Development of Physics Teaching Material: Guided Discovery Learning with Liveworksheet to Improve Work and Energy Problem Solving

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Keywords :	ABSTRACT
Teaching Material; Guided Discovery Learning; Problem Solving Ability	*This study aims to describe the characteristics of teaching material, identify the level of feasibility, and determine the level of readability of teaching material based on guided discovery learning assisted by liveworksheet applications to improve problem-solving ability in work and energy material. The research method used is research and development with the ADDIE research design developed by Mollenda and Reiser in 2003 consisting of 5 stages, namely: 1) analyze; 2) design; 3) develop; 4) implement; and 5) evaluate. In this study only up to the develop stage. The feasibility test data collection used a questionnaire sheet with a Likert scale, while the readability test used the overlap test. The subjects of this research include physics lecturers, physics teachers, and students totaling 36. The characteristics of the teaching material developed contain work and energy material in the form of interactive pdfs equipped with discussion activities and experiments assisted by liveworksheet applications, sample problems and discussions, and evaluations with Polya problem-solving ability indicators. The results of the feasibility test of the teaching material obtained a score of 88%, indicating that it included very feasible criteria. The readability test obtained a result of 76.67%, so it is included in the criteria for teaching material that is easily understood by students. The results of this research can be utilized by teachers to teach the topic of work and energy, as well as to design and develop other learning materials that are more effective and interactive.*

INTRODUCTION

The goal of 21st century education is to encourage students to master the important and useful 21st century skills, which have evolved to emphasize the acquisition of knowledge and attributes necessary for students to make successful contributions to the workforce and global economy amidst the ever-

changing and evolving times of the 21st century [1] [2]. The pattern of learning that is still carried out by teachers is conventional learning, which can be understood as a learning pattern where the teacher gives a lot of lectures while students listen, record, and memorize [3]. This is not aligned with 21st century education, which is student-centered while the teacher is a facilitator. 21st century learning focuses on the student center with the aim of providing students with thinking skills including: (1) critical thinking; (2) problem solving; (3) metacognition; (4) communication; (5) collaboration; (6) innovation and creativity; and (7) information literacy [4]. In short, these standards aim to shift the focus away from emphasizing content-based drilling and memorization towards developing advanced skills such as critical thinking, creativity, and collaborative problem-solving [5]. Changes of conventional learning approaches into digital approaches that are considered more relevant due to the needs of students should be taken by the teachers as a chance to improve the key problem. One utilization of information and communication technology in learning can be done through internet-based learning (e-learning) or interactive media using computers [6] [7]. The use of technology in the field of education can be applied through teaching material. Physics textbooks are prepared in such a way that experts have assessed the feasibility of use by the National Education Standards Agency (BSNP) and meet the feasibility requirements for use in learning through the Regulation of the Minister of National Education. However, each textbook has weaknesses and advantages that need to be complemented with other textbooks because the material is broad and cannot be sufficiently supported by one book alone [8]. Therefore, the development of teaching material needed to complement ongoing learning activities by paying attention to the right learning model.

Learning models need to be well chosen because each one can affect student learning outcomes. One of the learning models that can be used in learning physics is the guided discovery learning model [9]. The guided discovery learning model gives students the experience of discovering concepts and principles contained in learning material through various experimental activities. Since there is a self-discovery experience, it is expected that students understand more and are stronger at remembering the material, so that the learning outcomes obtained by students can be maximized [10]. The main point of this guided discovery learning model is to change the passive learning atmosphere into an active and creative one, the focus remains on students, with the teacher taking on the role of a facilitator and guide [11] [12].

Previous research, namely "The Development of Chemical Equilibrium Modules Based on Guided Discovery Learning for Class XI IPA SMA" conducted by Oktaria & Yerimadesi [13] and "The Development of Reduction and Oxidation Reaction Modules Based on Guided Discovery Learning for Class X SMA" conducted by Wanti & Yerimadesi [14], resulted in the modules produced having high validity and very high practicality. In addition, on the Development of Teaching Material Through a Guided Discovery Learning Model Based on Toba Batak Culture to Improve the Mathematical Problem-Solving Ability of High School Students produced teaching material that meet the criteria of effectiveness, positive responses from students, and the mathematical problem-solving ability of students taught using the developed teaching material has increased [15]. The things that need to be improved from this research are the absence of technology in modules and the development of teaching material. It shows that using technology with a suitable learning model is essential to achieve 21st-century education goals.

