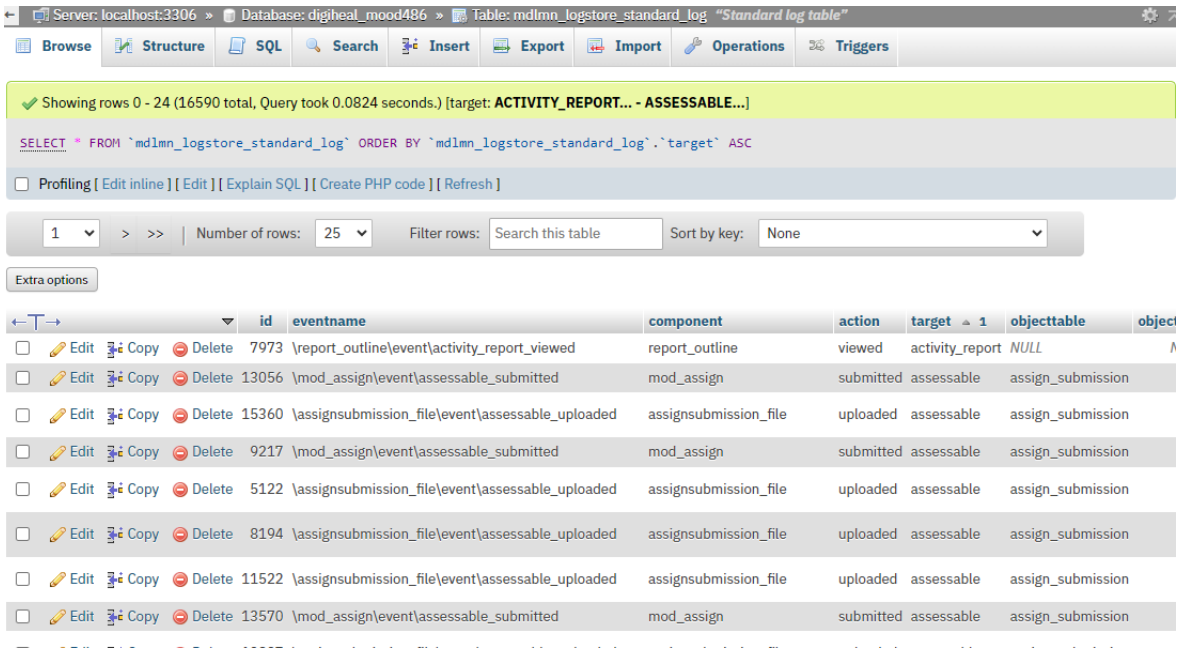
In the learning style analysis section, the VARK framework (visual, auditory, reading, and kinesthetic) is used to determine the learning style of the learners. The selection of VARK as a learning style prediction modeling framework is because Moodle Logs supports logs that can record the material access behavior used by learners (Chung & Ackerman, 2015; Karagiannis & Satratzemi, 2018). The use of VARK in learning style analysis has also been widely done, especially in presenting personalized learning in the organization of learning content (Ikawati et al., 2020; Papanikolaou & Boubouka, 2020).

In addition to enabling social learning scope for the analytics Moodle, the logs must be extracted from the "site-wide" logs system that makes user communication in other than course-related space to be included in the analysis. Social interaction in online learning, especially in LMS, has a significant role in learners' knowledge construction. By analyzing social interaction in LMS, it is possible to know the exchange of knowledge and information between learners in the online learning environment (Hernández-García & Conde-González, 2016; Kaliisa et al., 2019; Saqr & Alamro, 2019).

In the sake of accommodating the use of Artificial Intelligence, its used another data point used for measuring students attitude toward AI (Chai et al., 2024; Suh & Ahn, 2022; Wang & Chuang, 2024). The use of AI in the learning process has become widespread, even deliberate, to assist the learning process (Maningtyas & Kusumadewi, 2023; Murcahyanto, 2023; Suharmawan, 2023; Wibowo et al., 2023).

Framework Model Validation Stage

After the model framework was developed, it was validated through focus group discussions with panelists and peers to ensure that the framework was in line with the Moodle architecture and the learning process. The result is that the framework is valid within the scope of the Moodle architecture but needs minor adjustments to the task load analysis. The adjustment needed is to remove the node 'quiz/final semester exam load' because it is beyond the control of the learner. The result can be seen in Figure 2 as a valid modeling framework that is suitable to be used as an analysis framework.



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Edit Copy Delete	15360	\assignsubmission_file\event\assessable_uploaded	assignsubmission_file	uploaded	assessable	assign_submission
Edit Copy Delete	9217	\mod_assign\event\assessable_submitted	mod_assign	submitted	assessable	assign_submission
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Figure 3. Raw Unprocessed Moodle Logs Data

Learning Analytics Framework Implementation on SQL

To perform the analysis, SQL Query is used as a tool to run the processing of the raw data contained in the Moodle logs database. In the Logs database, all system activities are recorded without any filter, therefore, SQL Query is used to filter the activities that will be used in the process of predicting learner behaviors. One of the examples in Figure 3 is the filter result of assignment collection activities from various courses and students enrolled in Moodle. Many tools can be used in processing system logs from Moodle, but the use of SQL is the most appropriate choice. SQL is the native query language of the database used in Moodle. Besides SQL, the use of high-level technology services such as Google Cloud NLP is a promising option to perform sentiment analysis on messages published on forums or Moodle courses (Baharuddin & Naufal, 2023; Baihaqi & Munandar, 2023; *Cloud Natural Language*, n.d.; Jazuli et al., 2023; Nugroho, et al., 2024).

Discussion

This research has developed a basic framework that empowers Moodle Logs as a data source for analyzing the learning styles of learners. The data sources used are nodes that are available by default in Moodle without any special modifications. Please note that the framework that has been developed is a basic framework created from scientific literature related to learning styles and student success, so there are still parts that can be further developed. The biggest drawback of this framework is that it is still unable to consider interactions that occur outside the LMS, offline activities, and face-to-face interactions with learners. However, this framework will be useful for learning that is specifically organized online, and the interaction is done entirely through the LMS.

Although the analysis process is complex to perform in-house, plugins that power the Moodle Logs in real-time can be used. This study was conducted by Kadoic & Oreski (2018) in the context of higher education at the University of Zagreb. The result was that learner success had a significant correlation with the number of logins and time spent on the Moodle LMS. In addition to interaction with the features of Moodle, Lerche & Kiel (2018) analyzed the learners' interaction with the computer through the cognitive framework through keystrokes on the keyboard, mouse presses, and independence in using the LMS. It was found that physical activity with computer input devices does not significantly affect self-reliance in managing learning on the LMS, which is the main factor to achieve success. The design of the LMS must also be adjusted to the learning objectives. Soepriyanto et al., (2021) because it has a high correlation with learner learning outcomes.

This research does not discuss the algorithm used to find the sweet spot of the predictions used in the analysis, but rather the relationship between the components in Moodle Logs and learning behavior. Tamada et al., (2021) tested several algorithms that can be used to predict learner performance through Moodle Logs with the input of learning duration on the LMS. Through various duration parameters and student groups with low and high risk, it is found that the Random Forest algorithm has the best performance in predicting learner performance. Ademi et al., (2019) compared algorithms between Decision Tree, Bayesian Network, and Support Vector Machine to find the correlation between system activity on Moodle Logs and learner success. The result is that the Decision tree has the highest prediction accuracy. Conijn et al., (2017) also made the same prediction with more courses and a massive number of students with blended learning implementation. The result is that it is not enough to rely on LMS data in blended learning. The predicted results do not have similar results and even seem to have their characters between the courses that have been analyzed. From these two studies, Log data on Moodle cannot necessarily be used in all learning contexts and implementations.

CONCLUSION

This research aims to develop a learning analysis system framework that can be used to analyze learner behavior. This study is conducted through a literature study that discusses components in the LMS that can be used to predict learning outcomes, behavior, and the use of

artificial intelligence in the learning process. In the end, a learning analytics system framework is produced with the data source coming from Moodle system log records. This framework model is a theoretical framework and needs to be further investigated in real and massive learning environments such as universities and Moodle-based MOOCs. The weakness of this framework is that it focuses on student activities on Moodle; it still does not accommodate learning models that allow students to learn outside the LMS system. So, it is necessary to develop a more appropriate framework to measure the behavior of learners outside the LMS objectively and measurably. For future research, we can consider activities outside the LMS in building a learning behavior analysis framework. The use of simple algorithms can help build a simple prediction system for behavioral nodes. Considering the cognitive load that is present in both the material presented by the lecturer and the analysis of the difficulty of quizzes and exams.

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UMM metaverse batik as a learning media to introduce nitik batik motifs in the Sonobudoyo Museum

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ABSTRACT

The exposure of Yogyakarta's Nitik Batik motifs is one of the important efforts to maintain and introduce Indonesia's cultural heritage to the younger generation. In this context, metaverse-based learning media is used as an innovative solution. This research discusses the implementation of metaverse-based learning media with an Extended Reality (XR) approach to introduce the Yogyakarta Nitik Batik motif. This research uses the Game Development Life Cycle (GDLC) development method to design a VR-based Batik museum virtual space, with black box testing and refinement testing to assess functionality and fun aspects. Involving 33 participants from visitors to the Sono Budoyo Batik exhibition in Yogyakarta, this study analyzed the data descriptive quantitative to develop recommendations for improving user experience and introducing Yogyakarta Nitik Batik culture through the metaverse. The test results showed that the virtual space of the Batik Museum passed the functional test without failure and had a feasibility rate of 86.1% in the category of "Excellent." These findings indicate that VR technology effectively introduces and preserves Batik culture, especially as an educational material in virtual media. This metaverse based learning media is anticipated to be an innovative step in introducing Yogyakarta's dotted Batik while offering a valuable immersive experience for users. Future research can be done by adding gamification to increase visitor involvement and optimizing multimedia aspects that have not been the main focus.

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INTRODUCTION

The cultural richness of Indonesia is highly diverse, spanning from music to ancient forms of written art. One enduring cultural facet that remains preserved is Batik (Ripai & Kunci, 2021). Batik stands as an iconic cultural symbol of Indonesia, acknowledged as a cultural heritage by UNESCO on October 2, 2009 (Wulansari et al., 2022). In Javanese, the term "Batik" originates from "mBatik" (to write) and "titik" (dot or point), signifying the act of drawing dots on cloth (Sari, 2018). Batik encompasses a wide array of patterns or motifs, traditionally drawn on fabric. These patterns are recurrently arranged to illustrate a fundamental motif throughout the fabric. Originating on the island of Java, Batik has expanded to various regions across the archipelago, resulting in the creation of diverse motifs corresponding to respective regional cultures. This diversity makes it challenging for people to distinguish between the various Batik motifs and their regional origins (Flaurensia et al.,

2016). The development of technology in the modern era has significantly influenced multiple aspects of life. One notable impact of technology is the digitization of education and culture. In the realm of education, it has been observed that the presence of online learning media or digital tools has a positive impact on learning motivation, academic achievement, and engagement in the learning process (Mandasari, 2020).

Furthermore, technology also plays a significant role in providing different explorative experiences towards culture. Batik encompasses various motifs in different regions across Indonesia. One of these is “Batik Nitik," originating from the Yogyakarta region. Modern technology has enabled us to comprehend and appreciate this cultural heritage in new ways. One such method involves the use of metaverse technology. The term "Metaverse" is a compound term consisting of the elements "Meta" and "universe," referring to a post-reality, perpetual universe that merges the physical world with the digital virtual world (Mystakidis, 2022). According to Zhang et al., (2022), the metaverse is defined as a technology that signifies the creation of a new virtual universe that surpasses the real world. The metaverse is a reality that enables user interaction and provides functionalities similar to real-life scenarios (Mystakidis, 2022), such as engaging in commercial activities, socializing, learning, teaching, and even virtual meetings like conferences. The metaverse can be accessed through various platforms, ranging from Desktop Web, Android, and iOS to VR Headsets.

In the context of technological innovation, Extended Reality (XR) has become a highly compelling concept. XR is a general term that encompasses all immersive technologies generated by computers. XR includes virtual reality (VR), augmented reality (AR), and mixed reality (MR) (Çöltekin et al., 2020; Rauschnabel et al., 2022). XR technology has significantly transformed our learning paradigms and interactions with culture. As a learning medium, XR enables society to explore worlds previously inaccessible through traditional methods (Sulistiani et al., 2023). With the aid of XR, entire communities can obtain in-depth and detailed visualizations of objects or environments being studied (Haris & Purbojo, 2024). Furthermore, the use of XR allows for more intimate interactions with the content contained within the XR environment itself. Additionally, the benefits of the metaverse can enhance the desire to learn, as the nature of augmented reality present in the metaverse can elevate students' imaginations with the real world directly (Pauji et al., 2022). Education today is not merely collaborating with technology but has become a potential source for developing education in the era of digitalization (Wijayanto et al., 2023). Presently, we are amid the fifth industrial revolution, characterized by a world of virtually limitless life or communication, supported by the internet, digital technology, computers, and other devices. The rapid advancement of technology is beyond human comprehension (Harianto, 2021).

With the potential of XR (Extended Reality) technology in both education and cultural appreciation and the difficulties in preserving cultural treasures such as the distinct Yogyakarta dot motif Batik, there exists an opportunity to fuse these components into metaverse-centered educational tools. However, as of now, there's a lack of research that explicitly combines XR technology with teaching the intricate patterns of Batik within the metaverse setting. Studies focusing on educating about Batik designs through metaverse learning tools are infrequent. Present research solely showcases a metaverse exhibition of Batik, primarily intending to market or enhance Batik sales following the COVID-19 pandemic (Purnawirawan et al., 2022). Hence, metaverse-based learning resources are evolving as an innovative approach, particularly in introducing the Yogyakarta dot motif Batik and delivering an immersive encounter for users.

This research aims to create a Batik museum virtual space that can be accepted by the public to preserve Batik culture as an Indonesian cultural heritage and focus on introducing the Yogyakarta-dotted Batik motifs. Alongside technological advancements in the modern era, the digitalization of education and culture has significantly provided positive impacts. This method is expected to enhance motivation for learning Batik, a cultural heritage owned by Indonesia, especially among the younger generation tasked with perpetuating this culture. Furthermore, this technology enables exploration and appreciation of cultural heritage, such as Batik, in new and immersive ways. Thus, this metaverse-based learning media is anticipated to serve as an innovative step in introducing Yogyakarta's dotted Batik while offering a valuable immersive experience for users.

METHOD

This research applied the development method as the main approach. The development model used is Blitz Game Studio's Game Development Life Cycle (GDLC), which consists of six stages: 1) Pitch, 2) Pre-production, 3) Main Production, 4) Testing, 5) Beta, and 6) Master. In the fourth stage, format details testing using the black box method was conducted, as well as refinement testing that focused on the fun and quality aspects of the virtual space that had been developed. The three main components that contribute to the fun experience in this media are expectations, engagement, and endurability, which are measured through playtesting using a Likert scale. This study involved visitors to the Sono Budoyo Batik exhibition in Yogyakarta, with participants randomly selected from visitors who were willing to try the metaverse application during the exhibition. A total of 33 participants, consisting of men and women aged 10 to 50 years, participated in this study. The data obtained was analyzed using a quantitative descriptive method based on the results of the participant questionnaire. The results of this analysis are used to formulate conclusions and recommendations related to the development of metaverse applications to introduce culture, especially Yogyakarta Batik Nitik motifs, with an emphasis on multimedia aspects and optimal user experience. The stages of this research can be seen in Figure 1.

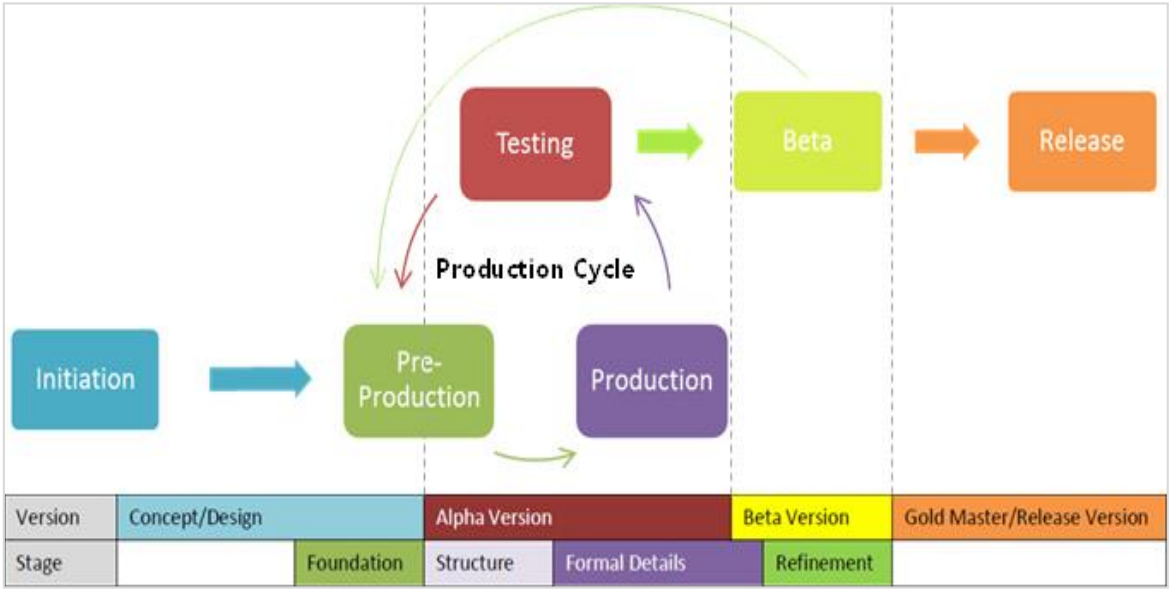

Figure 1. The Flowchart Development Process of Batik Metaverse

RESULTS AND DISCUSSION

Results

The conventional method of familiarizing oneself with Batik patterns, typically limited to museum visits, has now transformed into a repeatable experience through the virtual realm or metaverse. Sono Budoyo Museum stands out as one of the institutions showcasing a diverse array of Indonesian arts, notably Yogyakarta's Batik Nitik. Utilizing metaverse-based applications employing an Extended Reality approach, the exploration of Batik motifs serves as an educational tool, aiming to sustain Indonesia's cultural heritage. The educational tool developed to introduce Yogyakarta's Batik Nitik motifs in this study is a 3D simulation environment constructed using the Unity Game Engine. This virtual space is accessible across various platforms such as PCs, mobile devices, Virtual Reality Headsets, and other gadgets supporting Augmented Reality mode. Users can convene within this developed virtual space, echoing the concept of metaverse technology. This metaverse application is accessible via the spatial.io website under the name UMM Metaverse - Batik, leading to an interface resembling the depiction in Figure 2, and can be accessed at https://bit.ly/40W84Xb.

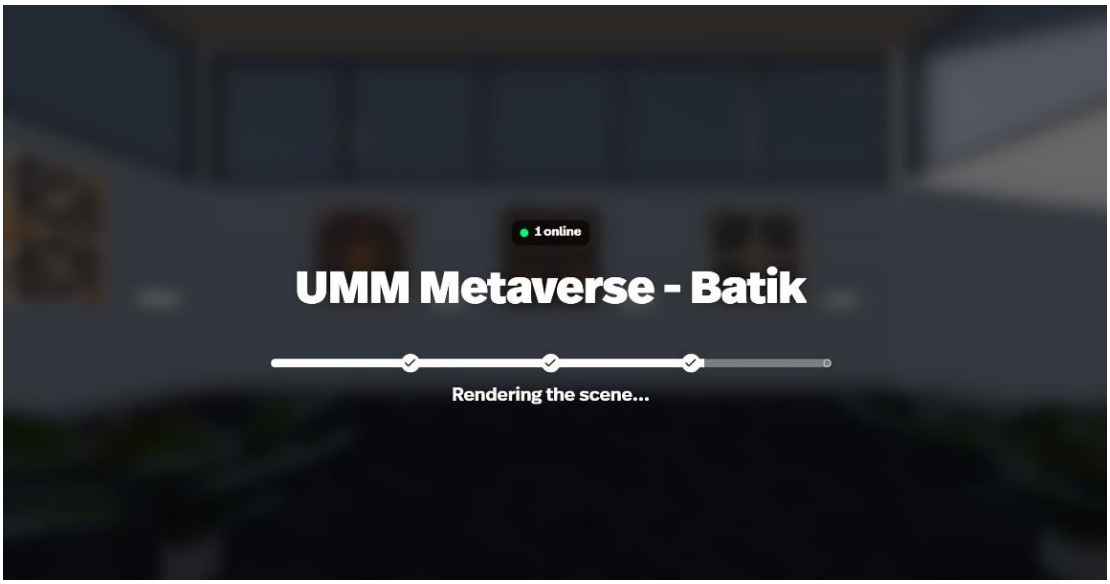

Figure 2. Thumbnail Screen

A compelling aspect of the metaverse is the ability for users to create virtual identities or avatars, representing themselves within this digital realm. The metaverse presents substantial potential across diverse domains, encompassing education, entertainment, business, and the cultural arts. For instance, it serves as an innovative platform for remote learning, including the exploration of Batik patterns.

Following the appearance on the page, there will be guidance for logging in and subsequently choosing an avatar. However, if accessed through a mobile device, users are obligated to first download the spatial application from the Play Store. Once the user has logged in, the interface resembling image 2 will become visible below. Figure 3 shows a sample of the Batik virtual space.

Figure 3. Sample of Batik Virtual Space

On that page, there is an audio feature of gamelan sounds to make the application more realistic as if one were in a museum exhibition. Additionally, there are instructions located in the bottom left corner in the form of a black box to guide users in navigating the application, such as walking towards the Batik exhibition or enlarging the layers to see the displayed Batik motifs. Furthermore, the names of the available Batik motifs are provided, as shown in Figure 4 below.

