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Development of Mobile Learning-Based Electronic Student Worksheets with Guided Inquiry Models on Newton's Law Material

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Abstract: Education is an endeavour to infuse civilization in the lives of individuals so that they can reach their greatest potential as human beings. Individuals are expected to be able to monitor the advancement of science and technology, as well as science and information and communication technology, through education. As a consequence, the study's goals are to establish the outcomes of the e-requirements Student Worksheets analysis, define the feasibility level of guided inquiry-based e-SW; and determine guided inquiry-based e-practicality. Electronic Student Worksheets in this study focuses on the e-SW, which is based on guided inquiry. Six media and materials professionals, one physics instructor, and 24 students took part in this project. The steps of ADDIE development are used as a research technique, comprising analysis, design, development, and implementation, however the assessment stage is not completed. The findings of this research led to the conclusion that educational product creation is viable and practicable. This is based on the results of a validation test conducted by media and material experts that scored above 80% in the very excellent category. And as well as a poll of teacher and student responses that scored above 90% in the very excellent category.

Keywords: Electronic student worksheets; Guided inquiry models; Mobile learning; Newton's law

Introduction

Education is an effort to instill civilization into society's life so that they can fulfill their potential as human beings to the maximum. Education is a deliberate and planned process that can help students realize their full potential and adapt creatively to various environmental conditions (Sejati et al., 2021). Consequently, education is highly important for human beings to enhance their knowledge and abilities to the fullest.

Education has become an essential necessity for humans in order to foster a next-generation of exceptional and high-quality individuals, capable of facing the current challenges of globalization. Education stands as a highly crucial element in human existence. Through education, individuals will flourish and progress as well-rounded personalities, and the advancement or decline of a nation's development in various domains greatly hinges on its level of education (Fauhah & Rosy, 2021).

The advancement of information and communication technology has a significant impact on the progress of science, including in the field of education. Every individual must be educated to be able to keep up with the times and be able to compete in it. The knowledge era, knowledge-based economy, information technology era, globalization, fourth industrial revolution, and so on are terms used to describe the twenty-first century. The twenty-first

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century is characterized by changes in various fields (Monika et al., 2018).

To produce human resources capable of addressing the challenges of the twenty-first century, the quality of education in the twenty-first century must be improved. The implementation of the 2013 curriculum, which focuses on students' problem-solving abilities, identifying things, and learning to realize their ideas to improve their thinking skills, is one example of efforts to improve the quality of education. To meet the needs of the millennial era, 21st-century learning must be technology-based, with the aim of students becoming accustomed to 21st-century life skills (Sugiarti, 2018). According to the 2013 curriculum, learning must be produced through student-centered learning, where students are placed as the subject of learning (Asni et al., 2020). The demand for personalized learning and the use of information and communication technology to improve the efficiency and effectiveness of learning is addressed by the implementation of the 2013 curriculum. With the rapid growth of ICT, various sophisticated practical teaching resources, such as electronic teaching materials, have emerged.

Physics is one of the sciences based on technological development (Bakri et al., 2020). Physics is also a branch of science that investigates natural phenomena logically, experimentally, rationally, and methodically while combining scientific attitudes and methods. Physics teaching materials must be presented carefully to arouse students' learning interest and stimulate their curiosity. As a result, conveying ideas or concepts from the offered content can attract students' attention and be useful for them (Sinaga & Harahap, 2018). Therefore, learning physics not only requires reading books and listening to professors' explanations but also involves scientific research (Hikmawati et al., 2018). What is needed in physics learning is a learning activity that provides opportunities for students to discover and apply the knowledge they have acquired. Through laboratory-based practical learning activities, one effort that can be done to cultivate students' skills (Suryaningsih & Nurlita, 2021).

The utilization of technology in physics education has become increasingly important and relevant in the context of modern education. Based on research that has been conducted, it is revealed that the integration of technology, such as interactive simulations and instructional software, can provide a more engaging and effective learning experience in comprehending complex physics concepts. Technology enables better visualization, interactive exploration, and the application of concepts in real-world scenarios. This approach can enhance students' interest in physics and improve their understanding of the learning material (Tazkia et al., 2019).