Digital technology that is widely used today is through platforms provided for free by Google, such as Google forms, Quizzes, Kahoot, and so on. However, these platforms are used only for the assessment of cognitive and summative aspects. One of the platforms that can be used as an assessment tool as well as providing learning material Liveworksheet. Liveworksheet is a web-based platform that provides alternative delivery of material in the form of worksheets that can be accessed and responded to online by students [16]. Liveworksheet offers a variety of features that make it an interactive multimedia platform. By utilizing Liveworksheets' interactive worksheets, teachers have the opportunity to enhance learning experiences beyond traditional printed materials by seamlessly integrating audio, video, and hyperlinks, thereby creating a more dynamic and engaging learning environment [17]. Therefore, the liveworksheet application is suitable for use in the guided discovery

learning model to achieve the 21st century educational goals of making the learning process more active and innovative.

Based on the results of interviews with physics teachers at SMA Negeri 1 Binangun Cilacap Regency, it was found that the learning resources for physics subject matter used by students were handbooks in the form of student modules prepared by the Cilacap Regency Subject Teacher Conference (MGMP), which were centered on material and practice questions. The teaching material prepared by MGMP Cilacap Regency are not interactive and do not invite students to think about solving existing problems. Other learning media are limited to YouTube learning videos containing material explanations and sample questions. Therefore, most students are less active in learning and find it difficult to solve problems that are different from the examples given by the teacher.

Partnership for 21st Century Learning, identifies 21st-century skills to include critical thinking, problem-solving, communication, and collaboration, which require learners to possess skills, knowledge, and abilities in technology, media, and information, learning and innovation skills, as well as life and career skill [18] [19]. Some of the learning activities applied in 21st century learning are creativity, critical thinking, cooperation, problem solving, communication skills, community involvement, and character development. Proficient in problem solving means being able to overcome the problems that are being faced by them [4]. Students are usually constrained in mastering concepts, formulas and calculations, graphs and diagrams, and practicums that are presented simultaneously [20]. The level of students' ability to solve problems involving work and energy in physics learning is included in the very low category [21]. Factors that cause students to have difficulty in problem solving students have confusion about what concepts are used in solving physics problems and not knowing the formula to be used, so students experience errors in making calculations [22] [23]. The goals of learning the work and energy material are to teach students how to distinguish and understand the concepts of work and energy and how to apply them so that they can be used in everyday life [24].

Based on the problems, describes it can be illustrated that learning resources in the form of innovative and interactive teaching material is needed as an work to improve students' ability to solve problems in 21st century education.

METHOD

The research was conducted at SMA Negeri 1 Binangun Cilacap Regency in the even semester of the 2022–2023 academic year. The sampling technique used in this study was purposive sampling. Thus, class X-8 totaling 33 students was obtained as a sample. This research uses the research and development method (research and development). The research design used in this research is the ADDIE model (Analysis-Design-Develop-Implement-Evaluate) [25]. In this study, only up to develop or development.

The feasibility test of teaching material carried out by processing data obtained from the feasibility test questionnaire by expert lecturers, as well as physics teachers as respondents. The feasibility test questionnaire was prepared based on the modified BSNP book feasibility assessment standards, namely the aspects of content, presentation, linguistic, and graphical feasibility assessment. The scoring system in this questionnaire uses a Likert scale [26]. The scales used are shown in Table 1.

Table 1. Likert Scale Feasibility Test Questionnaire

Criteria	Score
Excellent	4
Good	3
Moderate	2
Poor	1

Furthermore, the feasibility level of teaching material analyzed using equation [27]:

$$P = \frac{f}{N} \times 100\% \tag{1}$$

Description:

P : percentage of assessment

f : score obtained

N : maximum score

The criteria for the feasibility level of teaching material [28], are shown in Table 2.

Table 2. Teaching Material Feasibility Criteria

Percent Range (%)	Criteria
$85 < P \leq 100$	Very Feasibility
$70 < P \leq 85$	Feasibility
$50 < P \leq 70$	Moderate
$1 < P \leq 50$	Not Feasibility

The small-scale trial conducted was a readability test. This readability test is in the form of a hollow test. This overlap test question contained incomplete reading because each sentence in the reading contained 50 words that were omitted. The readability level of teaching material was analyzed using equation [27]:

$$P = \frac{f}{N} \times 100\% \tag{2}$$

Description:

P : percentage of assessment

f : score obtained

N : maximum score

The criteria for the readability level of teaching material [29] are presented in Table 3.

