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Development of Guided Inquiry-Based Learning Modules to Improve Students' Science Process Skills

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Abstract: A research on the development of a Guided Inquiry-Based Learning Module for Students of MAS Ummul Mukminin 'Aisyiyah in South Sulawesi Region has been conducted. This study aims to: produce a guided inquiry-based learning module to improve students' science process skills theoretically; produce a guided inquiry-based learning module to improve students' science process skills empirically; describe the effectiveness of using a guided inquiry-based learning module to improve students' science process skills. The research method used is the Research and Development (R&D) method with the 4 D model. The results of the study indicate that the guided inquiry-based learning module developed based on theoretical and empirical validity is recommended for use. The results of the analysis of practitioner responses to the guided inquiry-based learning module developed, obtained an average score of 131.67 which indicates positive criteria. The effectiveness of the guided inquiry-based learning module is seen from the science process skills using the guided inquiry-based learning module and analyzed for the dependent sample t test. The t table value for db = 30 and a significance level of 0.05 is 2.04 so that the t0 value (calculated) = 3.64 or H0 is rejected.

Keywords: Based on guided inquiry; Empirical; Learning module; Science process skills; Validity

Introduction

The guided inquiry learning model is a learning model that actively involves students in every step of the activity. The main objective in the guided inquiry-based learning process lies in the ability of students to understand, then identify carefully and thoroughly and end by providing answers or solutions to the problems presented (Stanton & Roelich, 2021; Jegstad, 2024). The type of inquiry chosen in this physics learning is the guided inquiry learning model (Hasmawati et al., 2023; Kurani & Syarifuddin, 2020). The consideration of researchers in using the guided inquiry learning model is because students are considered to still need guidance or direction from educators when they still experience obstacles or confusion in solving problems in learning. Students cannot be completely released to carry out activities completely independently (without teacher guidance) considering the limited terms that can be understood, with the presence of educators as companions it is hoped that learning activities can be facilitated.

The independent curriculum is a curriculum with varied intracurricular learning, where the available content is more optimal so that students have enough time to explore and understand competencies (Dwivedi et al., 2023; Dasmo et al., 2023). Teachers are free to choose teaching tools independently according to the interests and learning needs of the students. The teaching tools in question are teaching materials. Learning Modules are a set of modules containing materials collected from various relevant sources and arranged systematically to describe concepts that can direct students in achieving learning outcomes (CP)

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(Adnyana et al., 2019; Armansyah et al., 2019; Haryadi et al., 2021). In compiling learning modules, they are adjusted to the needs of students so that material analysis is needed in the curriculum used (Hendri et al., 2021; Rincon-Flores et al., 2024; Cahayningrum et al., 2017).

The development of learning modules is very important for educators so that learning is more effective, efficient, and does not deviate from the competencies they want to achieve and is close to the student's environment (Torsdottir et al., 2024). The structure of the independent curriculum from the government that must be implemented in madrasas requires a special policy from the Ministry of Religion, considering that madrasas are general educational institutions with Islamic characteristics. In terms of strengthening programs that are characteristic and superior, madrasas can innovate and develop curricula at the education unit level (Atin & Rokhimawan, 2024; Suhelayanti et al., 2023).

In accordance with the explanation above, the components contained in the KPS include: observation, classifying, interpretation, prediction, communicating, asking questions, submitting hypotheses, planning experiments, using tools or materials or sources in applying concepts, and carrying out experiments or investigations. Based on the components of the KPS, it can be concluded that the use of the guided inquiry learning model is considered very suitable for application in science learning, especially physics subjects. With the view supported by several previous studies, the guided inquiry learning model is considered to be able to improve scientific attitudes while providing a positive impact in the sense of improving the KPS of students taught by the model.