Improving students' interest and understanding in physics learning can be achieved by harnessing technology in education. The utilization of technology-driven, inquiry-based learning approaches can motivate students to be more active and explorative in their physics education. By employing applications such as simulations, interactive videos, educational software, and online learning platforms, physics education can become more engaging and relevant for students. Additionally, well-designed educational software enables students to engage in virtual experiments, visualize abstract concepts, tackle physics-related problem-solving, and enhance their understanding through self-directed exploration. This approach facilitates profound learning, bridges theory with real-world experiences, and significantly boosts students' interest and comprehension in the subject of physics (Sutrisna & Gusnidar, 2022).

According to Andriani et al. (2021), enhancing students' interest and understanding in physics learning can be achieved through the application of technology, particularly by using electronic modules. In their research, it was demonstrated that the utilization of guided inquiry-based electronic modules can enhance students' science literacy. These modules not only present material in a more engaging and interactive format but also encourage students to engage in real-world physics problem-solving. By stimulating active engagement and self-exploration, this approach positively influences students' interest and comprehension of physics concepts.

E-modules are one of the learning products that play a crucial role in facilitating self-directed learning for students while harnessing technology. E-modules can serve as effective tools in encouraging students to take a more active role in their learning. They combine learning content with interactive features such as multimedia, interactive links, and gamification elements that stimulate participation and self-exploration. This approach provides flexibility for students to learn at their own pace and according to their learning styles while utilizing technology that has become an integral part of modern life (Aprileny et al., 2019).

Another learning product that allows students to learn independently while utilizing technology is the Electronic Student Activity Sheet (E-LKPD) (Syafitri & Tressyalina, 2020). Electronic Student Worksheet (E-SW) is one of the learning products that enable students to engage in independent learning while utilizing technology. E-LKPD offers a digital platform for students to interact with educational content and complete activities on their own. This approach fosters self-directed learning, allowing students to engage with the material at their own pace and explore various concepts through interactive technology (Firtsanianta & Khofifah, 2022).

The advantages of developing Electronic Student Worksheets (E-SW) based on Mobile Learning are well-documented in educational research. Mobile Learning offers the flexibility for students to access learning materials anytime and anywhere using their mobile devices. E-SW designed for mobile devices can incorporate multimedia elements, interactive features, and real-world applications, enhancing engagement and interaction. This approach not only provides personalized learning experiences but also encourages active participation and self-directed exploration, leading to improved student interest and understanding. However, E-LKPD cannot stand alone without the implementation of instructional models within it. Therefore, the created e-LKPD must be tailored to the students' conditions and the curriculum needs that are applied. The appropriate instructional models for the 2013 curriculum include inquiry-based learning, discovery learning, problem-based learning, and project-based learning.

Therefore, the learning model applied in the developed e-SW is the guided inquiry learning model. Guided inquiry learning is a constructivist-based learning model. Constructivism is a perspective in learning that considers students to actively construct their own knowledge to understand theory and acquire knowledge. The teacher does not act as someone who transfers information but facilitates learning that helps students build their own knowledge (Nisa et al., 2018). Keiler (2018) states that guided inquiry learning model is a learning model that meets many curriculum requirements through engagement, motivation, and learning challenges in line with the 21st century goals for educational institutions to guide students to think and learn through inquiry. Students acquire knowledge through exploration with their senses, including observing, listening, touching, tasting, and smelling. The inquiry learning model invites students to explore their understanding through inquiry. The role of the teacher in the inquiry learning model is to determine the type of research that students conduct and provide active guidance to students in collecting data, analyzing, and drawing conclusions (Sund & Trowbridge, 1967).

In addition, the guided inquiry learning paradigm is also one in which the instructor offers students with somewhat broad directions or instructions (Lovisia, 2018). According to Nurlaila et al. (2021), guided inquiry is a method for overcoming learning problems. Students are encouraged to participate in discussions and are expected to actively formulate learning challenges so that they can draw their own conclusions, solve difficulties independently, and enhance their learning activities.