Table 3. Criteria for Readability Level of Teaching Material

Percent Range (%)	Criteria
$60 < P$	Teaching material is easy to understand
$41 \leq P \leq 60$	Teaching material is suitable for students
$P \leq 41$	Teaching material is difficult to understand

RESULTS AND DISCUSSIONS

Teaching Material Development Results

Analysis Stage

In this stage, the main activity is to analyze the need for instructional material development in the learning objectives, to determine the learning needs and identify issues. The analysis phase aims to identify problems that occur with students during the learning process [30] [31]. The initial phase of the project involved conducting a needs analysis through observations and interviews with school teachers regarding the utilization of teaching materials and learning models. Additionally, curriculum analysis, Teacher Books, Student Books, and examination of the KI (Core Competence) and KD (Basic Competence) were conducted to determine the appropriate science content to be included [32]. The things done at the analysis stage are: (1) syllabus analysis, including core competencies, basic competencies, indicators of competency achievement, and subject matter; (2) analyzing learning resources; at this stage, several things must be considered, namely, availability, suitability, and ease of use; and (3) analysis of student needs; in this analysis, interviews are conducted with teachers to find

out the needs and problems of students in the learning process.

Design Stage
The design stage of teaching material begins with making an initial design in the form of a storyboard to make it easier to make teaching material [31]. The design is done manually. The results of this stage are in the form of a framework for teaching material to be developed. At this stage, researchers also designed feasibility test sheets and readability test questions.

Development Stage
The development stage of teaching material began to be developed according to the results of the analysis and design stages [31]. In this stage, the main activity is to analyze the need for instructional material development in the learning objectives include activities of creating and modifying instructional materials [30]. Teaching material is made with the help of liveworksheet. In the development process, the editing stage of teaching material using Liveworksheet is carried out. Teaching material based on guided discovery learning assisted by liveworksheet applications to improve problem-solving ability on work and energy are presented in this study in the form of interactive PDFs. This teaching material is made using Microsoft Word with variety of styles fonts with the aim of making the appearance of teaching material more attractive and less boring. The font size used also on the cover, title, and subtitle is larger, bolded, and different in color. The teaching material developed in this study amounted to 66 pages on A4 paper size (21 cm x 29.7 cm), which consisted of a cover, preface, author's bio, instructions for use, table of contents, concept map, learning materials, summary, evaluation, and bibliography. The learning material in this teaching material consists of three topics: work, energy, and the relationship between work and energy. Each topic of this teaching material has core competencies, basic competencies, learning indicators, learning objectives, pre-concepts, discussions, experiments, material, and writing conclusions. Teaching material developed are prepared based on the steps of the guided discovery learning model, which consist of stimulation, problem statement, data collection, verification, and generalization [32].

After the teaching material have been developed, the teaching material is carried out feasibility tests by two experts, namely, physics lecturers and subject teachers. The feasibility test of teaching material the first step to assessing whether the design of the teaching material that have been made is feasible enough to use or not. The next stage is the trial of the teaching materials. Based on the results of the feasibility test, suggestions and improvements to teaching material were obtained. Improvements made based on suggestions from validators are compiled in Table 4.

Table 4. Suggestions and Improvements for Teaching Material

Num	Suggestions	Improvements
1.	Layout of teaching material can be made more interesting	Headers and footers have been added to make the teaching material look plain.
2.	Please to upgrade the illustrations	Other illustrations have been added to each topic 3 question discussion.