Physics learning aims to improve student skills with knowledge, understanding, and abilities to develop science and technology (Amelia et al., 2021; Doyan et al., 2022; Zakirman et al., 2023). Physics learning emphasizes the concept of physics that is based on the nature of natural science and concerns products, processes, and scientific attitudes (Dewi et al., 2020). Based on the background and theoretical and empirical considerations, it is known that student learning outcomes are determined by the use of appropriate learning modules in the learning process at Madrasah. By using guided inquiry-based learning modules, students will be actively involved in learning and gain experience by doing activities that allow them to discover principles for themselves. In addition, the guided inquiry learning model that becomes the student's teaching model will be one of the supporting factors for increasing students' science process skills in discovering learning concepts. This is the basis for researchers to conduct research on "Development of Guided Inquiry-Based Learning Modules to Improve Students' Science Process Skills".

Method

Type of Research

This research is a type of research and development or Research and Development (R&D). The research and development method is a research method used to produce a particular product, and test the effectiveness of the product. This research design uses the 4D development model (Four-D) (Fahru et al., 2024). The 4D research and development model consists of 4 stages, namely; Define, design, develop, and disseminate.

Trial Design

The trial design used is "Post-test only design". In this design, the test is carried out once, namely after the administration is carried out.

Group	Treatment	Posttest
R_1	X	O_1
R_2	-	O_2

Figure 1. Post-test only design

Description
X: Treatment using guided inquiry-based learning modules
O1: Post-test results in classes that use guided inquiry-based learning modules
O2: Post-test results in classes that do not use guided inquiry-based learning modules
-: Not using guided inquiry-based learning modules
R: Random

Instruments

There are two research instruments used in this study, namely a physics learning interest questionnaire and a test of students' critical thinking skills. Determination of physics learning interest in this study is in the form of a self-assessment-based questionnaire sheet according to what is felt by students. The test of students' critical thinking skills used in this study is a multiple-choice test using critical thinking skills indicators, namely: interpretation, analysis, inference, evaluation, and explanation.

Research Procedure
Definition Stage

The purpose of the needs analysis is to explore the problem of the performance gap that occurs in a phenomenon and recommend solutions according to

existing conditions and determine student competencies which are the basis for developing learning modules in guided inquiry-based learning. At this stage, a preliminary study was conducted, namely an initial interview with subject teachers.

Initial Analysis (Learning Process)

The initial analysis was conducted to determine the description of the physics learning process at MAS Ummul Mukminin 'Aisyiyah, South Sulawesi Region by measuring students' science process skills, confirming the learning desired by students, and identifying the causes of problems that arise in the physics learning process. Success in the learning process when learning is centered on students. Student-centered learning will be achieved if supported by the availability of learning modules that can accommodate students in the learning process and can improve the science process skills provided. With this, the researcher conducted an initial observation to the Head of the Curriculum Section of the Madrasah as well as One of the Physics Teachers at MAS Ummul Mukminin 'Aisyiyah, South Sulawesi Region, attached in the appendix. After conducting the interview stage, it was found that the problem that occurred in physics learning was that students had difficulty understanding the learning material being taught (Sa'adah et al., 2023).

The learning process at Madrasah MAS Ummul Mukminin 'Aisyiyah, South Sulawesi Region only uses textbooks as supporting teaching materials for students when studying which are given during physics lessons only. The textbooks used cannot be used by students to study independently. To understand the book, students still need the role of teachers in explaining the various concepts. The use of textbooks in the library, students can use them at any time and can be loaned to students if students need them. The location of the library is in the appendix. Next is the implementation of practicums. MAS Ummul Mukminin 'Aisyiyah, South Sulawesi Region has many rooms. One of the rooms owned is a laboratory. There are three laboratories in the Madrasah, namely chemistry, biology and physics laboratories. The laboratories are combined with four educational units, namely SMP, MTs, SMA and MA.

Student Analysis

Student analysis aims to examine the characteristics of students which include the background knowledge of students, student learning styles measured through direct observation. The results of these observations are used as considerations for the design and development of learning tools. In terms of student learning styles, each student has their own way of understanding physics material. There are three learning styles possessed by students, namely visual, auditory and kinesthetic. The distribution of learning styles of class X students can be seen in Figure 2.