In other words, this learning model focuses on students; teachers do not tell students the concepts. Instead, the instructor guides students through learning activities to help them uncover these concepts, ensuring that the concepts taught through these activities and learning experiences are retained for a long time (Nurmayani et al., 2018). Students construct problems, design experiments, collect and evaluate evidence until they reach their own conclusions using the inquiry learning method (Dewi Muliani et al., 2019).

The syntax of guided inquiry learning model according to Wahyuni et al. (2022) is as follows posing questions or problems. In this case, students are instructed to identify a problem and place it on the board, then the teacher divides the class into several groups, formulating hypotheses. The teacher provides opportunities for students to voice their thoughts in the form of hypotheses and helps them identify relevant and prioritized hypotheses related to the problem, planning experiments. In this situation, the instructor provides students with the opportunity to choose the appropriate procedure to carry out the hypothesis, then guides them in sequencing the steps in the experiment, conducting experiments to obtain information with the guidance of the teacher, collecting and evaluating information. In this scenario, the teacher allows each group to present their findings after processing data and drawing conclusions.

The guided inquiry learning technique provides several benefits, including the ability to encourage students to learn more, provide opportunities for students to develop and advance according to their abilities and interests, and support students in acquiring cognitive readiness and mastery (Widani et al., 2019).

The advantages of implementing guided inquiry learning method are stimulating students' interest in seeking knowledge, providing them with the motivation to persist in their efforts until they find solutions and solve problems independently. The benefits gained by students in using inquiry-based learning include a better understanding of fundamental concepts and ideas, aiding in enhancing memory retention and the ability to transfer knowledge to new learning situations, as well as fostering the development of students' conceptual understanding. Students taught using the guided inquiry learning approach are able to achieve a deeper understanding of concepts compared to those taught using conventional teaching methods. Furthermore, the guided inquiry learning approach also encourages students to actively engage in the learning process, resulting in a positive impact on their grasp of concepts (Septiari et al. 2019).

Based on the needs analysis through interviews with teachers at the school, it was found that students have varying characteristics. During teaching physics in class, all students prefer and are enthusiastic about hands-on learning activities. In other words, students prefer laboratory classes. Teachers usually teach physics laboratories on certain topics such as momentum and impulse (collision), and the human motion system. However, they have never done a laboratory on the application of Newton's laws to push-ups. The teacher also stated that using e-SW to support laboratory activities is very suitable. Because so far, the electronic student worksheets used has only been in print form and not in electronic form. Therefore, laboratory activities will become more interesting and simpler. The results of interviews with students revealed that one of the difficult physics topics to understand is the Newton's law topic. Students also stated that they prefer learning by looking at pictures and videos rather than reading books with full-text writing. Therefore, based on the needs analysis of teachers and students, the developed e-SW is very suitable to be applied to students because it can help and facilitate students in conducting laboratory activities.

Based on the description, the development of Electronic Student Worksheets (e-SW) based on mobile learning with a flipbook is still rarely done. Therefore, it is necessary to develop electronic student worksheets based on mobile learning that aim to make learning more active. This study aims to develop an electronic student worksheets based on mobile learning on the topic of Newton's laws that is feasible and practical to use.

Method

The development stage of Electronic Student Worksheets (e-SW) in the form of a flowchart as depicted in Figure 1. This research is a research and development (R&D) project aimed at developing an electronic student worksheet (e-SW) based on guided inquiry for physics material, namely Newton's laws. The ADDIE development approach was used in this study, which stands for analysis, design, development, implementation, and evaluation (Sugiyono, 2019).

This research used a research & development (R&D) method with the aim of developing a product by adapting the ADDIE model which stands for analysis, design, development, implementation, and evaluation (Sugiyono, 2019). The study was conducted from January to April 2022 with 24 students of grade XI in Science major as the research subjects. The product resulted from this research is an electronic student worksheet (e-SW) based on mobile learning for the topic of Newton's law.