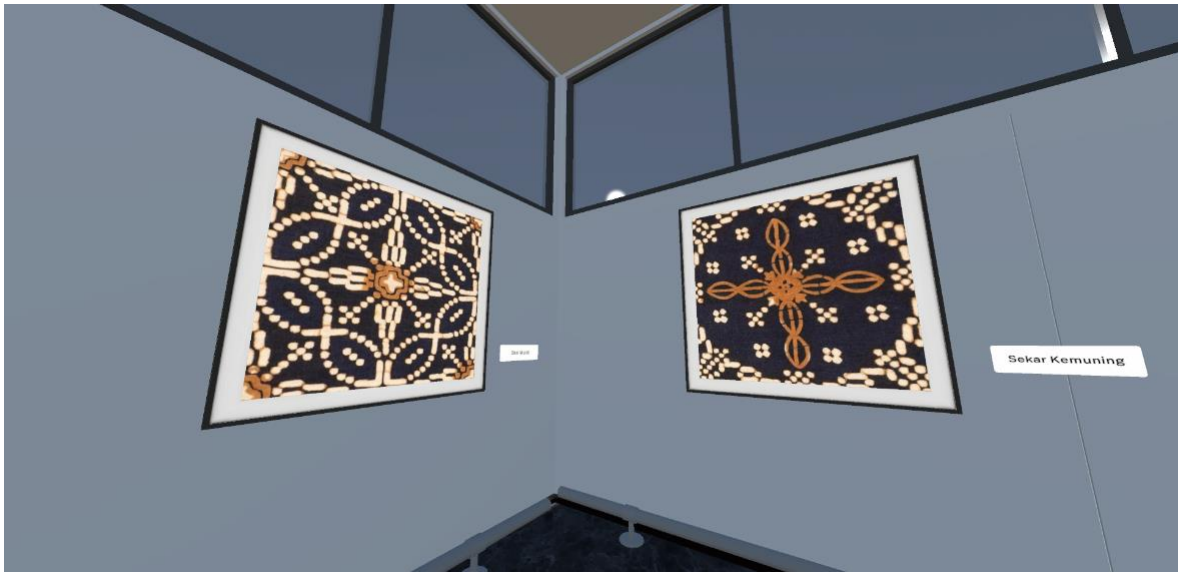

Figure 4. Batik Displays

Following the observation of Batik patterns through the application, participants were requested to complete a survey provided by the researcher. This study was conducted with 33 attendees of the exhibition, including 17 men and 16 women, spanning ages from 10 to 50 years. The research employed a 25-question survey to gather data after the participants' use of the Metaverse-based application with an extended reality approach focused on Batik Nitik Yogyakarta. The survey results will be classified into 5 distinct categories, ranging from very low to very high, as outlined in the accompanying figure.

Two types of testing were conducted, namely, alpha testing and beta testing. Alpha testing uses the black box method and refinement testing to test the success of functionality in virtual space. Alpha test participants involved three developers and one quality assurance person. Alpha testing covers the three main aspects of creating a fun experience in media, namely expectations, engagement, and endurability. The refinement testing process is done through playtesting, which aims to observe and document all feedback from testers, including any bugs, gaps, or failures found, as well as their responses regarding the fun aspects of the game.

The results of black box testing that has been carried out show that the functionality provided in the virtual space of the Batik Museum can function properly and by the input. After alpha testing is passed, the next stage is beta testing involving external parties, namely visitors to the metaverse booth stand at the Sonobudoyo Yogyakarta Batik Museum. Based on the results of the questionnaire sheets that have been distributed, a recapitulation is carried out to analyze the virtual space of the Batik Museum, which has been filled in by 33 respondents who are virtual space users. The following is a graph of the results of beta testing for each question based on the results of the calculations that have been carried out.

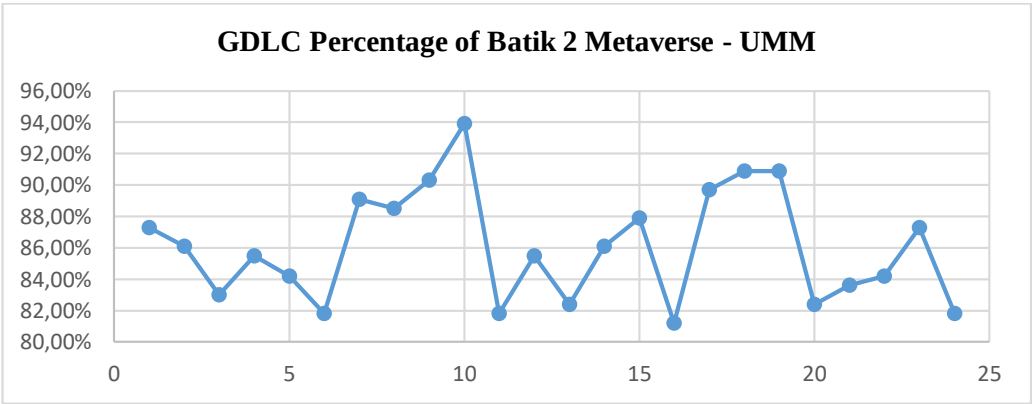

Figure 5. Percentage Chart of Batik 2 Metaverse – UMM

From the results of beta testing (see Figure 5), the Batik Museum virtual space obtained an average percentage of 86.1%. The highest percentage value of 93.9% for the tenth question assessment regarding the images available can give an attractive impression in the virtual space environment. The questionnaire results show that the text, images, audio, animation, and controller in the batik virtual space get a positive assessment from the respondents. The text is considered easy to understand and relevant, the images are considered high quality and give a real impression, the audio fits the atmosphere and enhances the experience, the animation strengthens the visualization and is not overwhelming, and the controller is easy to use and very responsive. Overall, these elements support comfortable and effective interaction in the virtual space, and the design of the batik museum virtual space using the GDLC method can make it easy to understand and can also increase public interest in batik culture.

Based on the survey analysis, individuals aged 49 experienced difficulties in understanding and reading the text in the application, whereas others found it clear and easy to read. This difference may be due to age-related vision issues or challenges in understanding English, as mentioned in the application's instructions. In terms of images, audio, and animations, most participants perceived them as clear and comprehensible. However, many users expressed dissatisfaction with the controller, likely due to unfamiliarity or difficulty in maneuvering avatars, particularly for first-time users. This indicates that there are still attendees at the exhibition who might not fully grasp the application's usage or for reasons not explored, like age constraints in adopting technology or other unidentified factors. Nevertheless, over 60% of the surveyed participants affirmed that the Metaverse-based media utilizing Extended Reality techniques is deemed effective, ranging from good to excellent, in introducing the Batik Nitik motif from Yogyakarta.

Discussion

As media becomes an essential human requirement, it evolves alongside the development of electronic platforms in the virtual realm (Hapidz et al., 2022). Education and learning in various activities cannot disregard technological advancements (Indrabayu et al., 2022). Instead, such progress can be leveraged as a positive tool, such as in familiarizing individuals with the Batik Nitik motif. Hence, all societal segments, whether voluntarily or not, must prepare for and engage in understanding these developments.

The era of education influenced by the Fourth Industrial Revolution has now utilized digital technology in the learning process known as the cyber system, where this system is capable of making the teaching and learning process happen without spatial or temporal limitations (Endarto & Martadi, 2022). Research conducted by Raharja et al. resulted in the recognition of the Yogyakarta Batik motifs using Backpropagation Artificial Neural Network technology to create learning media using various technologies to introduce Batik motifs to the public (Raharja & Widyatusti, 2022). Furthermore, research conducted by Sanjaya et al., introducing Batik motifs using the metaverse, serves not only as an educational tool but also as an opportunity to introduce Indonesian products and seek attention from many people, fostering numerous expectations within the metaverse. Moreover, the possibility of connecting many people globally in one location is also feasible (Sanjaya et al., 2022).

In the research conducted by Handayani, it was stated that the community lacks sufficient knowledge about the various types of Batik. Considering that the artistic creations of Indonesian Batik motifs need to be preserved and legally established for the learning of the nation's future generations (Handayani, 2023). The preservation of Batik is consistently confronted by issues related to the lack of knowledge within the community and the shortage of skilled human resources proficient in Batik-making (Suryaningsih et al., 2016). Therefore, the creation of educational media becomes a valuable development to introduce Batik motifs to the community, enabling them to expand and preserve the cultural heritage owned by Indonesia.

CONCLUSION

This research has designed a UMM Metaverse Batik using the Game Development Life Cycle (GDLC) method. The test results show that all functions in the virtual space of the Batik Museum

pass the functional test based on black box testing without any failures. In addition, the refinement test shows a feasibility level of 86.1%, which is categorized as "Very Good," so this virtual space can be considered feasible to use. The implications of these findings show that VR technology can be an effective medium in introducing and preserving the Batik culture to the wider community. Nevertheless, there are still some aspects that can be improved. The researcher recommends adding gamification elements so that visitors not only explore but also get challenges or quests to increase their engagement. In addition, this research focuses more on designing virtual spaces so that the multimedia aspect has not received optimal attention. Therefore, methods such as the Multimedia Development Life Cycle (MDLC) are recommended to improve the quality of media presentation. In general, based on the test results, the design of the Batik Museum virtual space using the GDLC method proved to be easy to understand and has the potential to increase public interest in Batik culture.

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Analysis of awareness and confidence in learning outcomes with students' academic motivation: SEM approach

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ABSTRACT

Low self-awareness and confidence hinder learning strategies, reduce academic motivation, and prevent psychology-based educational strategies from developing optimally due to limited research integrating these factors. This study examines the influence of self-awareness and self-confidence on learning achievement, mediated by academic motivation. Data from 300 high school students in Indonesia were collected using a Likert scale questionnaire, while learning achievement was measured based on the average semester score. Structural Equation Modeling (SEM) analysis showed that self-awareness had a positive and significant effect on academic motivation ($\beta = 0.45$, $p < 0.01$) and learning achievement ($\beta = 0.30$, $p < 0.01$). Similarly, self-confidence positively influenced academic motivation ($\beta = 0.35$, $p < 0.01$) and learning achievement ($\beta = 0.25$, $p < 0.01$). Academic motivation was found to mediate the relationship between self-awareness and learning achievement (indirect effect = 0.20, $p < 0.01$) as well as between self-confidence and learning achievement (indirect effect = 0.15, $p < 0.01$). The proposed SEM model demonstrated a good fit with the data ($\chi^2 = 212.34$, df = 149, $p < 0.01$; RMSEA = 0.045; CFI = 0.97; TLI = 0.96). These findings highlight the importance of self-awareness and self-confidence in enhancing learning achievement through increased academic motivation. This study contributes theoretically to understanding psychological factors affecting learning achievement and has practical implications for developing educational interventions. Future research is recommended to adopt a longitudinal design and mixed methods and explore mediator or moderator variables for more effective educational strategies.

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INTRODUCTION

Students' academic achievement is often considered a key indicator of success in education (Siswanto, 2024; Sa'adah & Ariati, 2018). Factors that affect academic achievement include various aspects, including cognitive ability, learning environment, and individual characteristics (TL et al.,

2017). Among individual characteristics (Nugraha, 2019), self-awareness (Farenti & Sekonda, 2022) and self-confidence have been identified as important factors influencing student learning outcomes (Lestari, 2022). Self-awareness Fluerentin (2012), which includes an individual's understanding of their strengths and weaknesses, can help students manage their learning process more effectively (Sutiarso, 2009). Self-confidence, which refers to an individual's belief in his or her ability to achieve a specific goal, also plays an important role in determining the extent to which students struggle and persist in achieving academic achievement (Fahyuni et al., 2020; Kurniawati & Siswanto, 2024; Tanjung & Amelia, 2017).

Currently, many students face challenges in achieving optimal academic achievement, one of which is low self-awareness and confidence in the learning process. A lack of understanding of students' strengths and weaknesses can hinder the effectiveness of managing learning strategies, while low self-confidence often reduces motivation to face academic challenges. Although academic motivation is known to play an important role in improving academic achievement, many students still struggle to maintain consistent motivation, especially in an increasingly competitive and stressful learning environment. In addition, the integration of self-awareness, self-confidence, and academic motivation in the structural model is still limited, so educational strategies based on a thorough understanding of these psychological factors have not been fully developed (Waddington, 2023).

The theory of self-awareness by Duval & Wicklund (1972) states that when individuals become self-aware, they tend to evaluate themselves against internal standards. Self-awareness can be triggered by external factors such as mirrors or attention from others. This theory distinguishes between two types of self-awareness: personal self-awareness and public self-awareness. Personal self-awareness involves introspection and self-assessment based on personal standards, while public self-awareness involves paying attention to how a person is perceived by others (Diener & Wallbom, 1976).

The theory of self-efficacy introduced by Albert Bandura focuses on individuals' belief in their ability to succeed in a particular task or situation. Self-efficacy is influenced by four main sources: mastery experience, representative experience, social persuasion, and the physiological and emotional state of the individual. High self-confidence can affect a person's way of thinking, feeling, and behaving, increasing motivation and perseverance in facing challenges (Bandura, 1978).

Maslow's Hierarchy of Needs Theory, introduced by Abraham Maslow, states that humans have five levels of needs that must be met in order. These needs start from basic physiological needs (food, water, shelter), then security needs (physical and emotional security), followed by the need for love and belonging (social relationships and affection), the need for self-esteem (appreciation and recognition), and finally the need for self-actualization (realization of full potential and self-development). According to Maslow, individuals must meet needs at a lower level before they can motivate themselves to achieve needs at a higher level (Maslow, 2017).

This concept is relevant in the context of academic motivation, as high motivation can encourage students to be more enthusiastic and consistent in learning, which ultimately improves their learning outcomes (Amalda & Prasojo, 2018; Subakti & Prasetya, 2020). The need to feel safe, accepted, and valued can affect how students respond to academic challenges and how effectively they manage study stress. Therefore, understanding the relationship between self-awareness, self-confidence, and academic motivation within the framework of Maslow's hierarchy of needs is essential for developing effective strategies to improve students' academic achievement.

Academic motivation is another key factor that is often associated with learning achievement (Amalda & Prasojo, 2018). High motivation can encourage students to be more enthusiastic and consistent in learning, which ultimately improves their learning outcomes (Subakti & Prasetya, 2020). Previous research has shown that academic motivation can be mediated by a variety of psychological factors, including self-awareness and self-confidence. Therefore, understanding the relationship between self-awareness, self-confidence, academic motivation, and learning achievement is essential for developing effective strategies for improving students' academic achievement.

Previous research by Dewi and colleagues found that self-awareness is positively correlated with academic achievement through increased self-regulation (Dewi et al., 2020). Bandura (1997)

stated that self-efficacy plays an important role in determining the extent to which students overcome academic challenges (Rachmawati et al., 2021). Alsa and colleagues, in their research, showed that academic motivation is an important mediator in the relationship between psychological factors and learning achievement (Alsa et al., 2021). Research by Lutfiwati (2020) supports the importance of intrinsic motivation in optimal academic achievement. In addition, research by Zahn et al., (2020) emphasized that students' self-confidence in their academic abilities affects their effort and persistence in learning.

Although previous research has shown that self-awareness and self-confidence have a positive relationship with academic achievement and that academic motivation plays a mediating role in relationships, research that integrates these three variables in a single structural model is still limited. In addition, most previous studies used a simple correlational approach and did not comprehensively test mediation models using advanced analysis techniques such as Structural Equation Modeling (SEM).

This study aims to analyze the direct influence of self-awareness and confidence on student learning achievement and examine the mediating role of academic motivation in this relationship. By using the Structural Equation Modeling (SEM) approach, this study is expected to provide a deeper understanding of how self-awareness and self-confidence affect student learning outcomes, both directly and through increasing academic motivation. These findings are expected to make an important contribution to the development of effective educational strategies for improving student academic achievement.

This research makes a significant contribution in both the theoretical and practical realms. Theoretically, this study enriches the literature on psychological factors that affect academic achievement by integrating self-awareness, self-confidence, and academic motivation into one structural model. The findings of this study support and expand the theory of motivation and personality by showing that self-awareness and self-confidence not only have a direct influence on learning achievement but also affect learning achievement through the mediation of academic motivation.

METHOD

This study uses a quantitative approach with a survey method. The research design used was cross-sectional to collect data at a single point in time from the selected samples. The population of this study is high school students in Magelang City. The research sample consisted of 300 students who were randomly selected using a simple random sampling technique. The number of samples was determined based on the Slovin formula with a confidence level of 95% and a margin of error of 5%.

Data was collected using a questionnaire consisting of four main parts: Self-Awareness was measured using a self-awareness scale adapted from the Self-Reflection and Insight Scale (SRIS) instrument; Confidence was measured using a confidence scale adapted from the General Self-Efficacy Scale (GSES) instrument; Academic Motivation is measured using the Academic Motivation Scale (AMS); and Learning Outcomes are measured through the average score of student report cards in the last semester. Each item in the questionnaire is graded using a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 1. Measurement and Academic Achievement Questionnaire

No.	Indicator	Statement	Dimensions
1	SA1	I Understand My Strengths and Weaknesses.	Self-Awareness
2	SA2	I often Evaluate Myself after Completing a Task.	
3	SA3	I Realized how My Feelings Affected the Way I Learned.	
4	SA4	I can Recognize when I need Help with My Studies.	
5	SA5	I Always Try to Understand the Reasons behind My Successes and Failures.	
6	SC1	I am Confident that I can Complete Academic Assignments well.	
7	SC2	I feel Capable of Facing Difficult Academic Challenges.	Self-Confidence
8	SC3	I Believe that My Efforts in Learning will Bring Good Results.	
9	SC4	I Remained Calm and Confident Despite Facing a Difficult Test.	

No.	Indicator	Statement	Dimensions
10	SC5	I am Confident that I can achieve the Academic Targets I Set.	
11	AM1	I Learned because I wanted to Understand the Material well.	Academic
12	AM2	I feel Motivated to Learn because I want to achieve High Achievement.	Motivation
13	AM3	I Enjoyed the Learning Process and Understood its Benefits for the Future.	
14	AM4	I feel Happy when I achieve the Academic Targets I Set.	
15	AM5	I was Driven to Study because I wanted to get Good Grades.	
16	AA1	I always achieve the Value Targets I Set.	Academic
17	AA2	I Understand the Subject Matter well and can Apply it in the Exam.	Achievement
18	AA3	I got High Marks in Most Subjects.	
19	AA4	I Consistently Improve My Academic Grades Every Semester.	
20	AA5	I got Appreciation from Teachers for My Academic Achievements.	

Data was collected through questionnaires that were distributed directly to students at participating schools. Before filling out the questionnaire, students were given an explanation of the purpose of the research and how to fill out the questionnaire. Student participation in this study is voluntary and anonymous. The collected data was analyzed using the Structural Equation Modeling (SEM) technique with the help of the latest version of Jamovi software (Mustafa et al., 2020). The analysis was carried out in several stages: Descriptive Analysis to describe the characteristics of the sample and the distribution of the data; Validity and Reliability Test uses Confirmatory Factor Analysis (CFA) to ensure that the instruments used are valid and reliable; and Structural Model Test to test the relationship between the variables proposed in the research model. The model matching indicators used include Chi-Square, RMSEA (Root Mean Square Error of Approximation), CFI (Comparative Fit Index), and TLI (Tucker-Lewis Index).

RESULTS AND DISCUSSION

Results

Of the 300 students who participated in the study, 48% were male, and 52% were female. The average age of the respondents was 16.5 years, with a standard deviation of 0.8 years. Table 1 shows the statistical description of the research variables.

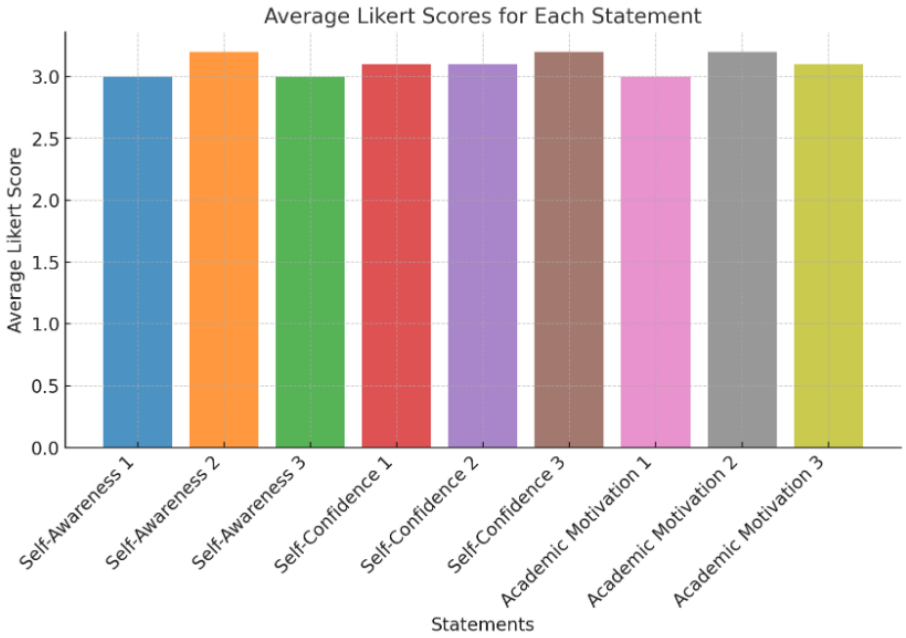

Figure 1. Average Likert Score for Academic Awareness, Trust, and Motivation

Figure 1 shows the average Likert score for self-awareness (Hooker, 2016), self-confidence, and academic motivation based on the results of a survey with 300 respondents. This graph provides a visual representation of how the average respondent rates each statement related to self-awareness, self-confidence, and academic motivation. The average Likert score is calculated for each statement, providing a comprehensive view of the respondents' response trends.