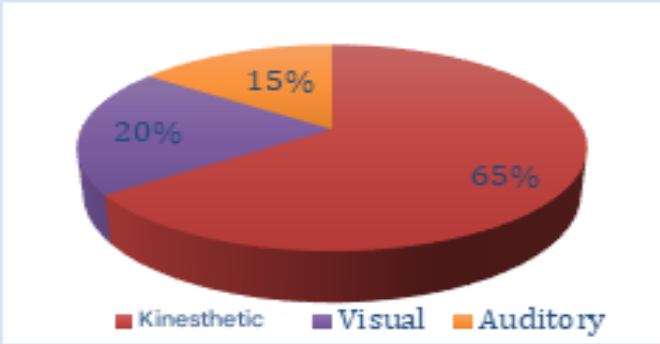

Figure 2. Learning styles of class x students of MAS Ummul Mukminin 'Aisyiyah, South Sulawesi region

Based on the distribution of students' learning styles, data obtained shows that students have various learning styles (audio - visual - kinesthetic). Based on the results of data analysis, among the three types of learning styles (audio, visual and kinesthetic) students in class X tend to have a kinesthetic learning style, this can be seen based on data analysis, where as many as 65% of students have a kinesthetic learning style, 15% Auditory, and 20% Visual. It can be concluded that students in class X 1 MAS Ummul Mukminin 'Aisyiyah, South Sulawesi Region have 3 (three) different types of learning styles and predominantly have a learning style that tends to enjoy learning with practical methods, likes activities that involve body movement or those related to physical activity of students. However, so far the learning resources used have only used printed books, and students who have a kinesthetic learning style or like activities and students with learning styles.

Based on the results of observations, it was found that there is a relationship between learning styles and science process skills. Kinesthetic learning style involves the use of physical movement and hands-on experience. to understand the material. Students are actively involved in the learning process, and can strengthen their science process skills. Thus, understanding students' learning styles and utilizing learning outside the classroom (such as outdoor learning) can contribute to the development of science process skills. Science process skills that involve high-level cognitive processes, namely interpretation, analysis and inference through scientific procedures in order to improve science process skills. From the definition above, the author uses as an indicator of science process skills are observing, grouping, conducting experiments, analyzing data, concluding and communicating.

Material Analysis

Concept analysis aims to identify and

systematically organize the main concepts that students will learn as reference material for researchers in compiling learning modules in guided inquiry-based learning. This concept analysis is made in a learning concept map which will later be used as a means of achieving certain competencies. Concept analysis is made to identify and systematically organize the main parts of the learning material according to learning achievements and learning objectives.This stage is very necessary to be carried out in order to determine the type of learning that is appropriate in improving the ability of science process skills in guided inquiry-based learning. All materials are discussed by presenting natural events that exist around students. The results of the material analysis that will be used as reference material for compiling learning modules are grade X odd semester materials. The reason the researcher took the material in grade X 1 was because it referred to the results of the analysis of students' science process skills and the results of the analysis of the measurement material in scientific work activities were still relatively low and in accordance with the conditions of students in the madrasah. The following is a concept map of measurement material in scientific work activities.

Task Analysis and Learning Objective Analysis

The material taken is measurement in scientific work activities. This material is linked based on guided inquiry-based learning. The following is a description of the elements and learning achievements of Phase E Class X, and is in accordance with the learning objectives based on guided inquiry. On the achievement of learning Physics Subject Phase E (Generally for class X SMA/MA).

Identification of Required Resources

At this stage, there are four resources identified, namely content resources, technological resources, instructional facilities, and human resources. Content resources are obtained by analyzing physics materials and teaching materials used in class X 1 MAS Ummul Mukminin 'Aisyiyah South Sulawesi Region. The material to be developed is measurement material in scientific work activities. The application of daily measurement material so that it is easy for students to understand measurement material in scientific work activities. If the learning material is linked to everyday life. The technological resources in question are in the form of computers that can be used to access lessons, projectors used by teachers in delivering material during the learning process are also fulfilled. MAS Ummul Mukminin has provided technological resources in the form of computers or projectors that can support teaching and learning activities that can be categorized as having normal internet access and adequate communication facilities.