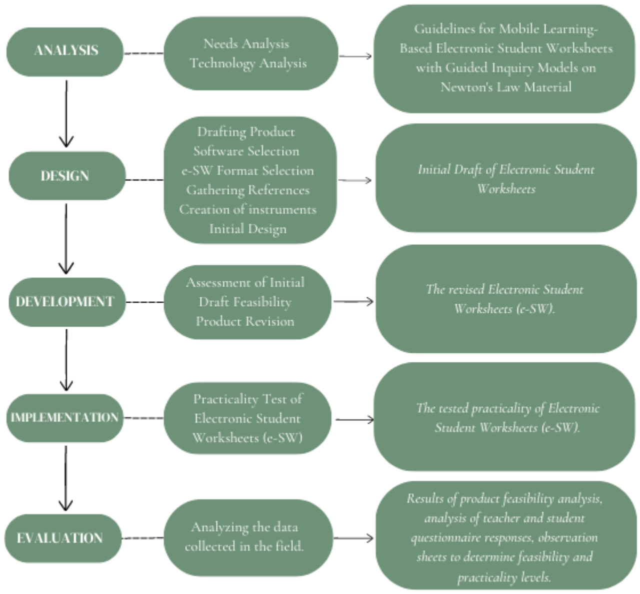

Figure 1. Flowchart of e-SW development

The analysis stage aims to determine the needs analysis related to the existing problems in the class, media and learning models used to address them, technology analysis, material analysis, availability of guided-inquiry-based electronic student worksheets, and collecting various information related to the product to be developed. This stage is carried out through interviews with teachers and students. In addition, observation is used to collect information about the school. The design stage aims to design guided-inquiry-based student worksheets on the topic of Newton's laws that will be developed. This stage includes the creation of draft products, selection of e-SW software, selection of e-SW format, collection of references, design of the electronic student worksheet (e-SW) layout, and the creation of instruments. The development stage produces an electronic student worksheet (e-SW) with flipbook assistance, validation results from material and media experts to determine the feasibility of e-SW, and testing results from teachers and students to test the readability of e-SW. The implementation stage is carried out by conducting a field trial, which is learning in the classroom to test the effectiveness of e-SW. The evaluation stage, which is the final stage of product development, was obtained from the analysis of field data in the form of product feasibility analysis sheets, analysis of teacher and student response questionnaires, and observation sheets to determine the feasibility and practicality level of the developed product.

The instruments used in this research are product feasibility sheets, teacher and student response sheets. The data analysis technique used is the analysis of product feasibility and practicality using equation 1.

$$\bar{X} = \frac{\sum x}{n} \quad (1)$$

Information:
$\bar{X}$: Average score
$\sum x$: Total score of each rater
n : Number of raters

The scores obtained are converted into qualitative values according to the scoring criteria based on the Likert scale (Chakrabartty & Nath Chakrabartty, 2019) as shown in Table 1.

Table 1. Likert Scale Scoring Criteria

Score	Qualification
4	Strongly agree/very good/ very worthy/ very practical
3	Agree/good/feasible/ practical
2	Disagree / less good / less interesting / less worthy
1	Disagree / not good / not worthy / not useful

Then to summarize the data criteria from the feasibility and practicality test results, the average score results are entered into the feasibility and practicality criteria tables. The feasibility criteria table can be seen in Table 2 (Chakrabartty & Nath Chakrabartty, 2019) and the practicality criteria table can be seen in Table 3 (Chotimah & Festiyed, 2021).

Table 2. Product Eligibility Category

Score (%)	Category
81 – 100	Very Feasible
61 – 80	Feasible
41 – 60	Quite Feasible
21 – 40	Less Feasible
0 - 20	Infeasible

Table 3. Product Practicality Category

Score (%)	Category
81 - 100	Very Practical
61 - 80	Practical
41 – 60	Quite Practical
21 – 40	Less Practical
0 - 20	Impractical

Result and Discussion

The media developed in this study is the Guided Inquiry-Based Mobile Learning Electronic Student Worksheet (E-SW) on the topic of Newton's Laws. The software used to create the E-SW are Canva and Heyzine Flipbooks. These two programs were chosen because of their adequate features and their ability to integrate effectively, as well as their user-friendliness suitable for beginners. Canva and Heyzine Flipbooks are two applications used for designing and converting pdf files. Canva is used to create attractive designs that can be saved in pdf format. On the other hand, Heyzine Flipbooks can edit and convert pdf files into electronic worksheets in flipbook format, providing a book-like appearance with flip-able pages. Heyzine Flipbooks offers features that can be accessed within the electronic worksheets, such as inter-page links, images, videos, quizzes, and various formats for worksheet distribution.