The appearance of teaching material before and after improvement according to validator suggestions are presented in Figure 1 and Figure 2.
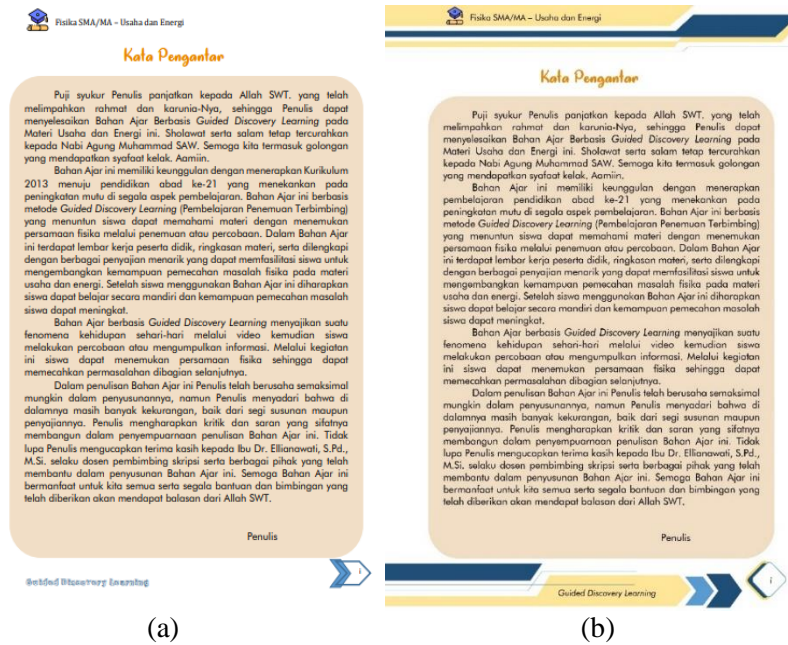
(a)   (b)

Fig 1. *Layout of Teaching Material (a) Before Improvement (b) After Improvement*
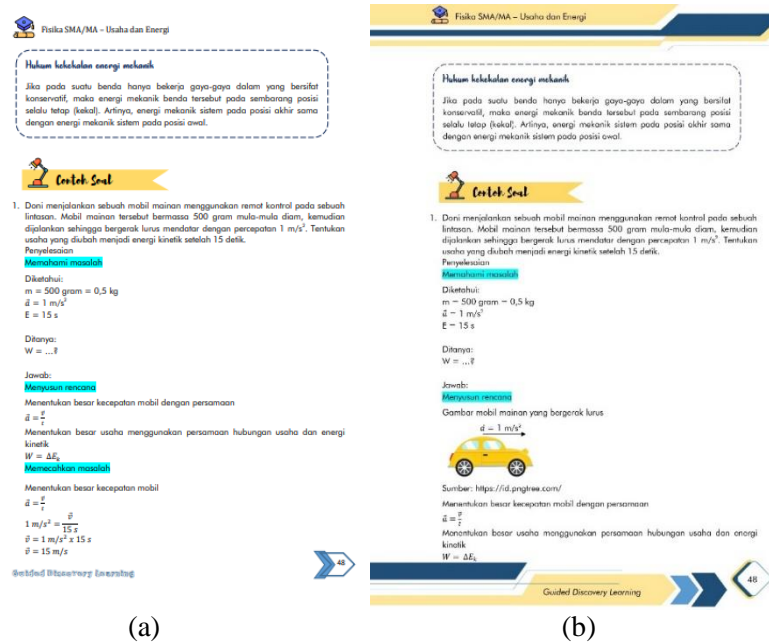

(a)   (b)

Fig 2. *Display of Problem Discussion that Does Not Have Illustrations (a) Before Improvement (b) After Improvement*

Characteristics of Teaching Material
The following is an explanation of the characteristics of teaching materials developed.
1. The teaching material that have been developed in this study is teaching material based on guided discovery learning presented in the form of interactive pdfs assisted by liveworksheet applications as a place for discussion and experimentation. So that these teaching material can be carried and accessed online, and these teaching materialutilize today's digital technology. The creation of digital learning content (learning application programs, interactive presentations, learning animations, etc.) is an important and aligned part because such learning processes can have a significant and maximum impact on students [33]. This interactive teaching material is an effective utilization of existing technology [34]. This interactive pdf is able to present columns

that can be filled in directly by students. Links are used in videos, discussion sheets, and student worksheets.

2. The application of the guided discovery learning model helps students understand the concept of material by providing experience through experiments and discussions. Through this model, students are expected to actively learn through an experience in the discovery process, with guidance provided by the teacher during the process. The guided discovery learning model has the advantage of actively involving students in learning activities, which can stimulate the emergence of students' thinking abilities [35]. In addition, through the problem-solving process, students can use knowledge and skills to solve these problems that are not routine [36]. This teaching material is prepared based on the steps of the guided discovery learning model, which consist of stimulation, problem statement, data collection, verification, and generalization.