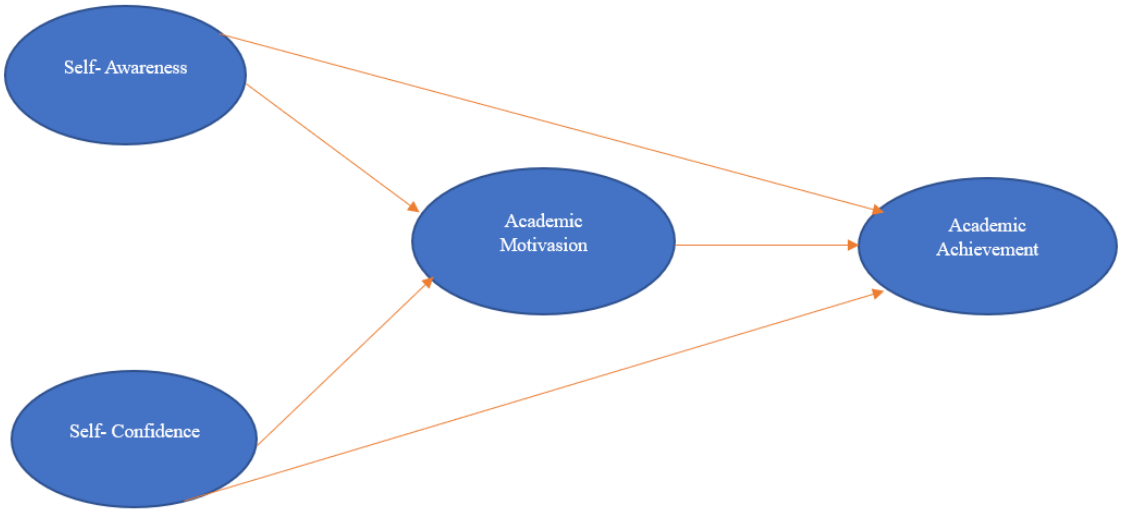

Figure 2. SEM Model Analysis of Self-Awareness and Confidence in Learning Achievement with Academic Motivation Mediation

Figure 2 The Structural Equation Modeling (SEM) chart used in this study illustrates the relationship between self-awareness, confidence, academic motivation, and student learning achievement. In this model, self-awareness and self-confidence play a role as independent variables that directly affect academic motivation, which in turn affects students' learning achievement. In addition, self-awareness and self-confidence also have a direct influence on learning achievement. Self-awareness was measured using three indicators adapted from the Self-Reflection and Insight Scale (SRIS), while self-confidence was measured using three indicators from the General Self-Efficacy Scale (GSES) (Cramm et al., 2013). Academic motivation is measured through three indicators from the Academic Motivation Scale (AMS), and learning achievement is measured through the average score of students' report cards in the last semester.

Table 2. Statistical Description of Research Variables

No.	Variable	Min	Max	Mean	SD
1	Self-Awareness	2.5	5.0	3.8	0.6
2	Confidence	2.8	5.0	3.9	0.5
3	Academic Motivation	3.0	5.0	4.1	0.4
4	Learning Outcomes	60	95	80.4	7.8

The Validity and Reliability Test Confirmatory Factor Analysis (CFA) is carried out to test the validity and reliability of the instrument (Gebremedhin et al., 2022). Table 2 shows the values of factor loadings, Cronbach's alpha, and Average Variance Extracted (AVE) for each construct. Table 2 in the article provides a statistical description of the variables studied, namely self-awareness and self-confidence. For self-awareness, scores varied between 2.5 to 5.0, with an average of 3.8 and a standard deviation of 0.6, suggesting that most students had relatively high levels of self-awareness with small variations. Meanwhile, for self-confidence, the score ranges from 2.8 to 5.0, with an average of 3.9 and a standard deviation of 0.5, which indicates that students generally have a good level of confidence with little variation between them. Overall, these data describe the characteristics of respondents who show high levels of self-awareness and self-confidence, which is the basis for further analysis of the relationship between these variables and student learning achievement.

Table 3. Validity and Reliability Test Results

No.	Construction	Charge Factor (Range)	Cronbach's Alpha	AVE
1	Self-Awareness	0.68 - 0.82	0.83	0.59
2	Confidence	0.71 - 0.85	0.85	0.62
3	Academic Motivation	0.72 - 0.88	0.88	0.64
4	Learning Outcomes	0.69 - 0.81	0.81	0.58

Table 3 presents the results of the validity and reliability test of the constructed study, namely self-awareness, self-confidence, academic motivation, and learning outcomes. All constructs show a Cronbach's Alpha value greater than 0.7 (Taber, 2018), which indicates good internal reliability, as well as an Average Variance Extracted (AVE) value greater than 0.5, indicating adequate convergent validity. Thus, the results of this test show that the instruments used in this study are valid and reliable for measuring the variables studied (Ahmad et al., 2016). The structural model test was carried out to test the relationship between self-awareness, self-confidence, academic motivation, and learning outcomes. Table 3 shows the results of the model fit test.

Table 4. Model Fit Test

No.	Match Index	Value	Criterion
1	Chi-Square	210.34	$p < 0.05$
2	RMSEA	0.045	< 0.08
3	CFI	0.97	> 0.90
4	TAG	0.96	> 0.90

Table 4 presents the results of the model fit test for the structural analysis conducted in this study. The model match index shows a Chi-Square value of 210.34 with a $p < 0.05$, which indicates that the model has a significant match. In addition, the RMSEA value is 0.045, which is below the threshold of 0.08, as well as the CFI and TLI values of 0.97 and 0.96, respectively, both exceeding the 0.90 criterion. These results show that the proposed structural model has a good fit with the data, supporting the validity of the model in explaining the relationships between the variables studied.

Table 5. Structural Path Estimation

No.	Paths	Standardized Coefficient	t-value	p-value
1	Self-Awareness -> Academic Motivation	0.35	4.23	< 0.001
2	Self-Confidence -> Academic Motivation	0.40	5.10	< 0.001
3	Academic Motivation -> Learning Outcomes	0.45	6.32	< 0.001
4	Self-Awareness -> Learning Outcomes	0.25	3.05	<0.002
5	Self-Confidence > Learning Outcomes	0.30	3.65	< 0.001

Table 5 presents the path estimation of the structural model that tests the relationship between self-awareness, self-confidence, academic motivation, and learning outcomes. The results of the analysis showed that self-awareness had a significant positive influence on academic motivation with a beta coefficient of 0.35 and a p-value < 0.001. In addition, self-confidence also had a significant positive effect on academic motivation with a beta coefficient of 0.40 and a p-value < 0.001. Academic motivation was proven to contribute positively to learning outcomes with a beta coefficient of 0.45 and a p-value < 0.001. In addition, self-awareness directly affected learning outcomes with a beta coefficient of 0.25 and a p-value of 0.002. These findings emphasize the importance of the role of self-awareness and self-confidence in improving academic motivation and student learning outcomes.

Discussion

The results of the SEM Model analysis show that self-awareness has a significant positive influence on academic motivation and learning achievement. Self-confidence also showed a significant positive influence on academic motivation and learning achievement. In addition, academic motivation is a mediator in the relationship between self-awareness and learning achievement, as well as between self-confidence and learning achievement. The results of this analysis as a whole show a good match with the existing data, which is indicated by the model fit

values. These findings confirm that self-awareness and self-confidence not only have a direct effect on learning achievement but also through academic motivation as an important mediator in the process.

This research makes several important theoretical contributions. First, the findings of this study support the theory of motivation and personality that emphasizes the role of self-awareness and self-confidence in determining learning outcomes (Bandura, 1997). This empirical evidence is in line with the research of Schleider et al., (2020) and Usher & Ford (2022), which stated that psychological interventions that increase self-awareness can have a positive impact on student motivation and learning achievement, especially in the context of education. In addition, self-efficacy plays a role in improving motivation and self-regulation in learning, which ultimately contributes to better academic outcomes.

Second, this study expands the literature by revealing that academic motivation functions as a mediator in the relationship between self-awareness, self-confidence, and learning achievement. These findings are consistent with Self-determination theory, which suggests that academic motivation is key in linking psychological factors to learning achievement (Deci & Ryan, 1985; Bandura, 1997). This is in line with previous research by Howard et al., (2021) and Chen (2024), who stated that academic motivation influenced by psychological factors such as self-awareness and self-confidence is a key mediator in achieving optimal learning outcomes.

Third, the use of Structural Equation Modeling (SEM) in this study emphasizes the importance of an advanced analytical approach to understanding the complex relationships between variables. Kline (2023) and Byrne (2013) emphasized the importance of an advanced analytical approach to understanding complex relationships between variables by using Structural Equation Modeling (SEM) in this study. SEM allows researchers to test complex hypotheses about the structure of relationships between variables in a single comprehensive model. The statement is in line with research by Hair (2010), which states that SEM allows researchers to test complex theoretical models by considering direct, indirect, and mediator relationships between variables.

In practical terms, the results of this study have significant implications for educators, counselors, and education policymakers. First, the findings that self-awareness and self-confidence have a significant influence on academic motivation and learning achievement suggest that self-development programs in schools need to be focused on improving both aspects. For example, mentoring and counseling programs can be geared toward helping students develop better self-awareness and increase their confidence. Second, the results of this study also provide an empirical basis for the development of a more holistic curriculum, which emphasizes not only the cognitive aspects but also the affective and psychological aspects of students. Third, schools and educational institutions can use these findings to design interventions aimed at increasing academic motivation in the hope of improving overall learning achievement (García & Weiss, 2020; Zhuo et al., 2024).

While this research provides valuable insights, some limitations need to be acknowledged. First, this study uses a cross-sectional design so that the causal relationship between variables cannot be definitively determined. Longitudinal research is needed to confirm these findings and understand the time changes. Second, this study only involved high school students in Indonesia, so generalizing the results to other contexts or other levels of education must be done carefully. Third, the measurement of variables using self-report questionnaires can cause social bias and memory bias. The use of more diverse measurement methods, such as observation or in-depth interviews, can provide a more comprehensive picture of the factors that affect learning achievement.

Further research suggests using a longitudinal design to understand the causal relationship between variables more accurately. The scope of the sample can be expanded to include different levels of education and cultural backgrounds to improve the generalization of the findings. Mixed-methods approaches, such as interviews or case studies, can be used to gain a deeper understanding. In addition, the exploration of moderator or mediator variables can provide additional insights for the development of more effective educational strategies.

CONCLUSION

This study successfully showed that self-awareness and self-confidence have a significant influence on student learning achievement, both directly and through the mediation of academic motivation. These findings make a theoretical contribution by expanding the understanding of the psychological factors that affect learning achievement and practical contributions in the form of recommendations for the development of more holistic educational programs. However, the limitations of this study indicate the need for further research that can strengthen and expand the existing findings.

Schools should develop programs to increase students' self-awareness and confidence, as well as integrate a holistic approach into the curriculum. Educators and counselors need to be trained to recognize and intervene in these problems to increase academic motivation. More research is needed in different contexts to explore the long-term effects. Policymakers should support the development of non-cognitive skills in education systems.

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Android-based virtual laboratory with starter experiment approach for learning vertebrate organ systems in high school

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ABSTRACT

Limited laboratory equipment causes practicum of vertebrate animal organ systems to be rarely carried out so that learning is only theoretical and has an impact on student understanding that is less than optimal. This study aims to develop and test the validity and feasibility of an Android-based virtual laboratory with a starter experiment approach on vertebrate animal organ system material for high schools. This media is also equipped with LKP (Practicum Worksheet) to support virtual laboratory activities. This research uses the Research and Development (R&D) method with the ADDIE model. Data were collected through validation questionnaires from media experts, material experts, and trials to students, then analyzed descriptively, quantitatively, and qualitatively. The validation results show that the virtual laboratory has a validity level of 91% from media experts and 89% from material experts, which is included in the "very valid" category. Meanwhile, the feasibility test results showed a value of 91% in individual trials, 96% in small groups, and 94% in large groups, all of which were included in the "very feasible" category. Thus, the Android-based virtual laboratory with a starter experiment approach on vertebrate animal organ system material is very valid and feasible to use in learning. This media helps teachers deliver material, enhances student understanding, and addresses lab limitations in technology-based learning. Further development should optimize app size for low-spec devices, ensure compatibility with iOS, and improve interactive features for a more realistic practicum experience.

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INTRODUCTION

Biology is a branch of Natural Sciences that focuses on discovering and understanding concepts and principles systematically and scientifically. Biology learning allows students to develop conceptual thinking skills independently (Purwaningsih & Mubarok, 2021). Biology includes scientific concepts that are abstract and can be understood through direct observation, experiments, and simulations (Adi et al., 2016). As a science-based subject, Biology demands critical thinking skills and an understanding of concepts that can be developed through practicum activities (Suryaningsih et al., 2020).

Practicum plays an important role in improving students' understanding of scientific concepts (Andhini et al., 2024; Fitriani, 2024). Through practicum activities, students can prove the theories that have been learned directly so that learning becomes more meaningful and provides real experience (Suryaningsih et al., 2020). However, in practice, practicum activities are often rarely carried out due to various constraining factors, such as limited laboratory equipment and materials (Abdjul & Ntobuo, 2018; Adita & Julianto, 2016; Suryaningsih et al., 2020), limited time (Andhini et al., 2024; Mirawati et al., 2021; Purwanti et al., 2014), and high maintenance costs (Fitriani, 2024; Suryaningsih et al., 2020).

The results of interviews with grade XI Biology teachers at Senior High School 1 Bluto show that practicum on vertebrate animal organ system material cannot be carried out due to limited laboratory facilities. The school has a science laboratory, but the available tools and materials are not sufficient to support dissection activities. As a result, learning is still theoretical, limited to the lecture method and learning resources from textbooks and the internet. This causes the students' level of understanding of the material to be still not optimal. The results of a questionnaire to 10 out of 30 students showed that 55% had difficulty understanding the material because they could not directly see the organ structure of vertebrate animals, while 45% of students who understood the material felt that learning resources and media were still not varied. Students expect more interactive learning media, such as a hands-on practicum or virtual simulation, to improve their understanding.

Along with the development of technology in education, the utilization of Android smartphones as learning media is a potential alternative. To support the teaching and learning process, learning media innovation is needed by utilizing technological developments, one of which is through Android-based digital learning applications (Risnasari et al., 2024). Android is a Linux-based mobile operating system that is open-source, offers high flexibility, and is the dominant OS (Putri et al., 2024; Sabado, 2024). Questionnaire data shows that 100% of students in class XI-C Senior High School 1 Bluto have Android smartphones, so this device can be utilized to support learning. One solution that can be applied to learning Biology is the use of a virtual laboratory (Liana & Kurniawan, 2019; Suryaningsih et al., 2020). A virtual laboratory is a simulation-based laboratory that displays the experimental process (Pramono et al., 2019; Zaturrahmi et al., 2020). Virtual laboratories can be accessed through Android devices that many students have, thus providing flexibility in learning, where students conduct experiments and observations without space and time constraints (Abdjul et al., 2024; Mirawati et al., 2021).

Virtual laboratory as a learning media can overcome the constraints of physical practicum and can present theories or visual concepts that are abstract and difficult to explain through verbal delivery (Abdjul & Ntobuo, 2018; Zaturrahmi et al., 2020). The advantages of virtual laboratories are proven to be able to facilitate students' learning, improve their understanding of complex scientific concepts, and hone students' practical skills in applying theory to real life (Abdjul et al., 2024; Andhini et al., 2024; Suryaningsih et al., 2020). The use of virtual laboratories has been shown to produce a level of learning that is equivalent to direct practicum in the laboratory (Moosvi et al., 2020; Stahre et al., 2019). In addition, virtual laboratories can also provide virtual experiences for students that are fun and attract students' learning interests (Andhini et al., 2024; Suryaningsih et al., 2020).

Previous research shows that virtual laboratory can be an efficient alternative solution for practicum activities, (1) Suryaningsih et al., (2020) showed that Android-based virtual practicum is an alternative media for Biology practicum and helps students' creative thinking increase, (2) Liana & Kurniawan (2019) showed the results that virtual laboratory as a virtual laboratory is very helpful in overcoming laboratory limitations, thus helping students achieve competence optimally, (3) Mirawati et al., (2021) proved that the virtual laboratory is valid in supporting Biology learning, and (4) Abdjul & Ntobuo (2018) stated that the virtual laboratory is feasible to use in the learning process.

In implementing the virtual laboratory in Biology learning, the right approach is needed so that students can develop scientific thinking skills optimally. One of the relevant approaches is the starter experiment approach (SEA), which was developed by Schoenher J in 1996 (Risnawati & Antari, 2019). SEA is a science approach that emphasizes the process where students can independently discover the science concepts being studied (Astawan & Agustina, 2020). As Suastra

explained in Risa et al., (2019), the starter experiment approach has the advantage of familiarizing students with scientific thinking, increasing students' activity and creativity, and showing the connection between science and the surrounding environment. This approach has eight main steps, namely initial experiments, observations, problem formulation, temporary conjectures, testing experiments, concept preparation, concept application, and evaluation (Risnawati & Antari, 2019). To support the implementation of the virtual laboratory, this media is equipped with LKP (Practicum Worksheet) as a supporting media for the results of practicum activities that have been carried out by students.

Based on these problems, this study aims to develop an Android-based virtual laboratory learning media with a starter experiment approach on vertebrate animal organ system material. The virtual laboratory is equipped with LKP (Practical Worksheet) as a supporter of virtual laboratory activities. This media is expected to facilitate teachers in delivering material, improve students' understanding, and become a solution to laboratory limitations in supporting technology-based learning according to the Merdeka Belajar curriculum.

METHOD

This research is a Research and Development (R&D) study with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model. This model was chosen because it has structured, systematic, and sequential stages, so it can be used in developing learning media that are to the characteristics and needs of students (Permana & Nourmavita, 2017). The research and development procedure of the virtual laboratory is presented in Figure 1.

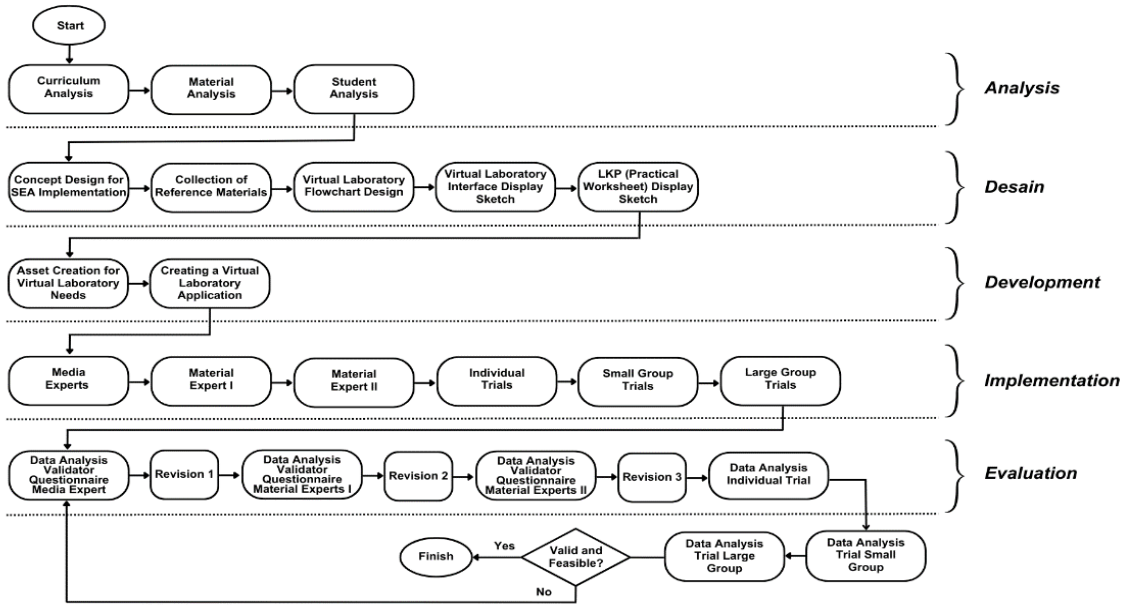


Figure 1. Research Procedure Flow

Analysis

The analysis stage is carried out to identify research needs consisting of analyzing the curriculum, the material to be presented, and the characteristics of students.

Design

The design stage is carried out to design an Android-based virtual laboratory with a starter experiment approach that will be made.

Development

At this stage, the product is developed according to the design that has been designed, resulting in the Virtual VerteLab application along with LKP (Practical Worksheet).

Implementation

At this stage, the product is tested by distributing an assessment questionnaire to determine the level of validity and feasibility. To determine the level of validity, trials were conducted with media experts and material experts. Meanwhile, to determine the feasibility level, the test was conducted on students of class XI-C Senior High School 1 Bluto.

Evaluation

The questionnaire results were analyzed quantitatively and qualitatively to determine the validity and feasibility of the product, as well as the basis for improvement before wider implementation.

The subjects of this development research consisted of media experts, material experts, and 30 students of class XI-C Senior High School 1 Bluto. The data collection techniques used in this study were interviews and questionnaires. Interviews were conducted with Biology teachers of class XI at SMAN 1 Bluto at the analysis stage as part of the preliminary study. Questionnaires were distributed to test subjects to assess the level of validity and feasibility of the product. The research instruments used include media expert questionnaire sheets, material expert questionnaire sheets, and student response questionnaires. Instruments for media experts include aspects of integration, balance, fonts, colors, language, and operation. Instruments for material experts include aspects of content feasibility, presentation feasibility, grammar, evaluation, and integration with the starter experiment approach. Meanwhile, the instrument for students includes aspects of attracting student interest, presentation of material, evaluation, and accessibility. The data analysis techniques used are quantitative descriptive analysis and qualitative descriptive analysis to process data and information obtained from the results of the questionnaire assessment by the test subjects.

