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Development of Physics Teaching Modules Oriented to Scientific Approach to Improve Students' Science Process Skills

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Abstract: This research is a development researchs. The aim is to produce a physics teaching module oriented to a scientific approach. This teaching module is used to improve students' science process skills. The subjects of the research trial were 34 students of class X of SMAN 13 Makassar. The development model of the physics teaching module oriented to a scientific approach is a 4-D instructional model consisting of define, design, development, dissemination. The research instrument used a validation sheet, a practitioner assessment questionnaire, and a science process skills test instrument. Based on the results of the data analysis, the following conclusions were obtained: the physics teaching module oriented to a scientific approach was declared valid and feasible to use with an integrated scientific approach learning activity structure and a collection of questions according to the science process skills indicators; the physics teaching module oriented to a scientific approach reviewed from the assessment of practitioners, namely physics subject teachers, was in the very good category; the effectiveness of the physics teaching module oriented to a scientific approach reviewed from students' science process skills using the N-Gain score was in the effective category. This can be interpreted that the physics teaching module oriented to a scientific approach that was developed is effective in improving students' science process skills.

Keywords: Scientific Approach; Science Process Skills; Teaching Module

Introduction

The education and learning system in the curriculum that applies in a country should be able to develop creativity, critical skills in solving problems and being proficient in communicating and collaborating (Thornhill-Miller et al., 2023); (Wrahatnolo & Munoto, 2018). The latest education system has been socialized comprehensively by the minister of education, culture, research and technology. The concept of education that is currently being developed is independence in critical thinking, creativity and intelligence in spirituality and emotion (Vestena et al., 2020). The implementation of the Merdeka Belajar curriculum continues to experience strengthening in changes to curriculum strategies along with learning recovery due to the results of learning quality during the pandemic recovery period in 2020-2021 (Isatul Hasanah et al., 2023). In the Merdeka Curriculum, teachers in education units are obliged to compile teaching modules completely and systematically so that learning takes place interactively, inspiringly, challengingly, enjoyably, motivating students to participate actively, and providing sufficient space for creativity, initiative, and independence according to the interests, talents, and physical and psychological development of students (Darling-Hammond et al., 2020).

Thus, the Independent Curriculum gives teachers the freedom to enrich teaching modules in two ways, namely teachers can use teaching modules that have been prepared by the government or teaching modules that are made by developing teaching modules that have been prepared that are adjusted to student character (Bukaryo, 2023). A teaching module is a learning tool or

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learning design that is based on the curriculum and is applied with the aim of achieving predetermined competencies (Lidyasari et al., 2023); (Hanisch & Eirdosh, 2023). One of the important tools that must be owned and mastered by every teacher in the successful implementation of the Independent Curriculum is a teaching module (Tong et al., 2022); (Taylor et al., 2021). To get maximum results in the development of Physics learning modules, it is also necessary to pay attention to the learning approach chosen. One approach that needs to be applied is the scientific approach (Kusumaningrum et al., 2017).

According to Permendikbud Number 103 of 2014, the scientific approach is operationalized in the form of learning activities which include learning experiences in the form of observing, asking, gathering information (trying), reasoning (associating), and communicating. Physics is essentially a science that studies natural phenomena that occur from a series of processes called scientific processes and will produce scientific products consisting of three components, namely concepts, principles and theories that apply universally. The right physics learning process will certainly produce superior and characterful students (Silverman, 2015); (Zakirman et al., 2023). Some physics (which is part of science) requires illustrations in its learning so that the material is easy to understand (Zakirman et al., 2023). Physics is part of science. Science is a product of scientific science, so methods, processes, principles, attitudes and others must also be scientific. Therefore, physics learning in schools should also be carried out with a scientific approach so that it is more meaningful in the minds of students and is able to shape the attitudes or characters of students.

The scientific approach will tend to emphasize the development of process skills. This module can include steps such as experiments, investigation tasks, and problem-solving activities. The scientific approach encourages the use of learning modules that support the exploration and problem-solving process, so that students can develop a deeper understanding of certain concepts. Process skills developed through learning modules with a scientific approach can help students become more active and critical learners, with the ability to think independently and overcome challenges. By integrating learning modules oriented to the scientific approach in improving science process skills, learning can be more contextual, interesting, and provide a more meaningful learning experience for students. Science process skills are grouped into two, namely basic science process skills and integrated science process skills.

Basic science process skills consist of observing, classifying, predicting, measuring, communicating and concluding. While integrated science process skills consist of formulating hypotheses, controlling variables, designing investigations, conducting experiments, interpreting, and applying concepts (Diani et al., 2020); (Vo & Simmie, 2024). Process skills are learning that emphasizes the learning process, activities and creativity of students in acquiring knowledge, skills, values and attitudes, and applying them in everyday life. To develop these process skills, a teacher must be able to deliver material by designing effective learning, creating the necessary instruments, and evaluating what has been taught. The development of science process skills allows students to independently construct their knowledge and give meaning through real experiences to find facts, build concepts, theories and scientific attitudes. The relationship between the scientific approach and science process skills in physics learning is very close. Both complement each other to create an active, systematic and scientific learning environment (Montenegro-Rueda et al., 2023); (Husna et al., 2022). The integration of the scientific approach with science process skills in physics learning creates an environment that supports an in-depth understanding of physics concepts and the development of relevant scientific skills (Ongowo, 2017). Through the combination of the two, students can experience physics learning that is contextual, interactive, and in accordance with scientific methods (Satriawan et al., 2020); (Desnita et al., 2020).