The developed electronic student worksheets are integrated with the guided inquiry learning model, self-guided inquiry is a learning model that can help students explore understanding and gain knowledge through investigation. The research model used in this study adopts the ADDIE model proposed by (Dick, Carey, & Carey, 2015; Birgili, 2019) which consists of the stages of analysis, design, development, implementation, and evaluation.

The first stage was defined, consisting of needs analysis, technology analysis, and content analysis. The first step in identifying needs was to review the curriculum used in the school. The curriculum used was the 2013 curriculum, followed by analyzing the competency standards and learning objectives. In order for students to recognize concepts through their own activities, the 2013 curriculum offers five main learning experiences (5Ms), namely: 1) watching; 2) asking; 3) collecting information; 4) associating; and 5) communicating. As a result, the 2013 curriculum mandates that students use appropriate learning models and media to promote these fundamental learning experiences. The purpose of needs analysis is to determine what teachers and students need to encourage learning.

Based on the results of interviews with physics teachers at the school, it is stated that students have various characteristics. While teaching physics in class, all students prefer and are enthusiastic about direct learning activities. In other words, students prefer laboratory classes more. The teacher usually teaches physics labs on certain topics such as momentum and impulse (collision), and the human motion system. They have never conducted a laboratory experiment on the application of Newton's laws to push-ups. The teacher also said that the use of e-SW is very suitable to support laboratory activities. Because so far, only printed Student Worksheets has been used, not electronic Student Worksheets. This way, laboratory activities will be more interesting and simple.

Meanwhile, based on the results of a questionnaire on Student Worksheets needs distributed to 24 students, it was found that 86.11% of the students stated that they prefer learning with a smartphone rather than printed books, 90.27% prefer learning by seeing pictures and videos rather than reading books with full written text, 91.66% also believe that the existence of e-SW can make them learn independently at home, then 93.05% state that with the existence of e-SW, they can easily conduct experiments, and 88.89% of the students stated that one of the difficult physics topics to learn is the material on Newton's laws.

Next is the design stage, where the product is designed and followed by the process of making the product, which is an inquiry-based e-Learning Activity Sheet (e-SW) on the topic of Newton's Law. In the design stage, software is used to create electronic student worksheets (E-SW) in the form of Canva and Flipbook. The format chosen is HTML5, which allows E-SW to be accessed on smartphones or laptops without installing it. The reference material used in the research is the Newton's Law practical. The developed inquiry-based E-SW contains materials, interactive quizzes, STEM projects, and simple activities before starting the main material. The creation of practical video starts with designing the cover and layout using Canva. The product consists of Cover, e-SW User Guide, Table of Contents, Basic Competencies and Objectives, Practical Title, Theory Basis, Formulating Problems, Formulating Hypotheses, Collecting Data that includes equipment, materials, steps, and experimental data, Testing Hypotheses, Drawing Conclusions, and References. Here is the process of making the e-SW. The first step is to prepare the Newton's Law material and other components needed to compile the E-SW. The second step is the design process using Canva. The appearance of the Electronic Student Worksheet (E-SW) cover can be seen in Figure 2.