Quantitative Descriptive Analysis

Quantitative descriptive analysis was used to process numerical data from the pilot test subjects. This analysis includes two aspects, namely validity and feasibility, which are assessed using a Likert 5 scale. The validity analysis technique is used to measure the validity level of the product based on the questionnaire results from media and material experts. The determination of the validity value refers to the modification of Akbar (2013) and is calculated using the validity formula presented in Formula 1.

$$Vah = \frac{Acquisition\ Score\ (TSe)}{Maximum\ Score\ (TSh)} \times 100\% \quad (1)$$

Description:
Vah = Total expert validation
TSe = Total score of assessment results from the validator
TSh = Total maximum score

After the quantitative calculations were performed, the results were categorized based on the validity criteria presented in Table 1.

Table 1. Validity Level Categories

No.	Value Achievement (Score)	Validation Category
1	25% - 40%	Invalid
2	41% - 55%	Less Valid
3	56% - 70%	Quite Valid
4	71% - 85%	Valid
5	86% - 100%	Very Valid

(Modified Akbar, 2013)

The feasibility analysis technique is used to assess the extent to which the product is feasible to use based on data from the learner response questionnaire. The determination of the feasibility value refers to the modification of (Akbar, 2013) and is calculated using Formula 2.

$$Lau = \frac{TSe}{TSh} \times 100\% \quad (2)$$

Description:
Lau = Total respondent eligibility
TSe = Total score of the assessment results from respondents
TSh = Total maximum score

Determining the feasibility level of the product requires a large number of respondents. Therefore, the calculation of feasibility is done by combining the results of all respondents. Based on Akbar (2013), to calculate the combined feasibility, one can use Formula 3.

$$L = \frac{Lau1+Lau2+Lau3+\cdots+Laun}{N} \times 100\% \quad (3)$$

Description:
L = Total combined eligibility value
Lau = Total respondent eligibility
N = Total respondents

After the quantitative calculations were carried out, the results were categorized based on the eligibility criteria presented in Table 2.

Table 2. Categories of Feasibility Level

No.	Value Achievement (Score)	Feasibility Category
1	0% - 20%	Not feasible
2	21% - 40%	Appropriate Valid
3	41% - 60%	Appropriate Valid
4	61% - 80%	Worth
5	81% - 100%	Very Feasible

(Modified Akbar, 2013)

Qualitative Descriptive Analysis

Qualitative descriptive analysis is used to process data in the form of suggestions, criticisms, and comments from the review of media experts, material experts, and student trials. The results of the analysis became a guideline for revising and evaluating the product to improve its quality. This research is focused on product development and validation to ensure the feasibility and validity of the virtual laboratory before it is applied to learning. Therefore, the effectiveness testing stage has not been conducted in this study and will be part of further research.

RESULTS AND DISCUSSION

Results

The results of the analysis stage of the curriculum, materials, and students show that based on interviews with Biology subject teachers, Senior High School 1 Bluto applies the Merdeka Belajar curriculum. The material studied covers the organ system of vertebrate animals, which is part of the Learning Outcomes (CP) of Biology subjects for phase F, namely class XI Senior High School Program C. The subject matter in this material includes morphology, anatomy, and abnormalities in vertebrate animal organs. In addition, the analysis also includes the identification of the Pancasila Learner Profile and Learning Objectives (TP) to ensure compliance with curriculum standards.

From the analysis of students, it was found that the level of understanding of students on the material of the organ system of vertebrate animals was not optimal. The main factors that cause this are the lack of use of varied and innovative learning media and the limited school laboratory facilities that are not adequate to support practicum activities. The teacher said that students have difficulty understanding the structure and function of animal organs in depth due to a lack of practical

experience. This condition results in abstract concepts in the material being difficult to understand, which ultimately has an impact on the achievement of competencies expected in the curriculum.

To overcome these obstacles, an innovative solution is needed that can bridge the limited facilities without reducing the learning experience of students. Therefore, an Android-based virtual laboratory application with a starter experiment approach was developed as an interactive learning media. This application is designed to virtually simulate the practicum experience, allowing students to observe and understand the organ system of vertebrate animals more comprehensively, even without a complete physical laboratory. With this learning media, it is expected that student understanding will increase significantly, and the learning process will become more effective and interesting.

The design begins with conceptualizing the application of the eight stages of the starter experiment approach that will be implemented in the Virtual VerteLab application, as well as collecting reference material from e-books and Biology textbooks used as the basis for preparing learning content. Next, the application workflow design is carried out in the form of a flowchart that describes the working mechanism of Virtual VerteLab, as well as a sketch of the Android-based Virtual VerteLab application interface and LKP (Practical Worksheet) display sketch. The flowchart of the Virtual VerteLab application can be seen in Figure 2.

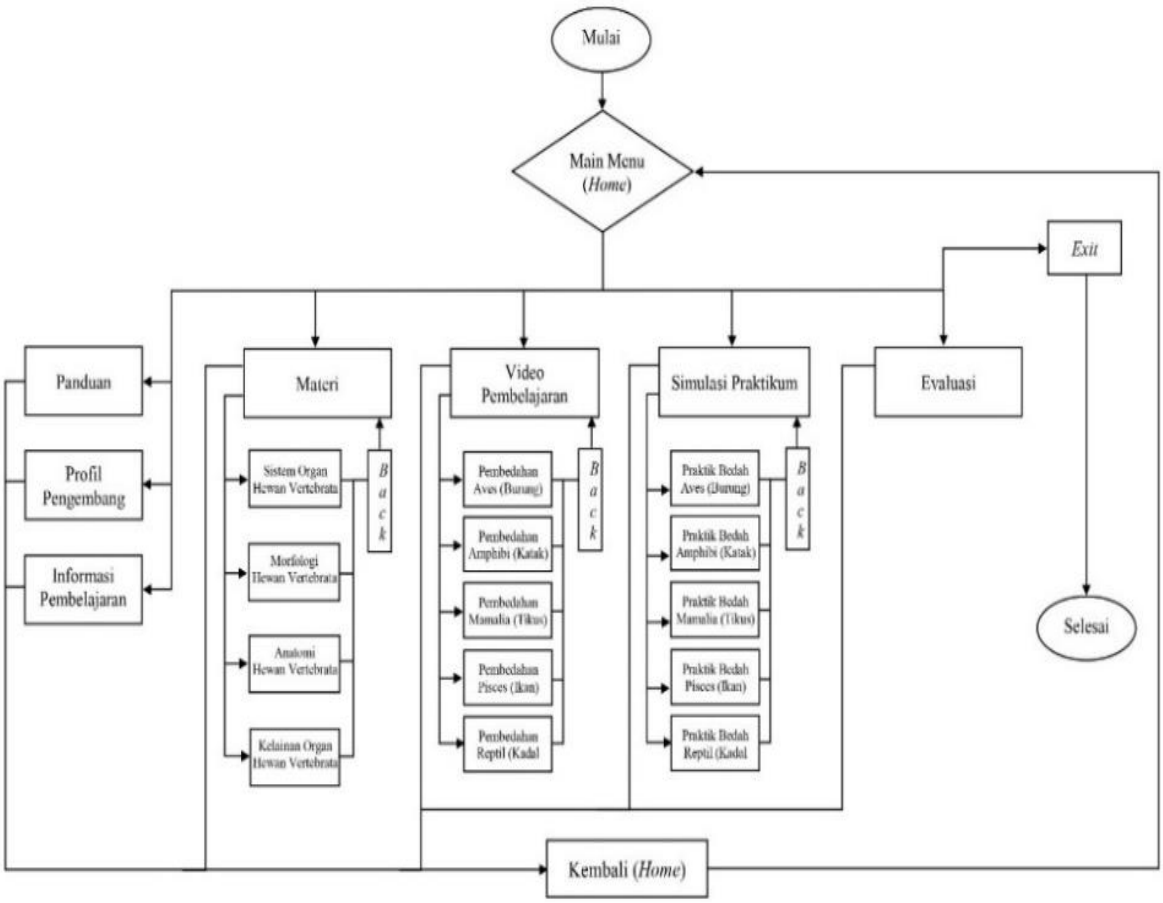
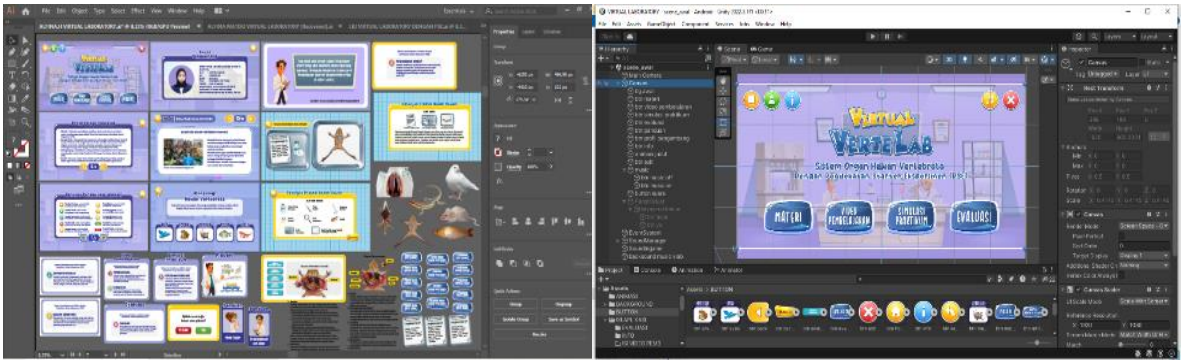


Figure 2. Flowchart of Android-based Virtual VerteLab with Starter Experiment Approach

At the development stage, a product is made in the form of a virtual laboratory application called Virtual VerteLab (Virtual Vertebrate Laboratory) and is equipped with LKP (Practical Worksheet). The manufacturing process begins with the creation of assets using Adobe Illustrator 2019. Furthermore, the Android-based Virtual VerteLab application was developed by combining assets using Unity Hub 3.3.0 and Unity 2022.3.1f1. The process can be seen in Figure 3.



(a) (b)

Figure 3. (a) Assets Creation; (b) Virtual VerteLab Application Assets Merging

The results of the development stage are presented in Figures 4, 5, 6, 7, and 8.

Figure 4. Main Menu (Home) Page

Figure 5. Developer Profile Page

Figure 4 displays the main menu page, which contains the name of the application and various navigation buttons, namely Guide, Profile, Information, Material, Learning Video, Practical Simulation, Evaluation, Music, and Exit. Figure 5 displays the developer profile page, which contains information about the developer of the Virtual VerteLab application.

Figure 6. Surgical Practice Instructions Page

Figure 7. Surgical Simulation Page

Figure 6 displays the instructions page for vertebrate animal surgery, namely amphibians (frogs), which contains information about the tools and materials that will be used in surgical practice. Figure 7 displays an amphibian (frog) surgery simulation page consisting of seven work steps. On this page, learners can perform virtual surgical practices with object displays that resemble live animal surgical practices. In addition, there is a work step guide as a reference for learners in performing each stage of surgery. The concept of surgical practice on this simulation page applies a drag-and-drop mechanism. Learners perform surgery by moving surgical tools from the equipment tray to the specimen on the surgical tray, according to the steps in the guide. Surgical tools can be positioned on the part of the specimen marked with a dashed red line. Each learner must follow a

series of predefined work steps. After completing one step, the system will display the next step until the animal dissection process is complete.

Figure 8. Display of Practical Worksheet (LKP)

Figure 8 shows the LKP (Practical Worksheet), which consists of a cover page and a content page that includes learning information and the application of the eight-stage starter experiment approach. Learners can write answers as a result of practicum activities according to the instructions contained in the Virtual VerteLab application and LKP.

At the implementation stage, product assessment is carried out on the test subjects through distribution questionnaires. The first assessment was given to media experts and material experts to determine the validity of the product. After the product is declared valid, the next assessment is given to students to assess the feasibility of the product. In addition, the trial results were used as the basis for evaluation to improve the product. Media expert trials were conducted by lecturers of the Informatics Education Study Program at Trunojoyo Madura University. Material expert trials involved lecturers from the Natural Science Education Study Program at Trunojoyo Madura University and Biology teachers at Senior High School 1 Bluto. Meanwhile, student trials were conducted on students of class XI-C Senior High School 1 Bluto, which was divided into three categories, namely, individual trials consisting of 3 students, small group trials consisting of 6 students, and large group trials consisting of 21 students.

At the evaluation stage, the results of the questionnaire assessment administered to the test subjects were analyzed. The data obtained consisted of quantitative data and qualitative data. In addition, revisions were made based on suggestions and comments given by validators to improve the product. The results of validation by media experts can be seen in Figure 9.

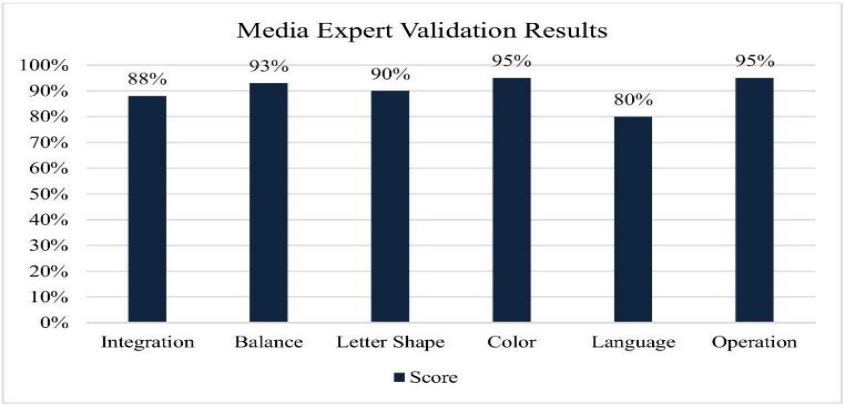


Figure 9. Diagram of Media Expert Validation Results

Based on Figure 9, five aspects of the Virtual Vertelab and LKP media fall into the highly valid category, namely, aspects of integration, balance, font, color, and operation, while the language aspect falls into the valid category. Thus, the average level of validity obtained from media experts is 91%, which is classified as very valid.

There are several suggestions from media expert validators, one of which is to add a Back button on the "Surgery Simulation" page so that users can return to the previous page, namely the "Veterinary Surgery Practice Instructions" page. The addition of this button aims to facilitate users in re-reading the instructions for veterinary surgery practice if there are things that have not been understood. Modifications based on media expert validator suggestions can be seen in Figure 10.

(a) (b)

Figure 10. (a) Before Revision; (b) After Revision

The results of validation by material experts can be seen in Figure 11.

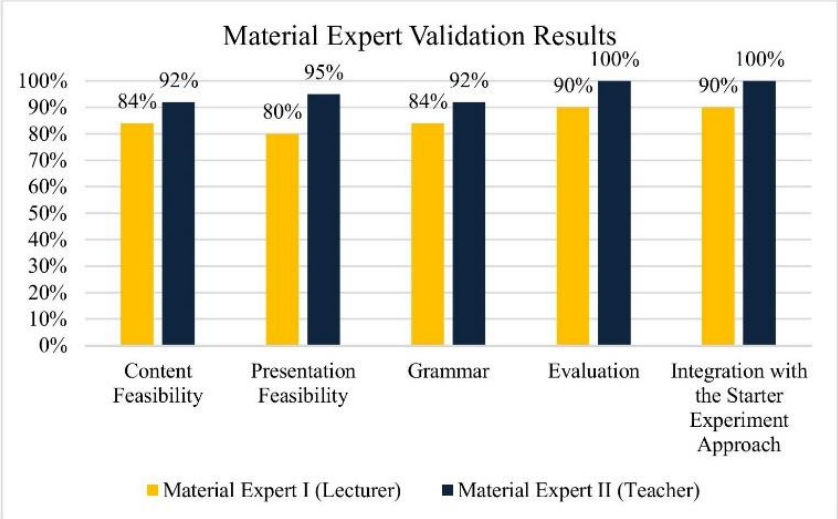


Figure 11. Diagram of Material Expert Validation Results

Based on Figure 11, all aspects of the Virtual Vertelab and LKP materials show a very valid category. Thus, the average level of validity obtained from material experts is 89%, which is classified as very valid.

There are several suggestions from material expert validators, one of which is to change the detailed content on the dissection simulation menu, especially in the detailed information section of vertebrate animal anatomy organs. The suggested change is to change the display that previously presented organ images along with descriptions and explanations of organ functions to only display organ images without descriptions and explanations of functions. It is intended that students can find their concepts of the material studied through the thinking process in practicum learning by the objectives of the experimental starter approach. Modifications based on material expert validator suggestions can be seen in Figure 12.

(a) (b)

Figure 12. (a) Before Revision; (b) After Revision

The results of the feasibility assessment conducted by students can be seen in Figure 13.

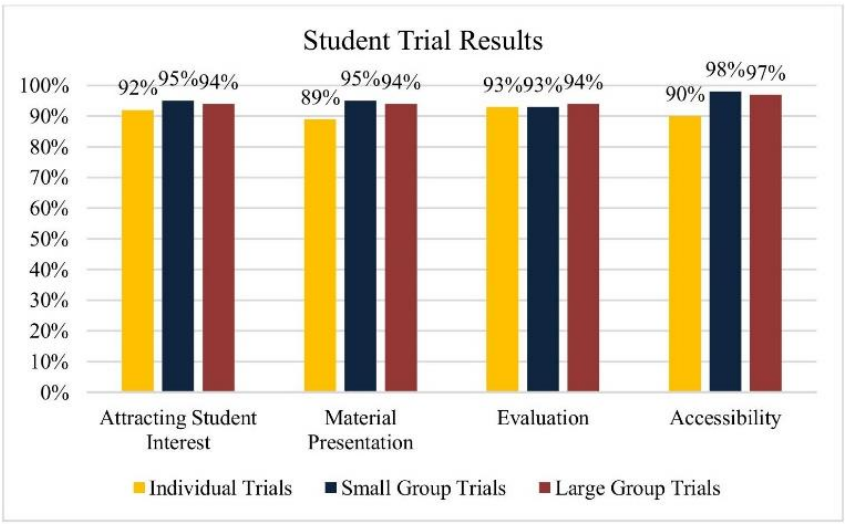


Figure 13. Diagram of Student Trial Results

Figure 13 displays the results of the learner trial assessment, which consists of individual trials, small-group trials, and large-group trials. Individual trials were conducted on 3 learners with an assessment result of 91%, including a very feasible category. Small group trials involving 6 learners obtained 96% with a very feasible category. Meanwhile, the large group trial, which was attended by 21 learners, received 94% with a very feasible category. In addition, in the learner trial, there were no suggestions or comments from the learners, which indicates that the product has been well-received and can be used without revision.

Discussion

The results of this study indicate that the development of an Android-based virtual laboratory with a starter experiment approach is an innovative solution for overcoming the constraints of physical practicum on vertebrate animal organ system material. In line with previous research, the use of virtual laboratories has proven to be an alternative to replacing the role of physical laboratories, especially in conditions of limited facilities and practicum equipment (Fitriani, 2024). The application of virtual laboratories in learning has succeeded in improving students' understanding of scientific concepts and providing a more interactive learning experience (Andhini et al., 2024; Suryaningsih et al., 2020).

Validation by media experts and material experts showed that Virtual VerteLab has a very high level of validity. Media experts assessed aspects of integration, balance, fonts, colors, language, and application operation, with an average result of 91% (very valid category). Some previous studies by Stahre et al., (2019) and Moosvi et al., (2020) showed that virtual laboratories can replace hands-

on experiments with some equivalent learning outcomes. Learning with virtual laboratories can help the learning process without having to rule out actual experiments (Adita & Julianto, 2016). The Virtual VerteLab application has an attractive laboratory room interface design with a harmonious color presentation so that students seem to feel the atmosphere of learning in a real laboratory (Syahfitri et al., 2019).

Material experts also gave an average rating of 89% (very valid category), which indicates that the content presented is by curriculum standards and can help students understand the material better. These results are in line with the research of Mirawati et al., (2021), which proves that virtual laboratories that can be accessed with Android smartphones are valid in supporting Biology learning. The use of virtual laboratories helps teachers deliver material more interactively and makes it easier for students to understand abstract concepts, especially in learning conditions with limited facilities.

The results of the learner trial showed a very high level of feasibility, with an average assessment of 91% for individual trials, 96% for small group trials, and 94% for large group trials (very feasible category). This supports the findings of Abdjul & Ntobuo (2018), which state that virtual laboratories are feasible to use in the learning process to improve student learning activities and outcomes. Virtual laboratories can provide students with tools, materials, and lab sets that are displayed on the screen to conduct experiments independently (Babateen in Pramono et al., 2019). Students can perform a virtual animal surgery practicum through the Virtual VerteLab application in the practicum simulation menu. The virtual laboratory can provide flexibility in learning, where students conduct experiments and observations without space and time constraints (Abdjul et al., 2024; Mirawati et al., 2021).

In addition, there is LKP (Practical Worksheet) as a companion media for students to write down the results of the practicum that has been carried out. Practical worksheets that are arranged systematically and interestingly can help students to be more active independently or in groups during practicum learning activities (Widayanti et al., 2018).

In the context of this research, the experimental starter approach is applied through eight stages of the scientific method, namely initial experiments, observations, problem formulation, temporary conjectures, testing experiments, conceptualization, applying concepts, and evaluation (Risnawati & Antari, 2019). The application of the experimental starter approach successfully encourages students to discover scientific concepts independently, as revealed in the research of Risa et al., (2019) and Astawan & Agustina (2020), which emphasizes the importance of investigation-based experiments in improving students' scientific thinking skills. In the learning process, this approach uses events that occur in students' daily lives as experiments so that learning becomes more interesting and helps foster students' scientific performance in studying and analyzing science problems in their surrounding environment (Dibia & Adiasih, 2017).