3. The liveworksheet application is used in discussion sheets and student activity sheets. Liveworksheet itself is a web-based platform that can be accessed directly by students, so they do not need to download it. The development of web-based learning will continue and provide a broader experience to teachers and students, as well as an interesting experience; when compared to traditional classroom learning, students will not be able to find this experience [36]. The advantages of liveworksheet include the fact that students can immediately respond to the answers on the sheet provided, and the answers stored can be directly corrected by liveworksheet so that it can facilitate the teacher in assessing the results of student answers. This application allows teachers to turn ordinary printable worksheets (documents, pdf, jpg, or png) into interactive online exercises while directly correcting themselves with the application [37].

4. The developed teaching material is equipped with a discussion sheet with the "Let's Discuss" trigger. Discussions carried out by students included analyzing phenomena in everyday life through videos and conducting discussions by accessing liveworksheets to determine examples of other phenomena in everyday life. Active learning is an interactive learning process where the atmosphere is created in such a way by the teacher so that students actively ask questions, question, discuss, and express their opinions to the extent that learning is said to be interactive when there is a two-way interaction process between teachers and students [38]. Student discussion sheets are discussion sheets for students in both intra- and co-curricular activities to facilitate understanding of the subject matter obtained [26]. The discussion sheet is presented by utilizing various liveworksheet features so as to make learning more varied.

5. The developed teaching material is equipped with student worksheets with the "Let's Experiment" trigger. Experimental activities are carried out using the PhET Colorado Virtual Laboratory application so that they can be carried out by each student without the need to go to the laboratory. With PhET software-based learning simulations, students become more interested in the learning process because exploring their initial concepts can be done through simulations [39]. The use of PhET Colorado Virtual Laboratory technology can provide a personal experience to students so that they are more active and innovative in learning. The stages of activities that invite students to be active in learning in the form of experiments and interactive games are expected to motivate students to complete each activity. One way to create meaningful learning experiences is by utilizing technology [16].

6. The material presented in the teaching material complete, in accordance with learning competencies, and equipped with various examples of problems and discussions that are explained according to the indicators of problem-solving ability. The material in this teaching material is about work and energy, with three topics of discussion: the concepts of work and energy; the relationship between work and energy. Learning material is presented in the "Let's Learn" section. The presentation of materials, supported by concepts, theories, and illustrative images, can enhance students' understanding of concepts. The preferred criteria for instructional materials by students are that the materials are complete, concise, compact, and clear, using language that is easy to understand, providing explanations for difficult terms, and accompanied by illustrations [40]. Illustrations of images in everyday life are presented at the problem-solving stage, which includes understanding concepts and finding equations, so that students can see the illustrations directly and not just imagine them, and they can easily find concepts in the material studied [41].

7. Teaching material based on guided discovery learning is equipped with evaluation questions to

measure students' problem-solving ability after using the material. Evaluation always complements instructional materials because it is used to measure the mastery of competencies for each learning objective [42]. Evaluation questions are activities to try directly in the form of application of material that has been learned so that students really understand the application of the material [43]. The questions are presented in the form of essay questions so that the teacher can find out how to improve students' problem-solving ability through the way they answer questions. The use of description questions aims to see the extent of students' problem-solving ability because the answers to these questions can be formed in a structured manner [41].

Feasibility of Teaching Material
The results of the overall feasibility test assessment of teaching material is shown in Table 5.

Table 5. Feasibility Assessment Results of Physics Teaching Material

No.	Components	Score (%)			Description
		Validator 1	Validator 2	Average	
1.	Content Feasibility	83	90	86	Very Feasible
2.	Presentation Feasibility	90	93	91	Very Feasible
3.	Language Feasibility	79	92	85	Very Feasible
4.	Graphic Feasibility	83	92	88	Very Feasible
	Average	**84**	**91**	**88**	**Very Feasible**

Based on the results of the feasibility analysis of teaching material as a whole, a percentage of 88% was obtained, meaning that it included very feasible criteria. This shows that the teaching material developed are suitable for use as a support for physics learning. As for the percentage per aspect indicator, 86% was obtained in the aspect of content feasibility, 91% in the aspect of presentation feasibility, 85% in the aspect of language feasibility, and 88% in the aspect of graphics feasibility. Based on the results of the feasibility test of teaching material, it can be concluded that the teaching material developed qualify as teaching material to accompany students in learning activities.