Instructional facilities at MAS Ummul Mukminin 'Aisyiyah South Sulawesi Region with 9 classrooms where each class can accommodate 29 - 34 students. While the human resources in question are physics teachers at MAS Ummul Mukminin 'Aisyiyah South Sulawesi Region, namely 2 people. The physics teachers are graduates of physics education so they are very relevant to educate or teach physics at MAS Ummul Mukminin 'Aisyiyah South Sulawesi Region. The results of the analysis stage are in the form of solutions that can be recommended based on the gaps that occur in class X 1 MAS Ummul Mukminin 'Aisyiyah South Sulawesi Region in physics learning. Teachers need to facilitate, guide students to practice science process skills by utilizing contextual physics learning. Students' interest in guided inquiry-based physics learning can be one of the supporters to produce learning that can touch the daily lives of students. Therefore, the researcher chose to develop a guided inquiry-based learning module to improve students' science process skills.

Final Analysis

The initial analysis shows that there is a significant need to develop a guided inquiry-based learning module. This is due to students' difficulties in understanding physics material and their dependence on the role of teachers in the learning process. In this final analysis, it underlines the importance of developing a learning module that not only presents physics concepts but also relates them to events in the surrounding environment to improve students' science process skills. In terms of facilities and infrastructure, adequate facilities and infrastructure in schools, including physics laboratories, are important factors in supporting physics learning. The development of learning modules must take into account the existence and availability of these facilities to ensure that practicums and direct learning can be carried out properly.

Result and Discussion

From the analysis of students' learning styles, it was found that most students have a kinesthetic learning style. This shows the importance of paying attention to students' learning preferences in developing learning modules. Concept and material analysis helps in identifying the main concepts that students must learn and compiling teaching materials that are in accordance with basic competencies and learning outcomes (Oktarina et al., 2018). The concept map of measurement in scientific work activities provides guidance in

compiling materials that are in accordance with the needs of students. Task analysis aims to adjust learning materials to basic competencies and learning objectives. The learning objectives that are compiled must be in accordance with the needs of students and the school context (Huda et al., 2024). From this final analysis, it can be concluded that the development of teaching materials in outdoor class learning must consider factors such as student learning preferences, availability of facilities and infrastructure, and the surrounding environment in learning objectives and tasks (Dai et al., 2023; Saleem et al., 2022).

Thus, the learning modules that are developed can more effectively improve students' science process skills (Arantika et al., 2019). The results of the analysis stage are in the form of recommended solutions based on problems that occur at MAS Ummul Mukminin 'Aisyiyah, South Sulawesi Region in physics learning. Therefore, the researcher chose to develop a guided inquiry-based learning module to improve students' science process skills in scientific work activities, which we often encounter in everyday life.

Planning Stage

At this stage, planning is carried out for the guided inquiry-based learning module that will be developed in accordance with the content framework of the results of the curriculum and material analysis and a design for the development of research instruments is carried out. Product design at this stage cannot be separated from the definition stage. The initial product in the form of a guided inquiry-based learning module (draft I) and the research instrument that has been created will then be assessed for validity by a team of expert validators and field tests (science process skills test instruments) before being tested. The activities at the design stage are as follows:

Selection of Learning Modules

The selection of learning modules designed to support the physics learning process is a guided inquiry-based learning module. This learning module contains measurement material in scientific work activities that contain science process skills adjusted to the needs of students.

Format Selection

The selection of formats is important to adjust the format of the guided inquiry-based learning module according to needs. The format used in the development of guided inquiry-based learning modules is an adaptation of the format of the components of the independent curriculum learning module preparation used in MAS Ummul Mukminin 'Aisyiyah, South Sulawesi Region and is adjusted to the content framework of the results of the curriculum analysis, materials and student needs by integrating aspects of science process skills, science process skills assessment framework with six assessment indicators according to According to Wetzel in Mahmuddin (2010) in addition, the study of the standard format of the learning module is adjusted to the BSNP format (2007) which includes aspects of the feasibility of content, readability of language and images, presentation and graphics.