In this study, the experimental starter approach offers unique advantages over previous research, especially in encouraging students to discover concepts independently through exploration. If the virtual laboratory developed in Liana & Kurniawan (2019) research focuses more on the application of the scientific approach with the stages of observing, questioning, gathering information, reasoning, and communicating, then the experimental starter approach emphasizes the initial exploration stage before students obtain further information from the teacher or other sources. In Virtual VerteLab, the initial experimentation stage is implemented through a practical demonstration of animal dissection in the form of a learning video. The purpose of this demonstration is to arouse curiosity and increase students' interest in learning (Risnawati & Antari, 2019). Thus, students can gain a more concrete understanding because the concepts learned are observed directly through initial practice guided by the teacher. One of the limitations of this study is the relatively large size of the Virtual VerteLab application (50 MB), which can be an obstacle for students with low-specification Android devices.

Based on the results of this study, it can be interpreted that the development of Virtual VerteLab is valid and feasible to be an effective alternative in learning Biology, especially in the material of vertebrate animal organ systems in class XI Senior High School. The implementation of an Android-based virtual laboratory not only helps students understand concepts more deeply but also provides a more interesting and flexible learning experience. Future research is recommended

to evaluate the long-term impact of using Virtual VerteLab on student learning outcomes as well as to develop additional features that are more interactive to increase learning effectiveness.

CONCLUSION

This research has developed an Android-based Virtual VerteLab with a starter experiment approach as an innovative solution to overcome the limitations of physical practicum on the material of the organ system of vertebrate animals in class XI Senior High School. The validation results show that this application has a very high level of validity, with a media expert assessment of 91% and a material expert assessment of 89%, both of which are included in the "very valid" category. In addition, the results of the learner trial showed a high level of feasibility, with an individual trial of 91%, a small group trial of 96%, and a large group trial of 94%, all included in the "very feasible" category.

The use of Virtual VerteLab, which is equipped with LKP (Practical Worksheet), contributes to improving students' understanding, providing an alternative to virtual practicum amid limited laboratory facilities, and supporting the implementation of technology in learning by the principles of Merdeka Belajar curriculum.

This research also provides implications for the development of technology-based learning models, especially in providing a more interactive and flexible practicum experience. For further development, it is recommended that the size of the application be optimized so that it can run more lightly on devices with low specifications. In addition, further development can include application compatibility on various platforms such as iOS, as well as enhancing interactive features to make the learning experience closer to real practicum.

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Developing the Educaplay grammar assessment for tenth graders of senior high school in Kediri

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ABSTRACT

Teaching English as a Foreign Language (EFL) faces challenges in engaging students with grammar instruction. Grammar is a critical component of language education that underpins effective communication and comprehension. This study aims to develop an Educaplay-based grammar assessment tool for tenth-grade students at Senior High School 5 Taruna Brawijaya in Kediri, Indonesia. The instruments used for data collection included a grammar test, validated by experts to ensure content validity, and a questionnaire for expert feedback. The Research and Development (R&D) method was employed, following the steps outlined by Borg and Gall (1983), which involve product development, validation, and iterative revisions. Data analysis involved assessing the validity, reliability, difficulty index, and item discrimination of the grammar test. The findings indicate that the tool is valid and reliable, with a Cronbach's Alpha of 0.884, although there is a need for more challenging items to better cater to a range of student abilities. It is concluded that Educaplay provides an effective and engaging alternative to traditional grammar assessments. These results are expected to provide valuable insights into how digital platforms such as Educaplay can be used to improve grammar teaching and student learning outcomes, not only in Indonesia but also in other countries facing similar challenges. The study recommends further development of the tool to incorporate more complex items and suggests exploring the long-term effects of using digital tools like Educaplay in grammar education.

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INTRODUCTION

Grammar is a critical component of language education that underpins effective communication and comprehension. It serves as a foundation for fluency in both written and spoken language, making it essential for academic success. According to Brown (2001), grammatical competence is a major element of communicative competence, providing the structural framework necessary for forming sentences and conveying meaning. However, many tenth-grade students face

significant challenges in mastering grammar, particularly when it comes to understanding and applying complex rules. Despite its importance, teaching grammar remains a significant challenge in many educational contexts, including Indonesia. Traditional teaching methods often rely on rote memorization and repetitive exercises that fail to engage students or foster deep understanding. These difficulties are compounded by traditional methods of instruction that often fail to make grammar relevant or engaging for students (Harmer, 2015). Consequently, students frequently struggle with grammatical concepts, hindering their ability to express ideas fluently in both written and spoken forms (Pamilu, 2022). In Indonesia, this problem is particularly evident in the context of senior high school education; national standards for language proficiency are set high, and these challenges are particularly evident. Despite government efforts to reform education, many students struggle to meet these standards due to outdated instructional practices that do not cater to their needs.

Existing studies highlighted that traditional grammar assessments, such as paper-based exams, were often less engaging for students and tended to provide delayed feedback. Traditional grammar assessments, such as paper-based tests and rote memorization exercises, often emphasize the mechanical aspects of language rather than encouraging meaningful understanding. Ameliani (2019) described grammatical correctness as the analysis and explanation of sentence structure, highlighting that without a solid grasp of grammar, learners may struggle to express their thoughts and ideas accurately. These methods not only disengage students but also provide delayed feedback, hindering their ability to make timely corrections and improvements. Immediate feedback is crucial for helping students understand their mistakes and build a stronger grasp of grammar (Chappuis & Stiggins, 2002).

The limitations of traditional grammar instruction highlight the urgent need for more interactive tools that align with contemporary pedagogical approaches. As noted by Pamilu (2022), students who lack knowledge of grammar struggle to express their ideas freely, leading to poor academic performance. Recent studies emphasize integrating technology to create engaging learning environments (Hossain & Younus, 2024). Platforms like Educaplay, which offer customizable and interactive grammar activities, provide innovative solutions. By allowing students to engage with grammar in a dynamic and gamified manner, Educaplay has been shown to enhance student motivation and understanding (Mykytka et al., 2022). This aligns with Indonesia's educational reform goals, particularly the Kurikulum Merdeka, which promotes student-centered and inquiry-based learning approaches. This highlights the urgent need for more interactive learning tools that align with both the curriculum and students' needs for practical, engaging learning experiences.

In response to this gap, Educaplay, a digital educational platform, provides a solution by offering interactive and customizable tools for teachers to create grammar assessments and activities. With features that allow educators to design quizzes, games, and exercises tailored to specific learning goals, Educaplay enables students to engage with grammar more dynamically and enjoyably. Its key advantage is the ability to deliver immediate feedback, allowing students to correct their mistakes in real time, thus enhancing their learning experience (Educaplay, 2021). This platform is especially relevant in Indonesia, where the integration of technology into education has been increasingly prioritized, particularly in response to the challenges posed by the COVID-19 pandemic, which has accelerated the shift to digital learning (Kompas, 2022).

In recent years, research on grammar instruction and assessment has explored various innovative strategies to enhance student engagement and learning outcomes. Educaplay directly addresses the gaps in traditional grammar instruction by making the learning process interactive and gamified. For example, Castillo-Cuesta (2020) demonstrated the effectiveness of digital games in improving grammar and vocabulary retention in EFL learners. Similarly, studies like those by Hossain & Younus (2024) emphasized the motivational impact of gamified platforms like Kahoot in higher education grammar courses. Despite these advancements, many studies focus primarily on the broad use of gamification rather than its application in formative assessments tailored to specific learner needs. Additionally, while platforms like Educaplay have been identified as effective in interdisciplinary education (Graça et al., 2022), their potential to address grammar-specific challenges in Indonesian high schools remains underexplored. The platform's ability to combine learning with fun provides a refreshing alternative to the rote learning methods still prevalent in many

Indonesian schools. This research addresses this gap by developing an Educaplay-based grammar assessment tailored for tenth-grade students in Indonesia, thus aligning with curricular demands and technological advancements.

This study departs from the assumption that grammar is boring learning. Therefore, this study aims to develop an interactive grammar assessment tool using Educaplay, specifically designed for tenth-grade students in Indonesian senior high schools. By incorporating Educaplay into the classroom, the research seeks to evaluate how effectively the platform enhances students' comprehension of grammar and increases their motivation to engage with the subject. Given the growing integration of technology into Indonesian education, this research is timely and aligned with the government's broader efforts to modernize the national curriculum. The results are expected to provide valuable insights into how digital platforms like Educaplay can be used to improve grammar instruction and student outcomes, not only in Indonesia but also in other countries facing similar challenges.

METHOD

This study used the Research and Development (R&D) method proposed by Borg & Gall (1983). It is designed to develop materials for use in English education. The instruments used in this study included a grammar test, which experts evaluated as part of the validation process. The grammar test collected detailed feedback from experts to ensure that the product met pedagogical and technical standards and was then tested and also refined through iterative cycles of validation and revision, ensuring its effectiveness and alignment with the study's objectives. In this study, R&D was used to produce finished products such as textbooks, audiovisual games, training manuals, tools, etc., that can be used in educational programs (Borg and Gall, 1983). Such as grammar assessments using Educaplay games for use in schools as guided by the framework of Borg & Gall (1983).

Adaptation is done by modifying the process steps based on the problems found, research objectives, and time constraints in conducting this study. This study followed an adaption model that included: First, research and information collection. In this stage, the researcher conducted the research and information collection during a one-month observation of teaching and learning in the Tenth Grade of Senior High School 5 Taruna Brawijaya in Kediri. Those include identified challenges in grammar instruction, students' needs, a literature review, and report writing preparation.

Second, Preliminary product development. At this stage, a reference study was also carried out, theories were researched and used to guide development. These theories include the concept of learning grammar in senior high school and the use of Educaply games as a test media. The development process itself comprised some stages adapted from those proposed by Borg & Gall (1983) and Harris (1969). As a result, the test will be the final product of this study. Multiple cycles need to be completed to build the test in the Harris (1969) approach. Test planning, test item, instruction preparation, test review, test pretesting, and test analysis are the subsequent cycles.

Third, test validation was the next stage of the development process. At this stage, the researcher's tests were evaluated by an English teacher at Senior High School 5 Taruna Brawijaya Kediri. The evaluation is performed to determine whether the test developed meets the criteria for a good test or not.

The fourth is revision, in this stage, the author revises what has been corrected by the validator and follows all the directions suggested by the validator. A validation sheet was used to obtain data from an expert (English teacher) as the research instrument. The results of the questionnaire are recorded and used to improve the product. The validation sheet consists of (1) Content validity, (2) Language and writing of questions, and (3) Feasibility of questions.

The fifth step is the try-out, which has been known as empirical validation. The goal has been to determine whether the revised test is effective for students and whether it has truly helped students master reading comprehension skills. This trial has primarily been designed to gather data on the appropriateness of the test, including its level of difficulty, usefulness, effectiveness, and the attractiveness of the test display for students. Finally, the final product has been published. The final product must be an educational tool that can support the English teaching and learning process.

During the field trial, the researcher used the Educaplay games application to collect data through test questions. The test covered several topics, with questions designed to clarify specific areas, such as: (1) asking students to identify one part of speech in a sentence, (2) asking students to identify example sentences from one part of speech, (3) asking students to identify example words from one part of speech, (4) asking students to match the correct part of speech to a sentence based on a picture, and (5) requiring students to change words in brackets according to the instructed part of speech.

The data collected in this study has been essential in determining the validity and applicability of the tests developed. For the initial data, the researcher observed the teaching and learning process in the eleventh grade at one of the senior high schools (SMAN) in Kediri. The second set of data was obtained through consultation with an expert or teacher regarding a reading comprehension test based on the Educaplay games. The third set of data, which consisted of test data, was gathered through observation and implementation of the test. Expert validation data was collected using a questionnaire as the research instrument, and the results were recorded and used to improve the product.

In addition, data gathered from preliminary observations during research and information collection has been analyzed to describe the actual needs of students in the target context. This description has served as a guide in determining the adequacy of the test. Any remaining deficiencies or discrepancies in the test were identified, and the data has been utilized as a guide for revisions.

RESULTS AND DISCUSSION

Results

This section presented the results of preliminary research and information collection, expert validation, and the tryout results. After the draft had been developed, it was given to the expert for validation and revision and was then tried out with students. A questionnaire was provided to the expert, and a grammar assessment test using Educaplay games was given to the students to gather evaluations and suggestions for improvement.

The Result of Preliminary Research and Information Collecting

As previously mentioned, preliminary research and information collection were conducted through observation of the teaching and learning process. The results of this preliminary research showed that understanding English grammar was essential for students, especially for proficiency exams such as TOEFL tests and writing assessments. However, paper-based tests tend to bore students, making them reluctant to engage with the text or answer the questions. Additionally, teaching methods and learning media used by teachers had typically been monotonous, lacking innovation or use of internet-based tools, which reduced students' motivation for grammar tests. Students reported difficulties in understanding the vocabulary used in the tests, limited knowledge of the material, a lack of interest in the test format, and a delay in receiving test scores.

To address these issues, the researcher designed a preliminary product with multiple-choice questions, allowing students to choose the correct answer by selecting A, B, or C. These questions focused on parts of speech material relevant to tenth-grade students, with a variety of question types about basic grammar.

The result of Expert's Validation

After the preliminary product was developed, it was validated by an expert. Following the drafting of the grammar comprehension test, it was provided to an experienced English teacher for validation. A questionnaire containing seven aspects with nine statements was used to collect data, with each statement assigned a score of one.

The experts' scores largely indicated agreement with the developed materials. In terms of language and question formulation, the test was considered fairly clear and complete. The vocabulary

level, language, structure, and conceptual level were appropriate for the students, though there were suggestions for some additions and improvements. The content validity was deemed clear and understandable.

The developed test included various interesting topics related to parts of speech, aiding students in developing grammar knowledge. It covered both knowledge and skills, with a representative number of questions per area. The instrument as a whole met the required objectives, with each item requiring only one specific answer, and the adapted scale was appropriate. Additionally, the test's display was suitable for the content, and it was easily accessible via smartphones, allowing students to take the test online, akin to playing a game. The test was also noted to be less monotonous and more enjoyable. The total expert validation score reached 158. The data was then calculated using Formula 1 provided by Sugiyono (2008) to determine the level of validity.

$$Percentage = \frac{\Sigma\,(\text{response} \times \text{weighting on each response}}{N \times weighting\ the\ highest\ response} \times 100\% \quad (1)$$

$$Percentage = \frac{158}{5 \times 42} \times 100\% = \frac{15800}{210} = 75.24\%$$

According to Leatamia (2008), if the score is above 71%, it means that the development materials are eligible to be used by the users. From the data above, the calculation indicates that the developed tests were classified using appropriate criteria. Based on the teacher's validation feedback, the developed tests were generally suitable for use as the grammar assessment test for the tenth grade. However, some points required revision. The validation suggested providing a clear sentence related to the test question on numbers 3 and 19. Next, the instructions needed to be revised to change the part of speech. Furthermore, some typos should be corrected in the Educaply games.

After the draft of the developed test was revised based on the expert's validation, it was administered to students in the tenth grade at a senior high school in Kediri. It was conducted on May 2nd, 2024. The trial was conducted to determine the students' understanding and knowledge of the topics covered in the developed test. It was conducted to create tests that are appropriate for students. During the trial, the researcher served as the teacher. The tryout went well. The students appeared to be motivated as they participated in the trial. Furthermore, the atmosphere was quite conducive because the students were eager to follow the tryout. The test was carried out smoothly. Then, based on the data collected, the researcher calculated using SPSS 26 to check the validity and reliability.

Validity Testing

To check the validity, the researcher has compared the r-table and r-value. If the r-value > r-table, the item is declared valid; If the r-value ≤ r-table, the item is declared invalid, and items with a correlation coefficient greater than 0.3 are considered valid. From the comparison, it is found that there are 18 valid questions demonstrating strong validity with correlation coefficients above 0.5 and 2 invalid questions. The results of the validity test are presented in Table 1 below.

Table 1. The result of the Validity Test

No.	Item	Pearson Correlation	Validity
1	X01	0.747	Valid
2	X02	0.515	Valid
3	X03	0.722	Valid
4	X04	0.439	Valid
5	X05	0.532	Valid
6	X06	0.532	Valid
7	X07	0.665	Valid
8	X08	0.459	Valid
9	X09	-0.079	Invalid
10	X10	0.533	Valid
11	X11	0.451	Valid
12	X12	0.223	Invalid
13	X13	0.529	Valid
14	X14	0.501	Valid

No.	Item	Pearson Correlation	Validity
15	X15	0.509	Valid
16	X16	0.499	Valid
17	X17	0.615	Valid
18	X18	0.478	Valid
19	X19	0.441	Valid
20	X20	0.587	Valid

Reability Testing

Furthermore, to check the reliability of the test, there is a formula: If alpha >0.60, the item is declared reliable. However, if alpha ≤ 0.60, the item is declared unreliable. The reliability of the test was measured using Cronbach's Alpha. A value above 0.7 indicates good reliability. The results of the reliability test are presented in Table 2 below.

Table 2. The Result of the Reliability Test

No.	Cronbach's Alpha	N of Items
1	.883	20

Based on Table 2 above, the alpha coefficient is 0.884. The correlation result means the test is reliable because the alpha is >0.60.

Item Difficulty

Item difficulty is a more important technique for item analysis for selecting and rejecting the test items, which is utilized by research scholars in the present study (Gul et al, 2022). The researcher uses Microsoft Excel to determine the item difficulty and item discrimination scores in addition to verifying the test's validity and reliability. The level of difficulty of the questions is presented in Table 3 below.

Table 3. The Criteria of Item Difficulty

No.	Difficulty Index (P)	Description
1	P < 0.3	Difficult
2	0.3 < P < 0.7	Moderate (Optimal)
3	P > 0.7	Easy

The calculation of the item difficulty score shows that there are 1 question categorized as Easy (numbers 1, 3, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20) and 4 questions as Moderat (numbers 2, 4, 9 and 16).

Item Discrimination

The last aspect to be considered is the score of item discrimination. It follows the criteria as presented in Table 4 below.

Table 4. The Criteria of Item Discrimination

No.	Discrimination Index (D)	Description
1	D < 0.2	Poor
2	0.2 < D < 0.3	Fair
3	0.3 < D < 0.4	Good
4	D > 0.4	Excellent

The discrimination indices for the test items range from 0.13 to 0.67. Items with high discrimination indices, such as X01 (0.67) and X07 (0.47), are effective in distinguishing between high-performing and low-performing students. Conversely, items with low discrimination indices, such as X09 (0.13), are less effective.

Items with high discrimination indices are particularly valuable for assessments as they can differentiate between students who have mastered the material and those who have not. Items with low discrimination indices should be reviewed and potentially revised to enhance their ability to

discriminate between different levels of student performance. Improving these items will help in making the test a more effective tool for measuring student learning outcomes.

Discussion

The finding shows the analysis of the Educaply-based grammar assessment for tenth-grade students at Senior High School 5 Taruna Brawijaya provides valuable insights into the test's effectiveness and areas for improvement. The findings of this study revealed that the Educaplay-based grammar assessment tool demonstrates strong validity and reliability as an effective educational instrument. Of the 20 test items developed, 18 were found to be valid, indicating that they align well with the intended grammatical learning objectives. Reliability analysis using Cronbach's Alpha yielded a coefficient of 0.884, suggesting internal consistency among the test items. Furthermore, item discrimination analysis showed that the majority of test items could effectively differentiate between high- and low-performing students. However, the item difficulty analysis revealed that most items were categorized as easy, highlighting the need to incorporate more challenging items to ensure a balanced assessment that caters to diverse student abilities.

Educaplay is a potential grammar-based assessment that improves motivation and engagement among students. This is noted by the finding that game-based activities led to significant improvements in grammar acquisition (Alrwais, 2024). It occurs since digital games have been found to enhance grammar skills among EFL learners by making the learning process more engaging and interactive (Khan et al., 2024). By increasing student engagement, improving grammar proficiency, and receiving positive feedback from learners, Educaplay aligns well with the benefits observed in game-based and interactive learning studies.

These findings directly align with the main objective of this study: to develop an interactive grammar assessment tool using Educaplay, specifically designed for Indonesian senior high school students. The positive validation results and the ability of Educaplay to provide immediate feedback align with previous studies highlighting the benefits of digital and gamified learning tools. For instance, Castillo-Cuesta (2020) demonstrated that digital games significantly enhance grammar comprehension and student engagement in EFL contexts. Similarly, Graça et al., (2022) reported that platforms like Educaplay facilitate interactive and engaging learning environments. Furthermore, Educaplay-based learning can increase learning enthusiasm and concentration (Febrianti et al., 2024). Overall, the Educaplay-based gamification system has a positive impact on the quality of student learning. This study extends these findings by focusing specifically on grammar assessment, filling a gap identified in previous literature regarding the lack of context-specific applications of gamification for grammar learning (Mykytka et al., 2022). Besides, utilizing Educaplay for grammar assessments can help teachers improve the quality of their evaluation methods. It aligns with the development of teachers' language assessment literacy, which is crucial for the effective implementation of classroom-based assessments (Fitriyah et al. 2022).

Moreover, one of the key findings of this study is the importance of immediate feedback, which was central to the design and implementation of Educaplay. Hossain & Younus (2024) emphasized that real-time feedback plays a crucial role in sustaining learner motivation and improving learning outcomes. The immediate feedback feature of Educaplay was found to enhance student engagement, as it allowed them to correct their mistakes promptly and continue progressing through the grammar exercises. This directly supports the primary aim of the study: improving grammar learning through an interactive and engaging assessment tool, addressing the limitations of traditional assessment methods that often fail to engage students in meaningful ways. In addition, Educaplay offers assessments that apply ready-made templates and interactive tools. These facilitate teachers to implement the assessment despite the challenges they face in designing authentic assessments due to time constraints and lack of resources (Irsyad & Zaim, 2023). The use of Educaplay in grammar assessment is an important indication of the increasing implementation of technology in game-based assessment, which is certainly very popular with students (Blundell, 2021).

Despite the promising results, the study also identified areas for improvement, particularly regarding the difficulty level of the test items. The predominance of easy items suggests the need for more challenging questions to better differentiate between students with varying proficiency levels.