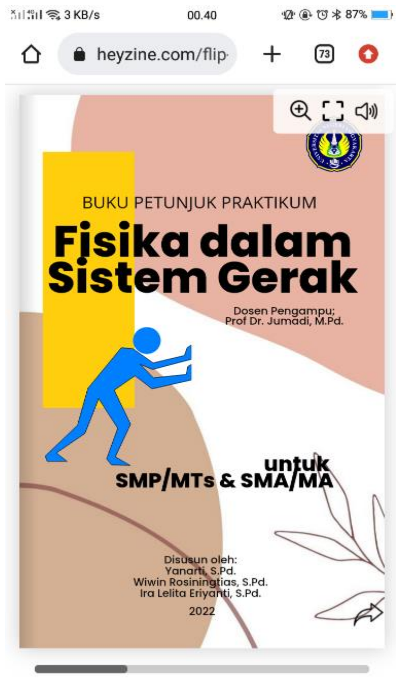

Figure 2. E-SW cover

In Figure 2, we can see the initial display of the flipbook, which is the cover of the e-SW. The cover page displays the title, university logo, name of the course instructor, name of the product maker, product target, and several buttons such as page navigation, zoom, fullscreen, and sound. To move to the next page, users can swipe directly or use the page navigation button.

Figure 3. Table of contents of E-SW

In Figure 3, the table of contents of the E-SW can be seen. Various topics are presented in the E-SW, including levers in the human body, the relationship between simple machines and muscle work in the skeletal structure of humans, and push-ups. The laboratory topic contains physics material or concepts related to the human body's movement system. But in its implementation at school, it is only focused on the Newton's laws material.

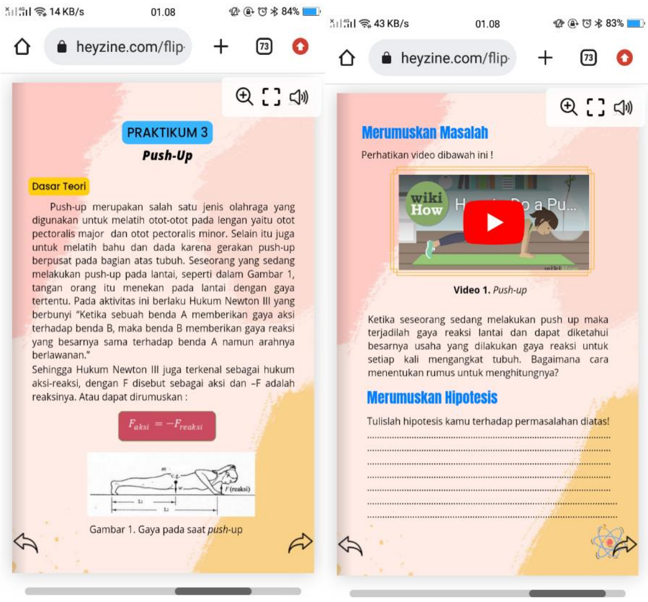

Figure 4. Practical activity content in E-SW

In Figure 4, the display of the explanation of each practical topic can be seen in the E-SW. Each topic will be explained based on the guided inquiry model steps. The content of the topic starts with the title of the practical, basic competence, practical objectives, theoretical basis, then contains the steps of the guided inquiry model, which are formulating problems, formulating hypotheses, collecting data containing tools and materials used, work steps, as well as an observation table for writing down the results. Followed by the stage of testing hypotheses, drawing conclusions, and closed with a bibliography. In this E-SW, the material is presented in the form of videos, images, and text that will facilitate students' understanding in conducting the practical.

The created product is then tested for its material and media suitability as well as readability. This E-SW was tested for its suitability by six material experts and media experts to assess whether the product is suitable or not. The validation results will be used to improve the product to be assessed accurately. The product is then revised based on expert feedback to create an even better product. The results of the product's validity test by media expert validators can be seen in the following diagram.