The format of the components of the guided inquiry-based learning module used in this development refers to the independent curriculum, namely (Sitepu et al., 2021; Noer et al., 2021): General information components, namely module identity, dimensions and elements of the Pancasila student profile, target students, facilities and infrastructure; Core information components, namely learning objectives, learning activities, assessments, teacher reflections, forewords; and Attachments, namely teaching materials, learning activities, glossary and bibliography, which in the design of the learning module also contains a foreword, table of contents, learning objectives flow, and assessment instruments. The preparation of the format of the guided inquiry-based learning module also cannot be separated from paying attention to the type of font used, attractive color combinations, spacing between lines to make it easier to read the text, paper format, presentation of punctuation to make it easier to know important things and clarify the contents of the material, the preparation of teaching materials that are structured and systematic and arranged proportionally between the title, sub-chapter and contents of the learning module (Sung et al., 2016).

Initial Design

The initial design is the development of a product in the form of an initial draft of a guided inquiry-based learning module and research instruments. The main stages carried out before the learning module is developed are preparing the initial design requirements such as the design of the learning module, images, learning videos, materials, questions, frames, and others are prepared before being developed. Material images are obtained from personal documents and downloaded from Google pictures. Learning videos are obtained from YouTube. Materials and questions are obtained from references to class X physics books, Basic Physics books, 7th edition, and question bank books. Cover design, contents of the teaching module frame and several material images are obtained using the design application, namely Canva.

After all the initial design requirements have been collected, they are then arranged into a teaching module using the Microsoft Word application based on teaching module standards. The teaching module that has been

designed by the researcher becomes the researcher's initial design (draft I) and research instruments (practitioner assessment questionnaires and student analytical thinking ability tests) which will then be assessed by a team of expert validators first at the development stage before being tested.

Development Stage (Develop)

The purpose of this stage is to produce a product in the form of a guided inquiry-based learning module and research instruments (practitioner assessment questionnaire and student science process skills test) that have been validated and have received advice from expert validators, namely Lecturers of the UNM Postgraduate Physics Education Study Program. The activities carried out at this stage are validating the contents of the developed module and research instruments and conducting field tests on student science process skills instruments (Miftakhurrohmah et al., 2023). Furthermore, the items are revised to carry out limited trials on the product, then a limited trial stage is carried out and a practitioner assessment questionnaire sheet is provided.

Expert Validation

Validation of the Content of the Guided Inquiry-Based Learning Module

The initial design that has been prepared in the form of draft I is then compiled into a systematic guided inquiry-based learning module (Suwito et al., 2020; Al-alang et al., 2023). Furthermore, the guided inquiry-based learning module on the measurement material is subjected to content validation analysis which is validated by three competent experts/experts to assess the learning module that has been produced and provide suggestions for improvement.

Validation of Research Instruments

At this stage, validation is carried out on the research instruments that will be used, namely the practitioner assessment questionnaire sheet and the student science process skills test sheet.; Validation of the Practitioner Assessment Questionnaire Instrument for Guided Inquiry-Based Learning Modules; Validation of the practitioner assessment questionnaire instrument for guided inquiry-based learning modules provides data on the quality and feasibility of the practitioner assessment questionnaire assessed by experts or a team of experts (Irwan et al., 2019; Bereczki & Kárpáti, 2021). The information obtained through this instrument is used as input in making improvements to the practitioner assessment questionnaire for the guided inquiry-based learning module that was developed.

Validation of the Science Process Skills Test Instrument

Validation of the science process skills test instrument provides information on the quality and feasibility of the test assessed by experts or a team of experts. The information obtained through validation of this instrument is used as input in creating and compiling the science process skills test that will be worked on by students in accordance with the science process skills indicators (Wazni & Fatmawati, 2022; Astutik et al., 2019).