This limitation is consistent with findings from Kaosayapandhu (2023), who stressed the importance of developing balanced assessments that cater to a wide range of student abilities. Future revisions of the tool should incorporate more complex grammar tasks to ensure that all learners, regardless of their proficiency, are adequately challenged.

In conclusion, this research highlights the potential of Educaplay to address the gap in traditional grammar instruction and assessment methods. By developing and validating an interactive grammar assessment tool, this study contributes to the growing body of literature that advocates for the integration of gamification and technology into language education. The findings demonstrate that Educaplay can be an effective tool for enhancing grammar learning, not only in Indonesia but also in other educational contexts with similar challenges. Further studies should explore the long-term impact of such tools on grammar proficiency and assess their scalability across diverse educational settings.

CONCLUSION

In conclusion, the purpose of this study was to develop an Educaply-based grammar assessment for tenth-grade students at Senior High School 5 Taruna Brawijaya. The findings demonstrate that the majority of the test items are valid and reliable, making the assessment a generally effective tool for measuring students' grammatical proficiency. This research successfully bridges a critical gap in grammar instruction by integrating gamification and technology, offering practical solutions to traditional assessment limitations. The immediate feedback mechanism within Educaplay enhances students' ability to learn from their mistakes and stay motivated, making it a promising alternative to traditional grammar assessments. Moreover, its ready-made templates and interactive tools support teachers in overcoming common challenges in designing effective classroom assessments.

However, improvements are needed in item difficulty and discrimination to ensure a more balanced and comprehensive evaluation of student abilities. By addressing these areas, the Educaply-based grammar assessment can better support targeted teaching strategies and enhance students' understanding and mastery of grammar. The integration of educational games through Educaply proves to be a promising approach for engaging students and improving their language skills in a modern educational context.

Based on the conclusions, further studies are recommended to explore the integration of advanced technological tools like Educaply for grammar instruction, focusing on refining test items to achieve optimal difficulty and discrimination levels. Additionally, research should examine the long-term impact of game-based assessments on students' grammatical proficiency and overall engagement. For senior high school grammar teachers, incorporating Educaply into their teaching practices can provide an innovative and interactive way to assess and enhance students' grammar skills. Leveraging such tools is important so that teachers can create more dynamic and effective learning experiences that cater to diverse student needs and foster a deeper understanding of grammar. By adopting these recommendations, educational institutions can further harness the potential of game-based grammar assessments, improving learning outcomes and promoting more dynamic, technology-driven language education practices.

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Measuring interest and talent in determining learning using the quadrant model in the learning process in a smart classroom

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ABSTRACT

Naturally, the learning process in smart classrooms is greatly impacted by the trend of individual learning, now known as personalized learning. Several studies have demonstrated that, because of the problem of technological advances, the effectiveness of the anticipated results has not been fully achieved. While there are technology benefits, some scholars link them to issues. This study aims to demonstrate it by evaluating learning interests and talents. A sample of at least 1000 students from 419 universities participated in the questionnaire experiment. Each of the three questionnaire domains, affective, cognitive, and psychomotor, was examined using ANOVA. The coefficient test uses two variables: interest and talent. With an ANOVA P-value of 0.021 for psychomotor and 0.031 for affective and cognitive, the three domains demonstrated a statistically significant connection. The coefficients of interest and talent, which average between 1 and 0.05 for P emotional and cognitive interest (0.054) and P talent (0.023) and between 0.027 and 0.055 for P psychomotor interest and P talent, demonstrate the significant values of both factors. The developed interest and talent measuring model can be used to forecast learning outcomes based on these findings. In addition to information technology, the results of this interest and talent-measuring design can be utilized to define and evaluate the learning process, including its appropriateness. Further research recommendations include a framework to measure interests and talents early, aiding admissions, curriculum, resources, methods, and learning media development.

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INTRODUCTION

Learning is a dynamic process between students and teachers, and each program must have a clear purpose (Ekantiningsih & Sukirman, 2023). Learning involves three main areas: affective, cognitive, and psychomotor aspects, and various factors must be considered when evaluating educational programs (Reis et al., 2021). Techniques, methods, and materials in the learning process are very important because they guide education and predict effective outcomes (Harefa et al., 2023). There are mixed claims about the effectiveness of smart classes, and ongoing research continues to explore this area (Mahler et al., 2018).

Interest and talent are two very important internal factors in the learning process. Interest provides motivation and encouragement for students to learn, while talent provides the potential and ability to achieve optimal results (Georgiou & Kyza, 2018). When students learn according to their interests and talents, they tend to be more enthusiastic, passionate, and focused. This can increase the effectiveness of learning and produce better learning outcomes (Akbari & Sahibzada, 2020). The ideal curriculum and education system should be able to accommodate the diversity of students' interests and talents (Gao et al., 2020). However, in practice, the curriculum is often too dense and uniform, so it does not provide enough space for students to develop their interests and talents optimally (Yu & Singh, 2018). An evaluation system that focuses too much on academic test results can also ignore students' potential in other areas, such as art, sports, or practical skills (Sutarto et al., 2020).

Recent developments point to the idea of society 5.0, where personalized learning based on established methodologies becomes more common (Santiko et al., 2025). Knowing whether interest in talent affects learning achievement, especially in the context of digital systems, remains an open question (Santiko et al., 2024). Although smart classrooms show promising results in improving learning outcomes, consistent evidence of their effectiveness is still limited (Santiko et al., 2022). Several factors influence outcome measurement and implementation variability, and each classroom situation may produce different results based on the specifics of teacher training and technology accessibility (Achmad & Mulyati, 2023).

According to a related study, a learning's efficacy is also determined by how appropriate it is for both the teacher and the students (Chen et al., 2021). Dimensional modeling of learning style classification is thought to be appropriate for assessing efficacy from the standpoint of the teacher's and students' respective learning type compatibility (Santiko et al., 2025; Lo & Hew, 2020).

Many students choose majors or fields of study that do not match their interests and talents due to pressure from parents, friends, or the surrounding environment (Désiron et al., 2024). This can lead to a lack of motivation to learn, difficulty in understanding the material, and suboptimal learning outcomes (Murillo-Zamorano et al., 2021). Many schools lack the facilities and support to develop students' interests and talents, such as laboratories, art studios, sports fields, or competent teachers (El-Sabagh, 2021). This can hinder students from developing their potential to the fullest. When students do not study according to their interests and talents, they tend to feel bored, fed up, and unmotivated (Lo & Hew, 2020). This can lead to decreased academic achievement, negative behavior, and even dropping out of school. An education system that focuses too much on academic test results can ignore students' potential in other areas, such as art, sports, or practical skills. This can lead to a loss of opportunities for students to develop their potential holistically (Shen & Ho, 2020).

This study will evaluate the influence of personal interests and talents on learning achievement in smart classes. This study will use an experimental method, collecting data from students in Central Java, Indonesia. The questionnaire will assess learning outcomes based on affective, cognitive, and psychomotor dimensions. This analysis will explore the correlation between students' interests, talents, and academic achievement using regression analysis (Jiao et al., 2022). The influence of interests and talents on learning outcomes is very significant. Therefore, it is important for all parties involved, namely the government, schools, teachers, parents, and students, to work together in creating an educational environment that is conducive to the development of students' interests and talents.

METHOD

To answer the problems that arise, this study will use an experimental methodology (Putri & Meilana, 2023). Several examples of the use of experiments are considered quite reliable in cases of measurement and assessment of a person (Tussa et al., 2024). Based on the experimental design, respondents who contributed around 1000 students in 419 Universities located in the Central Java Province Region have provided data for two semesters of learning. Universities that have used smart class services in their teaching and learning processes received questionnaires. As shown in Figure 2, the sample used is an evaluation of learning outcomes based on three elements,

namely affective, cognitive, and psychomotor. Next, as you will see in the next step, identify the independent and dependent variables for regression analysis. Then, to get the value of the variable, the researcher uses a question instrument that will be tested for validity and reliability first. After getting the value, a multiple linear regression analysis will be carried out to determine the prediction of whether the interest and talent variables have a strong influence or not on learning achievement according to Bloom's aspects.

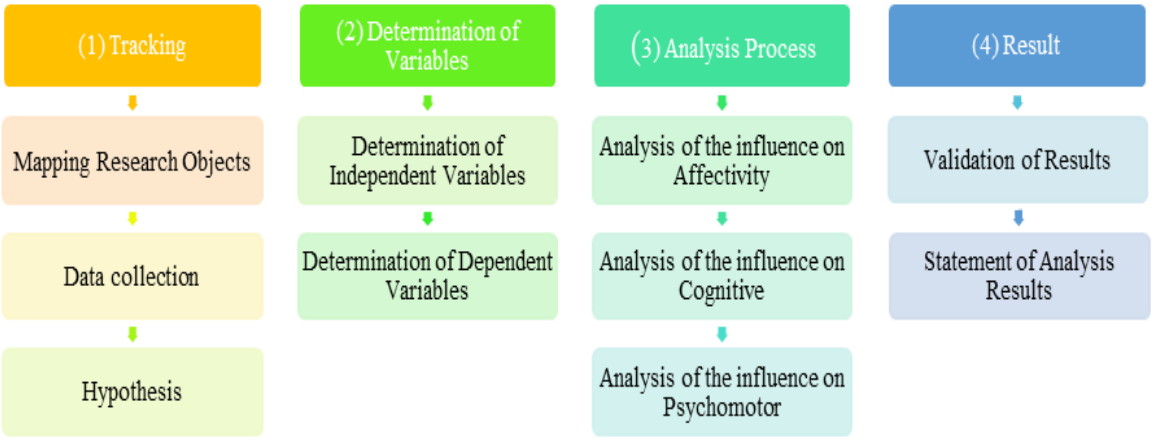

Figure 1. Stages of Research Implementation

The researchers developed an assessment tool in the form of questionnaire score findings to make the data in this study easily comprehensible. To gather and categorize variables, researchers separate them into independent and dependent categories using a variety of instruments. These categories serve as resources for the hypothesis that will be tested. Multiple linear regression analysis will be performed using the two derived categories. Table 1 below displays the variable distribution model:

Table 1. Pattern of Preparation and Determination of Variable Instruments

Aspect	Dependent Variable (Y)			Independent Variable (X)	
	Affective	Cognitive	Psychomotor	Interest (Motivation)	Aptitude (Learning Style)
Indicator	Attitude	Understand	Imitate	Happiness	Personality
	Responsibility	Analyze	Manipulate	Interest	Habit
	Obedient	Apply	Operate	Attention	Skills
	Organize	Evaluation	Create	Involvement	Achievement

Statistics are used in this research's data analysis procedure. The first test that is conducted is a validity and reliability test for every variable. This is required since qualitative data is used in the data linked to the evaluation of the variables' findings. To give the qualitative data a numerical value, it is transformed into quantitative data. The researcher then performed multiple regression analyses to examine the link between the independent and dependent variables once each variable was deemed legitimate and realistic. This experiment will demonstrate the extent to which the independent variable affects the dependent variable.

RESULTS AND DISCUSSION

Results

Tracking the sample was the researcher's initial action. Several campuses or colleges that have an intelligent class system and use this approach will serve as samples for the researchers. The Central Java Province of Indonesia's university population provided samples. Table 2 presents the distribution of sample data obtained.

Table 2. Sample of Universities that Use a Smart Classroom System

No.	Campus Name	Learning System	Learning Methods	Resource Material	Media Platform	Use of Technology
1	Campus 1	Hybrid Class	Discussions, Forums, Assignments, Practice	Book, Article, Video, Portfolio	Website, Webex, Zoom, Face Recognition Presence	Internet, IoT, AI, AR, VR
2	Campus 2	Online Class	Discussions, Forums, Assignments, Practice, Games, Sociodrama	Book, Article, Video, Library	Website, Mobile Apps, Zoom	Internet, IoT, AI, VR
	…	…	…	...	…	…
419	Campus 419	Offline Class	Discussions, Forums, Assignments, Practice, Drill	Book, Article, Video	Website	Internet

In the province of Central Java, 419 universities have adopted the smart class system; 76% still use the traditional method. The two factors that make up this thorough data are the learning system and the system's usage of technology.

Results for the learning system showed that 293 campuses out of 419 used hybrid technology, or 70% of all campuses; 326 campuses out of 419 used online technology, or 78% of all campuses; and 117 campuses out of 419 still used offline technology, or 28% of all campuses. The Central Java campus is dominated by the online system. It is also possible to conclude that, while technology use has temporarily advanced, the smart classroom system itself is still in the process of transitioning to dynamic learning, based on the hybrid usage statistics, which combine online and offline systems.

Using the data collected, tracking will be done once more using the 3M elements Methods, Materials, and Media as shown in Figure 2. Ten randomly chosen current students from each university served as the sample of students from which the tracking data was gathered. The following outcomes were attained:

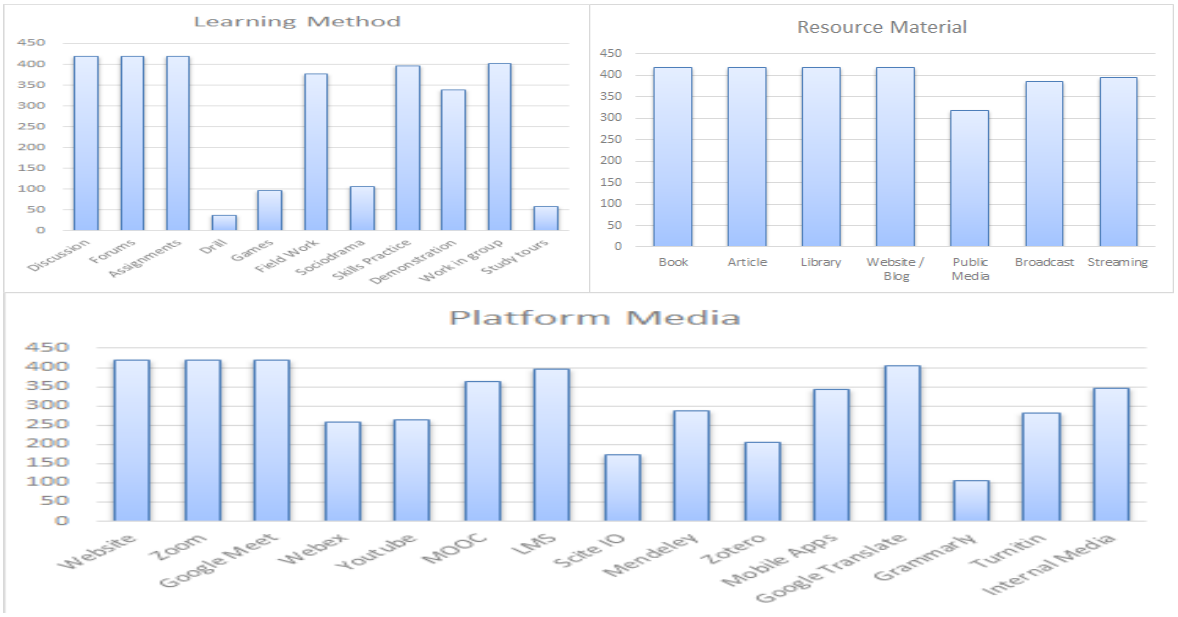

Figure 2. Tracking Diagram for the Use of the Intelligent Classroom System based on 3M Aspects

Figure 2 illustrates how campuses in the province of Central Java have, on average, integrated technology into their teaching and learning processes based on the 3M elements of methods, materials, and media. When it comes to methods, the most popular ones are the assignment, forum, and discussion approaches, all of which are comparatively frequent. When it comes to the material side, the majority of acquisitions originate from books, journals, and libraries, all of which are thought to be widely utilized on campuses. On the other hand, when it comes to the media that is utilized, colleges typically use websites that are associated with the commonly employed approaches, as well as teleconference tools like Zoom and Google Meet. This indicates that the learning services that take place still use patterns in general; they have just been replaced by the idea of teleconferences, which merely relocate the classroom setting and add flexibility to the schedule.

To determine the variables, the author first tracked student interactions in using technology in the learning process. The data taken is the result of student interactions in the use of technology regarding bloom aspects. The list of questions provided is measured based on previously determined Bloom aspects. Table 3 is an example of questions asked through a questionnaire from the affective aspect.

Table 3. List of Questionnaires

No.	Question List of Affective Aspects
Attitude	
1	I am Always Online on Time, According to the Lesson Schedule.
2	When Meeting Online, I Always Activate the Camera.
3	I Always turn off the Microphone when the Teacher is Explaining.
4	I Always Ask Permission when I want to leave an Online Forum.
Responsibility	
5	I Always Ensure the Network Connection is Secure before Learning Begins.
6	I Immediately Switched to Chat Media when the Connection was Interrupted.
7	I Always Upload Assignments on Time.
8	I Always Signal when I want to Interact.
Obedient	
9	I Accept the Results of the Learning Scores given Under any Conditions.
10	I Accept the Forms of Reward and Punishment given by the Teacher.
11	I Always Follow the Contract and Learning Plan that have been given.
12	I Follow the Rules Enforced by the Online System.
Organize	
13	I will Form a Team in a Separate Chat Group if You want to Discuss it.
14	I Always Pay Attention to the Duration given.
15	I Utilize the Mobile App Platform to Provide Instructions.
16	I Always make Decisions based on the Votes of the Members of the Group.

The list of questions, each of which will be assessed based on point values, is divided into 3 criteria, namely, Always (A) with a weight value of 3, Sometimes (S) with a weight value of 2, and Never (N) with a weight value of 1. The explanatory assessment model is presented in Table 4.

Table 4. Questionnaire Assessment Model

	Taxonomy Bloom Aspect		
Questions	**Always (A) - Point 3**	**Sometimes (S) - Point 2**	**Never (N) - Point 1**
		Dimension	
Q1	Value	Value	Value
Q2	Value	Value	Value
Q3	Value	Value	Value
Q4	Value	Value	Value

According to each criterion, they will be totaled in this value model. Next, an average value is derived from the total number of values for each criterion. The value will be combined to create a description value once the average value has been determined. The overall maximum value of all questions for each criterion, that is, the maximum value for criterion A is 12 points, the maximum

value for criterion S is 8, and the maximum value for criterion N is 4, is what yields the information value. The following are the average values for each criterion presented in Table 5.

Table 5. Description of the Average Value for Each Bloom Aspect Criterion

No.	Average Value	Rank	Description
1	8 – 12	High Level	Students have High Effectiveness Scores in this Aspect.
2	4 – 8	Medium Level	Students have Medium Effectiveness Scores in this Aspect.
3	0 – 4	Low Level	Students have Low Effectiveness Scores in this Aspect.

Create the same thing for the interest and talent elements after establishing an assessment model for the bloom aspect. Distinct in how interest and talent variables are scored. The author uses a quadrant matrix to organize value categories. The students' place in a certain quadrant will be ascertained by answering questions on their talent interests in the questionnaire. The correlation between the resultant quadrant value and the bloom aspect value will be examined. It will be evident from this value whether or not it had an impact. The question is now a statement with two values in this talent interest area, with positive statements having a value of 1 and negative statements having a value of -1. Table 6 shows examples of statements included in the student questionnaire.

Table 6. Examples of Statements in a Questionnaire to Determine Interest and Talent Values

Interest Aspect			
Statement		**Score**	**Rule**
When I Decided to Choose the Campus where I Studied			
a.	I'll Find out as I see Fit.	1	Positive
b.	I will Follow what Others Think is Good for Me.	-1	Negative
Talent Aspect			
Statement		**Score**	**Rule**
When I Decided to Choose the Campus where I Studied			
a.	I will Take the Initiative to Find out from Various Sources	1	Positive
b.	I will Wait for Good Information for Me	-1	Negative

This value applies to both aspects, therefore, the statements given to each aspect of talent interest must be balanced between positive and negative statements. The total score will determine the position of the student's interests and talents in the quadrant matrix. A description of the designed talent interest quadrant matrix is presented in Figure 3.

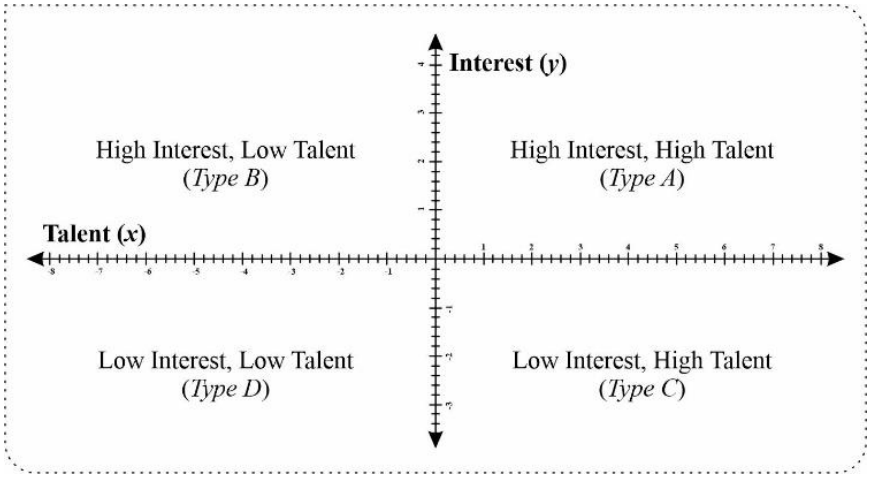

Figure 3. Interest and Talent Quadrant Matrix

The questionnaire is then given to several samples once an assessment model has been obtained to identify variables. Every university student in the province of Central Java made up the sample. Out of the 419 campuses, 1000 respondents in total completed the survey at random. The

data will be tested by the author using a sample of twenty responders. The following are the results of distributing the questionnaire, which are presented in Tables 7 and 8.