The content feasibility test component consists of four indicators: the suitability of the material with the KD, the accuracy of the material, the currency of the material, and encouraging student curiosity. In general, the learning style that students have is a visual learning style, so that students learn by prioritizing the sense of sight, where students are more interested if the material discussed is visualized either through images or experienced directly, such as in a practicum, and given examples in the form of phenomena related to everyday life [44].

The presentation feasibility test component consists of three indicators: presentation techniques, presentation support, and learning presentations. The presentation of teaching material declared feasible because it contains a cover, table of contents, concept map, coherent material, sample questions and discussion, summary, evaluation, and reference. This section is presented in the form of images, animations, audio, video, simulations, and features that can be of interest, provide knowledge, and improve student skills according to the learning objectives to be achieved [45]. The technique of presenting teaching material can invite students to be more actively involved in learning and lead to learning to improve problem-solving ability. The use of colorful instructional materials aims to make them visually appealing to students. Additionally, the presentation of images serves not only to clarify the content but also to create a sense of enjoyment and ease of understanding for students when learning the material [46].

The language used in teaching material is straightforward, communicative, and easily understood by students with standard language in accordance with the General Guidelines for Improved Spelling. Good learning resources use simple sentences so that the information conveyed is clear and user-friendly [47]. Good teaching materials should be communicative, ensuring that the content is easily understandable, well-organized, clear, and free of language errors. Furthermore, the font type and size used in the instructional materials are legible, and the instructions and information provided are

presented clearly [28].

Teaching material is presented in a size that is appropriate to the standard and content of the material, paying attention to the layout of the text and images presented. In addition, the fonts used are varied and attractive but still comfortable to read. Interesting fonts and images influence students to study teaching material and do not bore readers. States that materials should adhere to guidelines regarding fonts, layouts, illustrations, images, photos, and design, ensuring a visually appealing format that meets the needs of users [48].

Readability of Teaching Material
The readability test of the developed teaching material was given to the respondents from classes X–8, totaling 33 students. Previously, students were given time to read the teaching material, and then the researcher collected data by giving a readability test sheet with a processing time of 60 minutes. The readability test sheet was prepared based on a summary of the material for each subchapter in the teaching material and then made up of a total of 50 overlapping words. The results of the readability test of teaching material are presented in Table 6.

Table 6. Readability Test Result of Teaching Material

Respondents	P (%)	Criteria
33	76.67	Easy to understand

Based on data analysis, the percentage score of the readability test of the teaching material developed was 76.67%, so it was included in the criteria for teaching material that were easily understood by students. This shows that the use of language in teaching material communicative and the writing of material is interesting. The use of appropriate fonts, colors, and images increases student understanding of receiving information from teaching material. Quality teaching material have criteria including good language and readability [49]. In addition, teaching material is said to be good if students can read and understand them easily according to their level. The text in teaching material classified as good if it can be read by readers. High readability means that the texts can be read and understood by students without requiring additional explanation from the teacher [50].

The questions included in the developed teaching materials are not yet based on guided discovery learning, so for further research, it would be better if the questions and their solutions are explained in accordance with the sequence of problem-solving based on guided discovery learning.

CONCLUSION AND SUGGESTION

Conclusion
Based on the results of the research conducted, several conclusions were obtained, including that the characteristics of teaching material developed are physics teaching material presented in the form of interactive pdfs assisted by liveworksheet applications. This teaching material contains content and material arranged in such a way as to be presented, such as Concept Maps, Did You Know?, Let's Experiment!, Let's Learn!, Let's Discuss!, Writing Conclusions, Summaries, and Evaluation questions, so that they can improve students' problem-solving ability. The results of the feasibility analysis of teaching material assessed from 4 aspects, namely aspects of content feasibility, presentation feasibility, language feasibility, and graphics feasibility, obtained a percentage of 88%, indicating that it included very feasible criteria. The results of the data analysis obtained the percentage score of the readability test of teaching material is 76.67%, so that it is included in the criteria for teaching material easily understood by students.

Suggestion
Suggestions that can be given for further research are the questions contained in the teaching materials developed have not been based on guided discovery learning, so it would be better if the questions and

solutions are explained in accordance with the order of solving questions based on guided discovery learning. When using teaching material developed, it would be better to use a laptop or computer so that the columns contained in the teaching material can be filled in directly. If the use of teaching material that have been developed still involves smartphones, students can answer questions contained in the material by taking notes in a notebook.

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