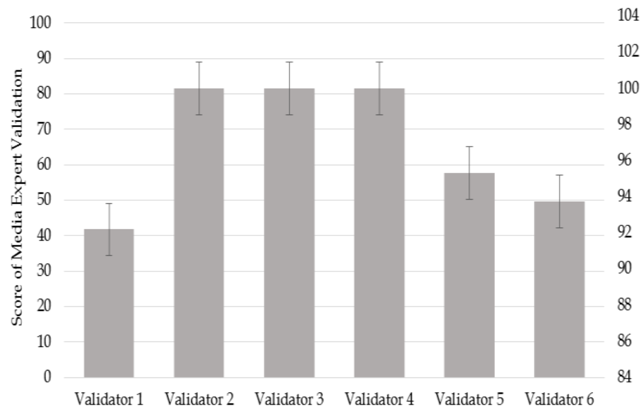

Figure 5. Validation scores obtained by media experts

In the diagram, it can be seen that validator 1 obtained an average score of 92.18 percent in the category of very good, while validator 2, validator 3, and validator 4 obtained an average score of 100 percent in the category of very good. Validator 5 had an average score of 95.31 percent in the category of very good, while Validator 6 had an average score of 93.75 percent in the category of very good. The results of the expert validation on the product development were deemed suitable and can be used as a learning resource.

Next, the results of the validity test of the product's suitability by expert material validators can be seen in the following diagram.

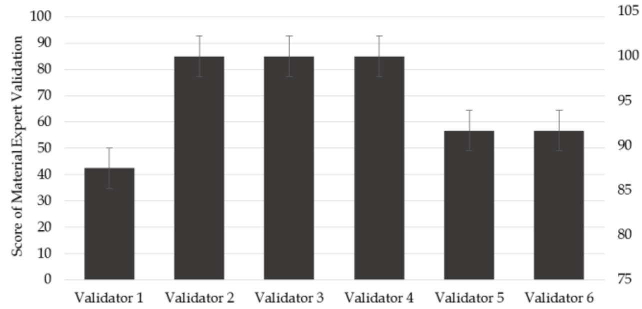

Figure 6. Validation scores obtained by subject matter experts

The results of the validity test by content experts can be seen in the following diagram. Based on the evaluation of validator 1, the validity score obtained is an average of 87.50% in the category of very good, while validator 2, validator 3, and validator 4 obtained an average score of 100% in the category of very good. Validator 5 and 6 obtained an average score of 91.67% with a very good category. The results of the content expert test for the development product are useful and can be used as a learning source. Therefore, the product can be considered practical for use based on the findings of the product feasibility test by media and content experts, which based on the results are categorized as very good.

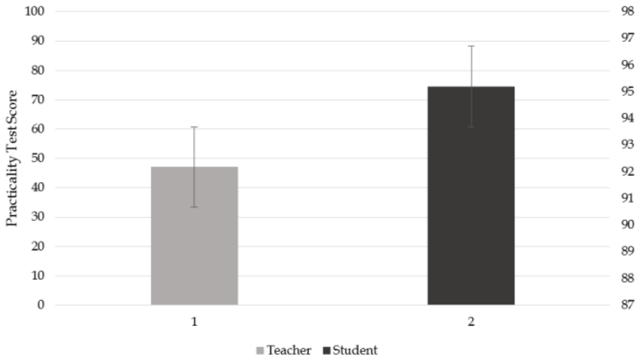

Figure 7. Results of practicality test by teachers and students

Based on the above graph, the average scores of the teacher and student questionnaire responses fall into the very good category, each at 92.18 percent and 95.20 percent, respectively. As a result, the findings of the practicality test conducted by teachers and students on the development product can be claimed to be practical and suitable for use as a teaching aid in the learning process.

Conclusion

As a result of the research findings, it can be concluded that the product development is feasible and practical. This is evidenced by the validation test results conducted by media and material experts, which yielded an average score of over 80 percent, indicating that the product is very good. Meanwhile, the average score of the practicality test through the teacher and student response questionnaire is 92.18 percent and 95.20 percent, respectively. These figures are above 90 percent with the category of very good, indicating that the product can be used as one of the learning materials. The suggestion for future research is to provide more detailed analysis of the feasibility and practicality of the product, both in terms of each aspect and the factors that contribute to the high or low scores. This is because this study was only limited to analyzing the feasibility and practicality tests.

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Author Contributions
Ira Lelita Eriyanti: drafting the initial manuscript, presenting findings, discussing results, outlining the methodology, and drawing conclusions; Jumadi, Yanarti, and Wiwin Rosiningtias: examining the data, proofreading the content, conducting a comprehensive review, and providing edits.

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Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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