Table 7. The Results of the Questionnaire Values are in the Form of Independent Variables

No.	Participant	Average value (Y)		
		Affective	Cognitive	Psychomotor
1	Student 1	8	4	5
2	Student 2	5	10	10
3	Student 3	4	8	9
…	…	…	…	…
1000	Student 1000	3	9	7

Table 8. The Results of the Questionnaire, Values are in the Form of a Dependent Variable

No.	Participant	Average value (X)	
		Interest	Talent
1	Student 1	3	3
2	Student 2	-2	3
3	Student 3	-1	4
…	…	…	…
1000	Student 1000	-1	6

After variables are created and specified value attributes are produced, data analysis is the next step. The analysis's findings are as follows:

Multiple Regression Analysis on Affective Aspects

The results of the multiple regression analysis for the affective aspect can be seen in Table 9.

Table 9. ANOVA Test and Coefficient Formula Between Affective and Interest Variables

Model		Sum of Squares	df	Mean Square	F	p
H_1	Regression	9.237	2	4.618	1.113	0.031
	Residual	70.513	17	4.148		
	Total	79.750	19			

Note. The intercept model is omitted as no meaningful information can be shown.

Coefficients

Model		Unstandardized	Standard Error	Standardized	t	p
H_0	(Intercept)	8.250	0.458		18.009	< .001
H_1	(Intercept)	8.620	1.682		5.124	< .001
	Interest	-0.276	0.186	-0.346	-1.490	0.054
	Talent	-0.150	0.416	-0.084	-0.360	0.023

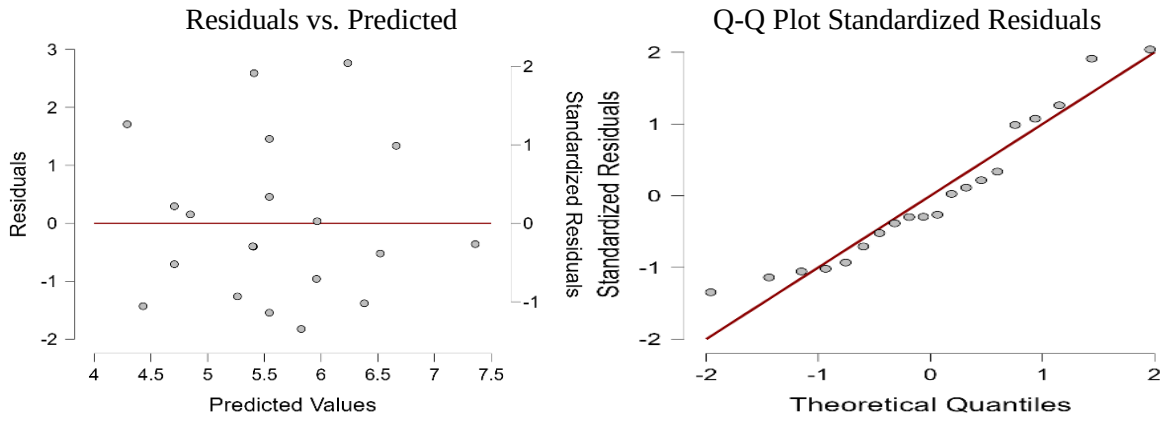

Figure 4. Results of Analysis of Residuals and Affective Quantiles

The ANOVA figure in the affective aspect was 0.023, which is less than the 0.05 principle, and the coefficient value was less than 0.001. Figure 4 illustrates how the residuals appear to be around the conventional quantile line and how the data distribution appears to be even. This investigation establishes a relationship between talent interest and effective achievement results, and the model can be applied as a predictive tool.

Multiple Regression Analysis on Cognitive Aspects

The results of the multiple regression analysis for the cognitive aspect can be seen in Table 10.

Table 10. ANOVA Test and Coefficient Formula Between Cognitive and Interest Variables

Model		Sum of Squares	df	Mean Square	F	p
H_1	Regression	9.237	2	4.618	1.113	0.031
	Residual	70.513	17	4.148		
	Total	79.750	19			

Note. The intercept model is omitted as no meaningful information can be shown.

Coefficients

Model		Unstandardized	Standard Error	Standardized	t	p
H_0	(Intercept)	8.250	0.458		18.009	< .001
H_1	(Intercept)	8.620	1.682		5.124	< .001
	Interest	-0.276	0.186	-0.346	-1.490	0.054
	Talent	-0.150	0.416	-0.084	-0.360	0.023

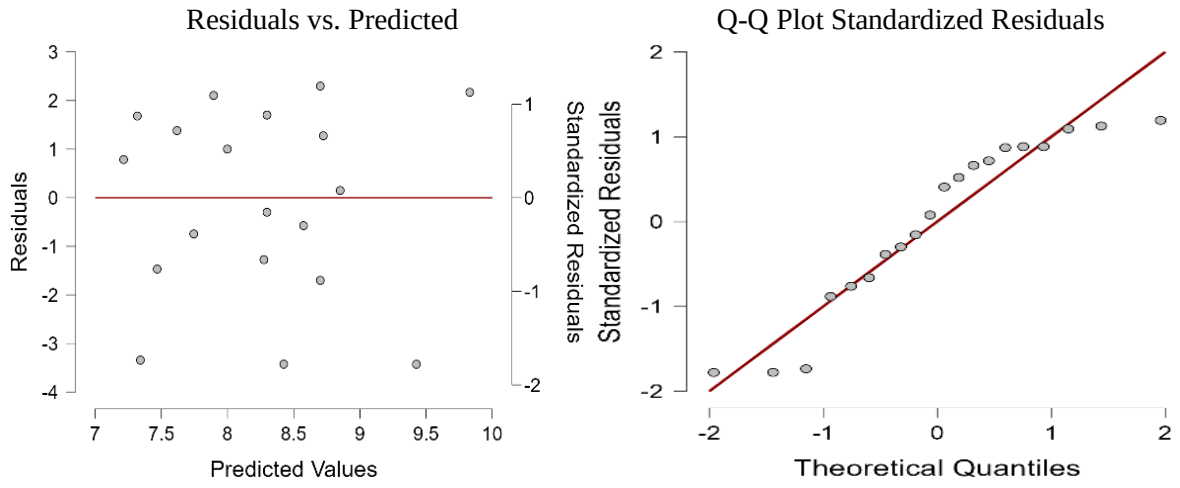

Figure 5. Cognitive Residual and Quantiles Analysis Results

The ANOVA number for the cognitive component was 0.031, which is less than the 0.05 principle, and the coefficient value was less than 0.001. Figure 5 illustrates how the residuals appear to be around the conventional quantile line and how the data distribution appears to be even. This investigation establishes a relationship between talent interest and effective achievement results, and the model can be applied as a predictive tool.

Multiple Regression Analysis on Psychomotor Aspects

The results of the multiple regression analysis for the psychomotor aspect can be seen in Table 11.

Table 11. ANOVA Test and Coefficient Formula Between Psychomotor and Interest Variables

Model		Sum of Squares	df	Mean Square	F	p
H_1	Regression	12.108	2	6.054	1.690	0.021
	Residual	60.892	17	3.582		
	Total	73.000	19			

Note. The intercept model is omitted as no meaningful information can be shown.

Coefficients

Model		Unstandardized	Standard Error	Standardized	t	p
H_0	(Intercept)	8.500	0.438		19.393	< .001
H_1	(Intercept)	7.406	1.563		4.738	< .001
	Interest	-0.276	0.172	-0.362	-1.604	0.027
	Talent	0.221	0.386	0.129	0.572	0.055

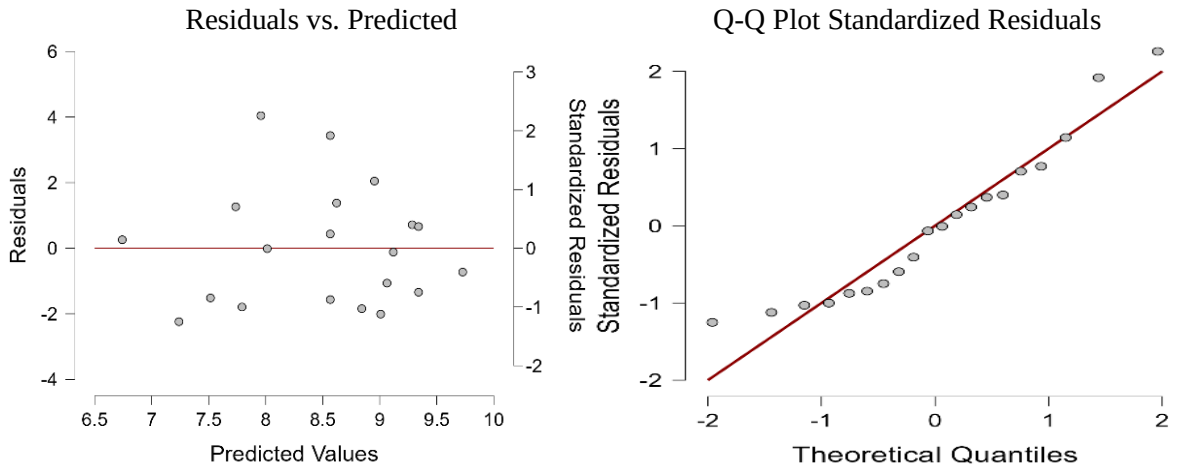

Figure 6. Results of Analysis of Psychomotor Residuals and Quantiles

The psychomotor component yielded an ANOVA number of 0.021, which was less than the 0.05 principle, and a coefficient value of less than 0.001. Figure 6 illustrates how the residuals appear to be around the conventional quantile line and how the data distribution appears to be even. This investigation establishes a relationship between talent interest and psychomotor achievement results, and the model can be applied as a predictive tool.

Discussion

In this discussion, we review the problems that have occurred previously, including educational inconsistencies, uniform curriculum, evaluations that only focus on academics, limited educational facilities, and lack of involvement and understanding. Some variables are considered very important but have not been implemented optimally, namely the variables of personal interests and talents (Hell et al., 2021). These variables are needed, considering that currently, it is a learning model where personalization is starting to run in the era of society 5.0. This paper also reveals how to initiate solutions to problems found in the variables of interest and talent in line with various research on learning motivation (Oubibi et al., 2022). After what was stated in the research results, that interests and talents can also predict affective, cognitive, and psychomotor abilities, the prediction results make it possible to provide recommendations for the development of future learning systems (Hsu, 2022).

The next solution is to develop a curriculum that is more flexible and adaptive to the needs of each student, implement a comprehensive and sustainable talent and interest identification method, and provide various extracurricular activities that are by the talents and interests of

students, this will go hand in hand with the previously known interest and talent measurement indicators using this talent and interest quadrant (Yesilyurt et al., 2016). By the concept carried out in measuring self-assessment of talent interests, the talent demand measurement design model discussed in this paper is by interests where before determining the learning we want, we first measure potential through interests and talent abilities that are by learning objectives in Education (Nguyen, 2022).

Theories such as Knowledge Tracing (KT) and Item Response Theory (IRT) provide dynamic and static models for assessing learning. These models help identify skill mastery and inform personalized interventions, improving educational strategies (Li, 2024). Meanwhile, the quadrant model built in this study can be said to be more in-depth in terms of personalization because it is immediately recognized when appropriate decisions are needed in choosing learning and does not look at past elements like the Knowledge Tracing model. Measuring and influencing students' interests and talents are vital for enhancing their learning experiences and outcomes. By leveraging frameworks, technologies, and personalized strategies, educators can foster engagement, creativity, and employability, ultimately addressing broader educational and societal challenges (Durmuşçelebi, 2018). The integration of these elements ensures that education systems adapt to individual needs, preparing students for future demands.

CONCLUSION

Based on the preceding discussion, the following deductions can be made: (1) The affective, cognitive, and psychomotor categories of Bloom's taxonomy can be used to assess learning outcomes in an intelligent classroom system. (2) Technology-focused services Technology services based on the Bloom aspect in the smart class system solely assist cognitive and psychomotor parts, with little to no impact on affective aspects, according to the analysis and mapping results. Technology currently merely modifies the process of assessing emotionally charged achievements. (3) The model illustrates how the two variables, the Talent Interest and the Bloom Aspect, affect learning accomplishment inside the smart classroom system and offers criteria for assessing learning achievement based on the Bloom Aspect. (4) Smart classes with all technology-based services must be able to adapt the learning process based on various factors, namely affective, cognitive, and psychomotor, to achieve learning outcomes that are considered effective and efficient. For technology services in smart classes to support learning holistically, there must be at least three technologies, namely artificial intelligence, the Internet of Things, and the cloud (big data). These three technologies will be able to provide services to interests and talents and facilitate the implementation of the processes, resources, and media needed to ensure that each student achieves the expected learning outcomes. The following recommendation, which includes a framework for measuring interests and talents at the start of the learning process, can be used as starting capital to create an educational system at the time of admission. It can also be taken into account when developing the curriculum, teaching resources, methods, and learning media.

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Exploring college-student insights on learning aids and practicum equipment

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ABSTRACT

Reflecting on the use of learning media will help students decide on a quality and user-friendly design. Thus, this study examines the experiences of second-year students in the Buddhist Religious Education program at Institut Nalanda who participated in the online distance "Learning Media" course during the 2023-2024 academic year. The researcher aims to understand the students' perspectives on the impact of instructional and practical equipment on their learning. This study used a case study technique, specifically the classroom research strategy, to collect data from 37 student forum posts on Google Classroom. Following a solitary session of asynchronous lectures, comprising a teaching module and three audio recordings, the students produced these postings. The researcher employed qualitative descriptive analysis, utilizing QDA Miner, to discern the principal themes and conclusions derived from the data. The data indicates that students had a variety of experiences using both instructional and practical equipment. Students experience the use of teaching aids to facilitate science experiments, classroom demonstrations, and accounting learning and support arts and sports classes. This study found that students have positive impressions of these media based on their learning experiences. Reflecting on their own learning experiences can inspire students to develop their learning media as a class project. The findings of this study can assist educators in designing learning environments that more effectively prepare students for academic and professional challenges. Research on other cohorts can be conducted as longitudinal studies. Comparing students' experience of on-site and online classes can also be done as a future study.

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INTRODUCTION

Enhancing learning outcomes and skill mastery depends on various elements, such as the utilization of effective learning media, engaging instructional activities, and students' willingness to initiate learning (Lubis et al., 2023). This concept corresponds with Gagné's instructional concepts, emphasizing the necessity of engaging learners' attention through suitable and captivating learning material (Firda & Anam, 2022; Gagne et al., 2005). The optimal use of educational materials and media within institutions can enhance the learning experience and improve instructional effectiveness (Chernetsov et al., 2022; Widhanarto et al., 2024). In response, numerous educators

have integrated various media, including instructional and practical equipment, which enhance effective learning and actively involve students in experiential learning opportunities. Merrill's methodology endorses this by claiming that selected learning media should facilitate knowledge discovery and the cultivation of practical skills (Irwansyah, 2021; Merrill & Frick, 2020; Tazkia & Suherman, 2016).

Prior research has shown that the utilization of teaching aids and practicum tools can improve students' capacity to apply theoretical knowledge through active engagement and skill development (Sinaga et al., 2023; Vera & Primasari, 2022). John Dewey's idea of "learning by doing" posits that students acquire significant experience and enhance their theoretical comprehension by active engagement with practical instruments and educational resources (Mutrofin, 2022). This claim is especially pertinent for students pursuing disciplines such as physics, mathematics, and vocational education, where abstract concepts may be difficult to comprehend without tangible imagery (Byrne, 2022; Craik, 2023). Consistent with Vygotsky's social constructivism, collaborative interactions and experiential learning supported by instructional aids enhance students' ability to internalize and utilize acquired knowledge, equipping them for real-world social responsibilities (Newman & Latifi, 2021; Pathan et al., 2018).

This study seeks to examine the influence of learning aids and practical equipment on the educational experience of students who participated in Learning Media lectures at Institut Nalanda. Data gathered from students' reflections in Google Classroom regarding their experiences with these technologies from elementary to high school will yield insights into the efficacy of experiential learning. Kolb's experiential learning theory (Morris, 2020), based on direct encounters and reflection, encourages students to describe and assess the practical methods they have used. This reflective practice seeks to improve students' planning and implementation skills related to teaching aids that can assist diverse educational disciplines, including science, art, and vocational training (Datta, 2023).

This study is of enormous significance in instruction, particularly in areas where practical skills are crucial, as it has the potential to improve teaching methods (Giyanti et al., 2024; Leny et al., 2024). By comprehending students' learning experiences with instructional aids and practical tools, educators can customize their methodologies to enhance student engagement and information retention. This study may also mitigate obstacles in abstract conceptual learning by employing practical methods that enable students to visualize and apply their knowledge proficiently. Pre-survey results and related literature show that students consistently said that instructional aids like globes, maps, and anatomical models helped them understand difficult subjects much better, while practical tools in science, like microscopes and lab equipment, greatly improved their practical skills (Mutrofin, 2022; Quay et al., 2022).

The primary objective of this study is to discover and advocate for the optimal utilization of learning aids and practicum tools that enhance long-term knowledge retention and practical skill development. It aims to promote instructional practices that integrate these resources with contemporary educational theories and student-centered methodologies. The findings of this study can assist educators in designing learning environments that more effectively prepare students for academic and professional challenges.

METHOD

This study implemented a classroom case study design to undertake a comprehensive, contextually rich examination of the participants' learning experiences. The case study approach Yin (2018) used helped the researcher narrow down and study the unique traits of the chosen students in the Learning Media course of the Institut Nalanda online distance learning program. The Academic Information System on campus reveals a total of 46 students enrolled in the Learning Media class, but only 37 of them participated in the posting. Therefore, this study only focused on students who engaged in a reflective learning exercise, which served as the principal data source.

Before submitting their reflections, students interacted with the course material via two learning modalities: e-modules and audio. The e-modules were accessible via Google Classroom as

downloadable PDF files, while the audio, each lasting no more than seven minutes, offered an alternative to text-based learning for students who favored audio content (see Figure 1). This multimodal strategy aligns with Gagné's ideas, which promote the utilization of diverse media to accommodate various learning preferences (Firda & Anam, 2022; Gagne, 2013). After reviewing these materials, the instructor assisted students in participating in a reflective exercise where they addressed a question about their experiences with educators using instructional aids and practicum tools in the classroom. The reflection guidelines required students to submit their responses in the comments within two weeks, consisting of 5-8 phrases, each with a maximum of 12 words. Google Forms and prompts for reflection served as the instrument and the way data was collected with guided written interviews.

Figure 1. Learning Media Google Classroom

The students' reflection posts were copied from Google Classroom into a notepad and saved as a text file (.txt). This file was used as the main data source for the qualitative analysis. The text file was subsequently imported into QDA Miner (see Figure 2), a qualitative data analysis software, to enable systematic coding and thematic analysis. In QDA Miner, tools such as keyword conversion and word cloud generation facilitated the identification of subthemes and the development of a codebook (Derobertmasure & Robertson, 2014; Miles et al., 2020). To ensure data accuracy, the frequency of keywords was corroborated by comparing the original keyword data with the word cloud generated in QDA Miner, a crucial step in qualitative data validation through triangulation, which entails cross-referencing several sources to improve dependability.

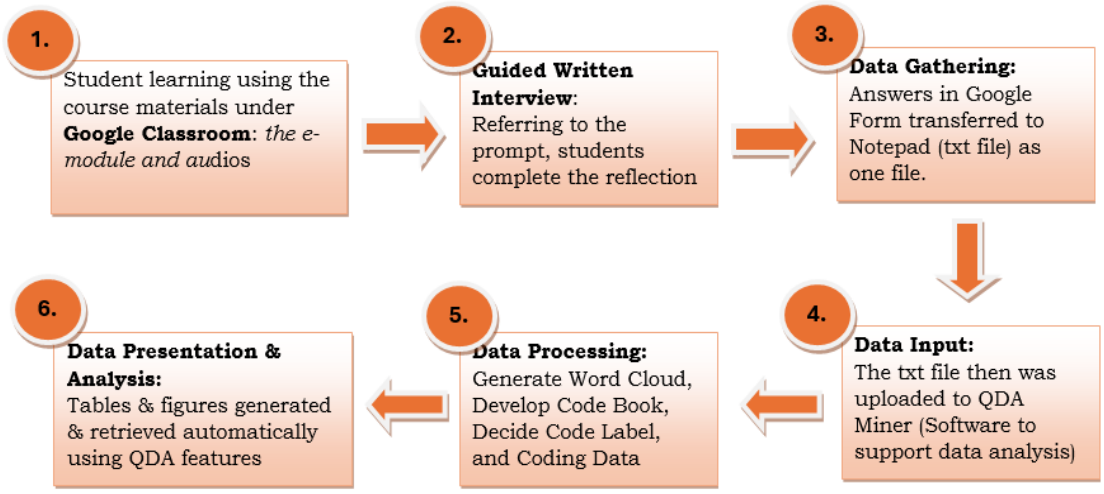

Figure 2. Flowchart of this Study

Based on the frequency and context of keywords, the codebook developed two main themes: "learning aids" and "practicum equipment," each containing subcodes that reflected specific categories of learning media. The operational definitions of sub-themes referenced authoritative sources, such as *Kamus Besar Bahasa Indonesia* (KBBI) and the Cambridge Dictionary. The researcher consulted blog articles and other scientific sources to provide additional clarity when necessary. The researcher also summed up the results and shared them with a small group of participants after the initial coding and thematic analysis. This was done to make sure the interpretation was correct and to improve the reliability of the data (Ajemba & Arene, 2022; Donkoh, 2023; Thomas & Oloyede, 2020).

The study applied several data analysis techniques, including frequency counting, word cloud generation, and theme coding, to enhance the depth and reliability of the results. Frequency counting allowed quantitative insights into recurring themes and key terms within the participants' reflections. Word cloud generation provided a visual representation of prominent keywords, which assisted in thematic identification and reinforced the consistency of subtheme development within the dataset. Additionally, theme coding enabled a more detailed interpretation of the students' experiences with different learning aids and practicum tools. By utilizing multiple techniques, the study aimed to achieve a comprehensive understanding of the data and strengthen the accuracy of findings from multiple analytical perspectives (Acosta et al., 2020; Salaria & Balu, 2023). All these data analysis processes can be easily done using the features offered by QDA Miner. Data produced in the form of tables and diagrams can also be automatically retrieved with features available in the application.