Field Test

After expert validation was conducted, a field test was conducted on the science process skills test instrument for students in class X 1 MAS Ummul Mukminin 'Aisyiyah in South Sulawesi who were not included as subjects in this study. The results of the field test were then subjected to item analysis and reliability tests.

Revision

Revision is done after the product is validated. Based on the results of the assessment, corrections and suggestions from experts, improvements are made to the product, namely the guided inquiry-based learning module and research instruments if there are any that need to be improved. If it is still needed, validation will be carried out again with the expert. After expert validation, the revision results are obtained which are used to revise the guided inquiry-based learning module (draft II).

Trial

Empirical Trial

The science process skills test instrument that has been validated by expert lecturers was then tested in class XI MIPA 1 and XI MIPA 2. The data obtained were then analyzed. The data analysis includes validation of question items and instrument reliability.

Field Trial

The validated guided inquiry-based learning module will be tested by implementing learning in classes X 1 and X 2 of MAS Ummul Mukminin 'Aisyiyah, South Sulawesi Region, 2023/2024 Academic Year. The trial design used is "Post-test only design". In this design, the test is carried out once, namely after the administration is carried out.

Group	Treatment	Posttest
R_1	X	O_1
R_2	-	O_2

Figure 3. Post-test only design

Description:
X: Treatment using guided inquiry-based learning modules
O1: Post-test results in classes that use guided inquiry-based learning modules
O2: Post-test results in classes that do not use guided inquiry-based learning modules.
-: Not using guided inquiry-based learning modules
R: Random

After the product trial is conducted, the next step is the response of teachers and students to the guided inquiry-based learning module. The questionnaire will be analyzed to provide information on the responses of teachers and students to the feasibility of the guided inquiry-based learning module that has been created and the effectiveness of the guided inquiry-based learning module is a measurement of success in achieving predetermined goals as seen from the t-test analysis (Noris et al., 2023; Rajabalee & Santally, 2021; Poerwanti et al., 2022).

Revision

Based on the trial data, the researcher conducted an evaluation and revision to improve the guided inquiry-based learning module draft 3 so that the final product (Final Draft) was produced.

Final Product

After conducting revisions and field experiences and having been revised, it produces a final draft product to be disseminated.

Dissemination Stage

At this stage, dissemination is carried out and practitioners' responses are requested using a validated practitioner assessment questionnaire. The teachers who provided responses were physics subject teachers at the Ummul Mukminin 'Aisyiyah Puteri Islamic Boarding School in South Sulawesi, totaling 3 teachers and physics subject teachers from several schools that joined the MGMP Physics SMA/MA Makassar City, totaling 10 people, and published in the e-journal.

Conclusion

The conclusion of this study is the results of the development of guided inquiry-based learning modules reviewed theoretically and empirically based on face validation from 10 respondents showed the accuracy of the items measuring indicators, the clarity of the language used, the graphic components for all instruments used were feasible and could be used in research. Based on expert validation from 3 physics lecturers, it showed that all instruments used were valid and could be used for field trials and the effectiveness of their application. Logical validity showed that the grid of the learning outcome test instrument before and after the trial. It appears that all aspects or indicators after the trial, both theoretically and empirically, were appropriate or represented in the grid before the trial. Practitioner responses to guided inquiry-based learning modules were in the very positive category. This shows that practitioners gave a positive response to the guided inquiry-based learning modules that were developed and have met practical criteria. The effectiveness of using guided inquiry-based learning modules to improve the science process skills of students at MAS Ummul Mukminin 'Aisyiyah in the South Sulawesi Region and the developed teaching modules were declared effective for use in learning.

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Author Contributions
N conceptualized the research idea, research method, and analyzed the data; S. A and H guided the writing of the review and editing, supervised and validated the instruments used in the research.

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Conflicts of Interest
The author declares no conflict of interest.

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