Ethical considerations were essential to this study. Confidentiality was strictly maintained by anonymizing all data to protect participant privacy. Participation was entirely voluntary, with students given the freedom to decide whether to share their reflections on learning experiences. Research ethics adhered to the standards recommended by the American Psychological Association, ensuring that all procedures followed established ethical principles and upheld the integrity of the research process (American Psychological Association, 2019).

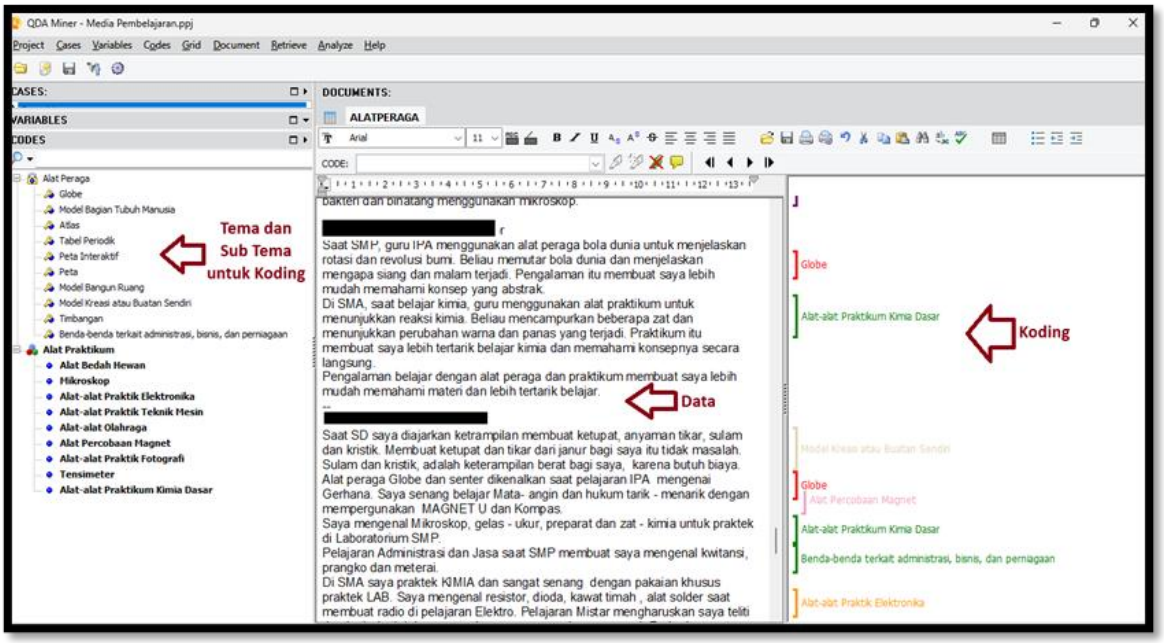

Figure 3. QDA Miner Coding Features

This structured approach to data collection, analysis, and ethical management provides a reliable foundation for interpreting participants' reflections on learning aids and practicum tools within their educational journey. This study's methodology validates the effectiveness and influence of these instructional tools, providing valuable insights for their effective integration into educational practices.

RESULTS AND DISCUSSION

Results

The QDA Miner data analysis system transformed the data from 37 participants into text documents for analysis. The frequency analysis and word cloud creation from this software are essential for identifying the most often cited keywords in participant statements. The analysis of word frequency relevant to the research objectives yielded the 10 most cited terms, with occurrences varying from six to twenty-two times. The terms ranked by frequency from highest to lowest are maps (22 occurrences), sphere and globe (13 occurrences each), magnet and model (12 occurrences each), Atlas (10 occurrences), microscope (9 occurrences), board (8 occurrences), and machinery and electronics (7 occurrences each). QDA Miner produces a word cloud (refer to Figure 3) to further evaluate the results and provide a visual depiction of the data.

Keyword mapping and frequency analysis establish the foundation for theme identification in data coding. The data were classified into two primary categories: learning aids and practical equipment. Each category is subdivided into sub-codes, comprising ten sub-codes for learning aids and nine for laboratory equipment.

The globe frequently serves as a medium that conveys an impression to the participants. Most participants claim that they primarily use these props to explain various geographical locations on the earth's surface. Moreover, the globe is essential for illustrating the Earth's rotation, the variations of day and night, and the phenomenon of eclipses. The actual utilization of globes has facilitated participants' comprehension in geography and science lectures, enhancing their ability to comprehend and grasp astronomical topics. Participants frequently referenced atlases and maps that are intimately associated with the globe. They assert that atlases examine the geographical positioning of seas, oceans, and nations. These two media have elucidated the disparities in magnitude and size among countries, rendering abstract geographic data more tangible. The instructor additionally illustrates a map on the chalkboard to depict the equator, the placement of the continents, and the positioning of the oceans. The image elucidates the interconnections among many geographical elements.

Figure 4. Word Frequencies and Word Cloud

Despite infrequent utilization, interactive maps constitute a significant element in the perspectives of participants. Interactive digital maps require supporting technologies, such as computers and projectors, to enable dynamic presentations that effectively engage students in their use. Furthermore, local maps, including sub-district and city maps, facilitate participants' engagement with their immediate surroundings and serve as a tool for assessing map-related skills.

Another frequently used educational tool is the model of human anatomy. Models of these anatomical structures are crucial for the study of anatomy and physiology. These models also elucidate the anatomy and function of many organs and systems inside the human body. Participants indicated that their instructors employed this model to describe human skeletal anatomy, dermal

layers, cerebral structures, visual organs, and the gastrointestinal system. Providing 3D representations of these components will enhance students' comprehension of human body functionality.

The spatial construction model is crucial in mathematics education, particularly in facilitating the calculation of the volume of three-dimensional figures. These models assist students in comprehending abstract notions of space and volume through the firsthand observation of objects. Physics employs spatial models to illustrate principles like gravity and vertical motion, allowing students to observe these forces in action and improve their understanding of their effects.

The periodic table serves as a crucial educational tool in the field of chemistry. Participants recalled an extensive periodic table in the classroom utilized by the teacher to elucidate the properties and interrelations of chemical elements. Participants indicated that the periodic table enhanced their ability to recall and comprehend the order of elements, atomic structure, and interactions throughout the Chemistry session. Moreover, scales are evident in the reflections provided by the participants. Educators utilize scales to instruct unit conversions, elucidate the functionality of different scales, and provide students with the opportunity to practice mass measurement. Participants develop practical abilities in measuring and comprehending weight and mass, which are essential in everyday life.

Participants should utilize readily accessible office administration tools, such as stamps and receipts, to enhance their understanding of administration and commerce. This medium facilitates the acquisition of knowledge regarding trading, management, and recordkeeping operations for commercial applications in real-world contexts. HVS typewriters and paper offer participants practical experience in business mail administration before utilizing a computer. Participants said that teachers often create their instructional materials for specific lessons. Teachers employ bamboo slats and bottle caps to enhance counting activities in mathematics education. During physics lessons, participants utilize balls, strings, and flashlights to comprehend concepts such as gravity and light. Participants also identified mats and bamboo as materials for skill instruction. Educators have adapted an innovative pedagogical instrument by integrating spheres and inclinations to illustrate Newton's Laws. This model assists participants in recognizing the principles of physics in real-world contexts, enhancing their comprehension of the theories that elucidate motion and force.

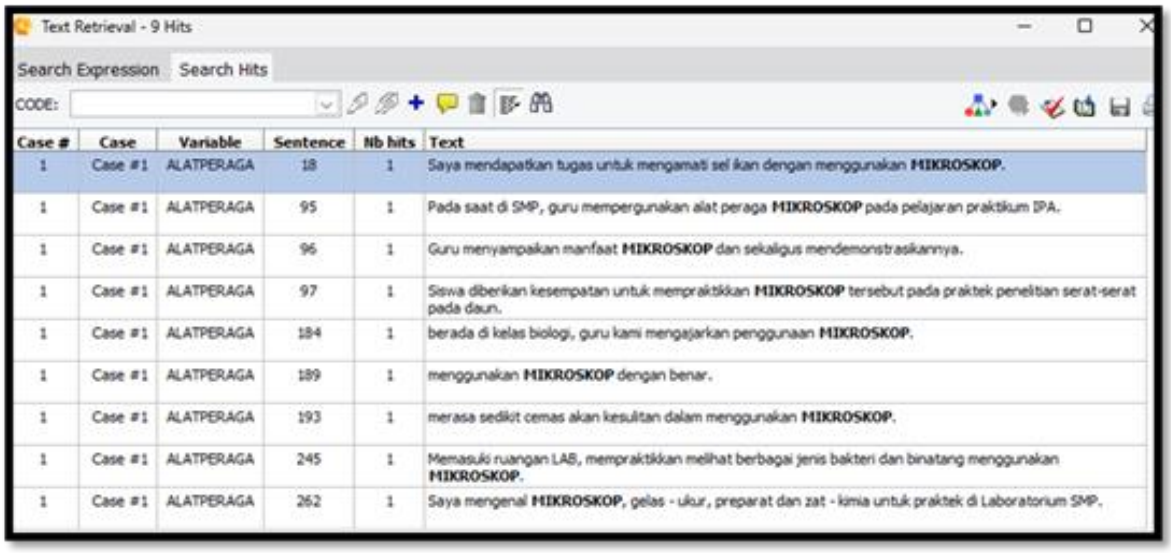

Figure 5. QDA Miner Code Retrieval Feature

The diverse educational tools identified by the participants in this study have demonstrated their efficacy in enhancing the quality of education. Globes and maps for the study of geography and anatomical models for biology, linking abstract principles to practical, real-world applications. Interactive and digital tools, however seldom referenced, possess significant promise as media for advancement in contemporary learning designs.

The readiness of educators to adapt learning aids reflects their commitment to a creative and effective teaching methodology, ensuring that lessons are engaging and comprehensible for learners. The utilization of diverse instructional resources across several disciplines demonstrates educators' capacity to adjust their pedagogical inventiveness to deliver quality education to students. The use of learning aids, as shown by participant responses, confirms that media can enhance the dynamism and efficiency of the learning environment, hence improving educational results for learners.

Practicum tools are essential for bridging theoretical knowledge with practical application. Multiple fields and educational tiers employ practicum instruments. This medium enables students to engage actively in experiential learning, cultivate a profound comprehension, and enhance their proficiency in utilizing work aids. Despite variations in accessibility and cost-effectiveness, participants consistently identify essential resources that facilitate their learning process.

The microscope is the most frequently referenced practical tool, rendering it highly instructive in science classes, particularly in biology. The participants employed microscopes to examine various subjects, including fish cells, leaf fibers, microorganisms, and bacteria. These findings show that microscopes are essential for comprehending cell structure and biological processes, which are core concepts in biology education. Microscopes enable students to examine the intricate features of creatures, facilitating a profound comprehension of biodiversity and environmental complexity. By examining these minuscule components of organisms, learners can cultivate an appreciation for the complexities of life forms and attain a more profound comprehension of the essential roles that living entities fulfill, despite their existence as invisible cells without assistance. This practical knowledge is essential for rendering abstract biological concepts more tangible and comprehensible.

The participants mentioned conducting experiments with the microscope to understand the properties and chemical reactions, but they didn't specifically mention the tool they used during the Chemistry session. Participants noted the utilization of practical instruments to evaluate the magnetic properties of items, which significantly enhanced their comprehension of magnetism and its practical applications. We acknowledge that magnets are beneficial for understanding cardinal directions and the functionality of compasses, which are crucial for imparting navigation and orientation abilities.

Chemical studies frequently note chemical reactions, variations in temperature, and alterations in color. Respondents did not specify the equipment utilized, although they emphasized the necessity of the experiment to get an understanding of chemical processes. Participants' direct experience enhances their comprehension of intricate chemical principles and fosters critical thinking and problem-solving abilities pertinent to the subjects examined. Participants clarified the use of electronic devices during educational activities at the school. Participants highlighted in their reflections that utilizing the basic electronic practicum device alleviates concerns regarding the hazards associated with the equipment. Electronic devices, including soldering tools, power generation equipment, and other components and instruments, are crucial for the assembly and comprehension of electronic circuits; hence, they facilitate knowledge in the field of electronics.

Practical engagement enhances participants' comprehension of electrical properties and the functionality of electronic devices. Active engagement in basic practicums during education enables students to enhance their comprehension of electronic principles, develop their technical skills, and cultivate confidence in operating electronic devices. Students aspiring to jobs in electronics and electrical engineering particularly gain from obtaining this practical expertise. Participants who attended vocational school reported utilizing specialized practical tools pertinent to their specific fields of study. Participants who study machines utilize various devices to comprehend their activities and operations. These practical experiences are crucial for vocational training as they provide learners with the skills required to operate and maintain machines across various industrial settings.

One individual, before attending a nursing vocational high school, acknowledged practicing blood pressure monitoring with a sphygmomanometer. This instrument is crucial for educating healthy students to accurately monitor and evaluate patients' vital signs. Students receive practical training with medical devices, ensuring they are well-prepared for clinical environments and capable of providing competent patient care.

Participants who had experience using practical equipment in the chemistry and biology labs demonstrated a variety of tools to aid in their scientific practicum. The chemistry laboratory employs practical instruments to examine and assess chemical reactions, temperature variations, and color

changes. These experiments facilitated their comprehension of the properties of various substances and the fundamental principles that regulate chemical interactions. Participants also recounted their experiences of avian dissection in the biology laboratory. This surgery is conducted to investigate the anatomy and physiology of the avian species. Dissecting the specimen enables participants to visually analyze and comprehend the internal anatomical structure of living organisms and their physiological activities. This pragmatic method enhances their comprehension of biological systems and processes.

Practicum tools possess broader applications beyond scientific and vocational fields. Participants also indicated that practice tools aided them in sports and skills instruction. One participant recounted her experience utilizing volleyball in a physical education lesson, highlighting the significance of the ball in imparting her volleyball skills. Sports equipment promotes the cultivation of students' physical abilities, encourages comprehension of collaboration, and improves their grasp of the rules and tactics pertinent to various activities.

In the domain of photography, participants indicated their engagement in the use of the camera without specifically referencing further specialist equipment. Cameras are essential in photography education, enabling students to understand composition, exposure, and several technical aspects of photo production. Students can enhance their artistic and technical photography abilities via hands-on camera experience.

This study underscores the significant importance of diverse practical methods in enhancing educational experience. These instruments, encompassing microscopes, chemical apparatus, electronic gadgets, and vocational training tools, facilitate practical study across diverse disciplines. Practicum equipment enhances students' comprehension of theoretical concepts and promotes the development of essential skills through practical applications. These tools provide students with the skills and information essential to navigate real-world challenges and pursue careers more adeptly in their selected field.

Discussion

The findings of this study align with the ideas outlined in other prominent educational theories. These educational ideas elucidate that the utilization of diverse learning aids and practical instruments significantly enhances the student learning experience and outcomes (Irwansyah, 2021; Tazkia & Suherman, 2016). Merrill's instructional design concepts prioritize problem-solving and active engagement as essential components of effective learning (Kurt, 2022; Pappas, 2023). The utilization of globes, maps, atlases, and human skeleton models in the classroom facilitates the elucidation of essential knowledge concepts that students must comprehend. These props can promote student engagement with the studied topic, enhance visualization of intricate concepts, and assist with problem-solving. Utilizing the globe to comprehend the earth's rotation and its impact on the alternation of day and night will engage students in critical thinking about this cosmic event. Anatomical models enable students to investigate and comprehend the structure and functions of the human body through manipulation and direct observation. Manipulation and direct observation enhance students' intellectual comprehension via practical applications (Merrill & Frick, 2020; Truong et al., 2019).

Vygotsky's constructivist theory posits that learning is a social process occurring as individuals gain knowledge via interactions with their environment and peers (David, 2014; Karpov & Bransford, 1995). Teaching aids, like maps, globes, and anatomical models, serve as instruments for investigation and mutual comprehension among learners and educators in the educational setting. Utilizing interactive digital maps enables students to participate, engage in discourse, and analyze geographic data. Similarly, during mathematics and physics classes, students participate in hands-on activities that involve using anatomical models and creating environments. They will not engage with the media independently but will attempt to do so collaboratively with teachers and fellow students inside their school setting. Discussing the fascination of the props will initiate a dialogue that encourages learners to actively examine the props associated with the new knowledge the teacher presents (Alkhudiry, 2022; Pathan et al., 2018; Rahmawati & Purwaningrum, 2022; Tohari & Rahman, 2024).

Kolb's Experiential Learning Theory underscores the necessity of acquiring knowledge through practical experience since the transformation of experiences yields new insights that are more expansive and profound for learners (Datta, 2023; Morris, 2020). The use of microscopes, chemical laboratory apparatus, and vocational training tools exemplifies Klob's assertion. These practicum methods furnish students with experiential learning that underpins reflection, conceptualization, and exploration (Bertoni & Bertoni, 2019). Utilizing a microscope to examine cellular structures enables students to connect directly with biological concepts, fostering better understanding via active investigation and intentional reflection on their observations.

Vocational training that integrates electronic equipment and medical devices enables students to apply their theoretical knowledge to practical scenarios, fostering experiential learning and skill enhancement (Bertoni & Bertoni, 2019; Datta, 2023; Mercer & Mcdonagh, 2021; Morris, 2020; Pradnya et al., 2023). John Dewey's concept of experiential learning underscores the significance of applying knowledge through practical engagement (Quay et al., 2022). Participants in this study possess knowledge of the media and have actively utilized it for educational purposes. Utilizing scales for unit conversions and weight measures while employing a typewriter for office tasks provides students with the opportunity to engage in practical, real-world applications while acquiring knowledge. These exercises facilitate students' comprehension of academic subjects while equipping them for future professional responsibilities by cultivating pertinent abilities through active engagement and practical application (Drolet et al., 2023; Hasbullah, 2020; Mutrofin, 2022; Quay et al., 2022).

Gagné's instructional principles offer a methodical framework for creating a successful learning experience (Gagne, 2013; Gagne et al., 2005). This study indicates that the application of various educational technologies aligns with the instructional concepts articulated by Gagné. Utilizing globes and maps to visually explore geography and astronomy effectively captivates learners and conveys new information. These tools facilitate the provision of learning recommendations by assisting students in acquiring a more profound understanding of the subjects under examination using illustrations and visualizations. Physically engaging models and equipment during the learning process transform the educational setting into a space for experiential learning and practical application. The instructional medium facilitates enduring retention of learning activities among participants and enables them to articulate their knowledge when prompted to reflect on their learning experiences. Teaching aids and practical tools have fostered significant learning in the recollections of the study participants (Bertoni & Bertoni, 2019; Firda & Anam, 2022).

This study demonstrates that the utilization of diverse learning media and effective instructional strategies aligns with the essential educational concepts proposed in educational theories. Merrill underscores the importance of active engagement and problem-solving through the utilization of interactive and stimulating teaching resources (Truong et al., 2019). Facilitating collaborative and experimental learning aids and practicum tools reinforces Vygotsky's constructivist theory (Newman & Latifi, 2021). The teacher's immediate application during the learning process signifies the manifestation of the direct learning experience Kolb refers to real-world applications and the development of practical learning skills (Morris, 2020), like using administrative and corporate tools, demonstrating Dewey's experiential learning (Hasbullah, 2020). Gagné's instructional principles provide a comprehensive framework for effectively utilizing learning resources in an educational methodology (Gagne, 2013). Collectively, these ideas give us a full picture of how using teaching aids and practicum tools improves the learning process by making abstract ideas more concrete and encouraging a deeper, more useful understanding of the subject.

CONCLUSION

This study emphasizes the importance of various teaching aids and practicum tools in improving educational experiences and student learning outcomes. Through the incorporation of many teaching resources, such as globes, maps, anatomical models, and digital tools, educators can successfully bridge the gap between theoretical understanding and practical implementation. These tools are based on various basic educational theories, such as Merrill's Principles of Instructional

Design, Vygotsky's Constructivist Learning Theory, Kolb's Experiential Learning Theory, Learning by Doing Dewey, and Gagne's Nine Instruction Events.

Merrill's concepts emphasize the significance of active participation and problem-solving, which are bolstered using interactive instructional tools and engaging learners. The direct and exploratory nature of this learning medium facilitates Vygotsky's constructivist approach, which prioritizes social interaction and collaborative learning. The utilization of actual knowledge through microscopes, laboratory equipment, and vocational training devices exemplifies Kolb's experiential learning theory. The real application and pragmatic competencies developed through these instructional tools are examples of Dewey's pedagogy about experiential learning. Gagne's instructional principles offer a systematic framework for incorporating functional learning resources in teaching.

The results of the overall study explain that the use of learning aids and practicum tools is crucial to making abstract ideas in the learning process concrete, promoting deep understanding, and fostering analytical reasoning and problem-solving skills. Educators can build a dynamic and efficient learning environment that accommodates a wide range of student needs by utilizing different instructional resources and ultimately improving educational outcomes.

Combining various teaching aids and practicum tools in education is not only done by established educational theories but also demonstrates pragmatic and efficient methods to improve students' learning experiences. Given the ongoing advancements in educational technology, educators must embrace and modify these tools to develop more captivating, dynamic, and significant learning experiences that equip students with the skills necessary to navigate the intricacies of the real world. The findings of this study provide useful direction for educators and policymakers in developing and implementing instructional techniques that maximize the use of learning media. Future research can compare the results of this study with the experiences of students from different cohorts as a form of longitudinal research. In addition, researchers can also compare it with the experiences of students who attend classes in the on-site classroom.

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