Based on the results of the researcher's interviews with class X students of SMAN 13 Makassar and the observations that have been made, it can be seen that most students still have difficulty in learning physics. Students have difficulty in learning due to the impracticality of teaching materials used by teachers in learning because there are too many theories and formulas in their application, and monotonous teaching materials are limited to publisher books/textbooks only. The learning process also only uses conventional methods that rely on teachers writing lessons on the board then students take notes or teachers dictate the discussion. There are no teaching modules used in the learning process and students are less active in learning physics. Teachers have not implemented learning using a scientific approach, and students' science process skills are low. Based on the explanation above, efforts are needed to improve and enhance the quality of the teaching and learning process in the classroom must always be carried out. One of these efforts is to choose the right teaching materials and approaches in learning. Scientific approach-oriented teaching modules can be used as an alternative teaching material and learning methods. Therefore, to facilitate physics learning which is expected to help students to be more active in learning and improve students' science process skills, researchers took the initiative to develop a physics teaching module

oriented to a scientific approach to improve students' science process skills.

Method

The type of research used in this study is research and development (Research and Development). Research activities are carried out to obtain information about user needs while development is carried out to produce teaching modules. This research is used to develop a product or improve a product. The research procedure was carried out using the 4-D development model design (Define, Design, Development, Dissemination). This development model consists of four stages, namely defining, designing, developing, and disseminating (Amini et al., 2020). The 4-D development model was chosen because this model is more appropriate to use and meets the needs of developing teaching modules oriented towards a scientific approach. The form of the 4-D model development flow can be seen in Figure 1 as follows:

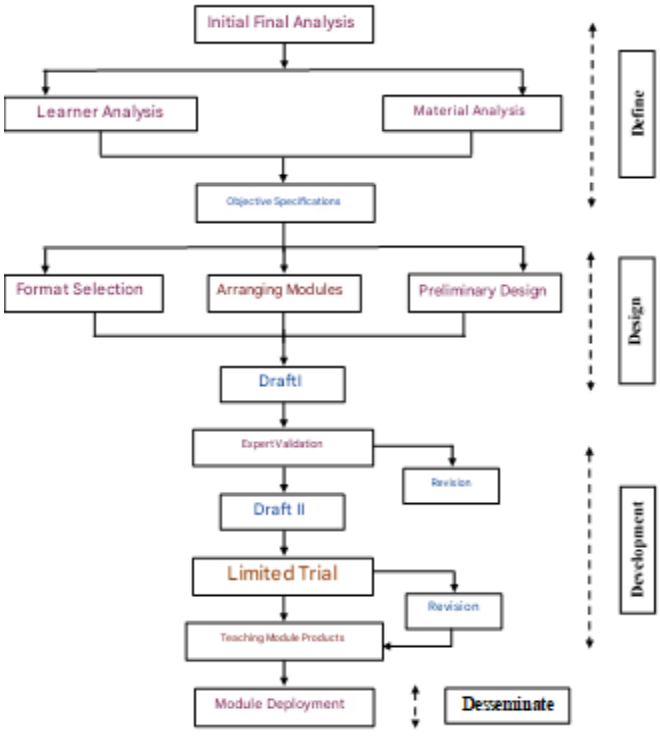

Figure 1. 4-D Model Development Stages

The developed scientific approach-oriented physics teaching module was tested on grade X students of SMAN 13 Makassar in the even semester of the 2022/2023 academic year using the "One Group Pretest and Posttest Design" trial design. The research instruments used were validation sheets, practitioner response questionnaires, and science process skills tests. The data collection techniques used were the validity test of the teaching module, practitioner responses to the teaching module, and the effectiveness test of the teaching module.

Result and Discussion

Results of Developing Physics Teaching Modules Oriented by Scientific Approach

The physics teaching module that has been developed is validated by experts to determine the feasibility of the teaching module. The aspects of content validity assessed by three experts are aspects of content feasibility, presentation, language, and graphics. The results of the content validity coefficient analysis test of the expert agreement index with the Aiken's V index analysis are presented in Table 1 below:

Table 1. Content Validation Analysis Test of Physics Teaching Modules Oriented by Scientific Approach

Aspects	Total Validity Item Score	V	Category
Content Feasibility	12.78	0.75	Valid
Presentation Feasibility	7.44	0.83	Valid
Graphic Feasibility	7.78	0.78	Valid
Language Feasibility	7.67	0.77	Valid

The teaching module in terms of content feasibility, the scope of the material is considered to be in accordance with the learning achievements and learning objectives, the accuracy of the images and illustrations and the latest references, the scientific approach aspect of the material can help students encourage curiosity and the spirit of innovation in students to develop. In terms of presentation feasibility, the three experts considered the material presentation technique interesting, activity sheets can make it easier for students to understand physics concepts, the presentation of questions can help to train and improve students' science process skills. In terms of graphics, the three experts assessed the aesthetics of the appearance of the teaching module which can provide comfort for readers to read the teaching module and increase students' interest in reading (Utami et al., 2024).

In the content section of the teaching module, the typography of the content and the combination of colors, there is a simple and harmonious teaching module content so that it is easy to read. In terms of language, the three experts assessed that the language used is in accordance with the development of students and the General Guidelines for Indonesian Spelling (PUEBI), the terms used use standard language and the formulas or equations used are in accordance with the correct writing method. Based on the validation analysis data

obtained as in Table 1, it states that the physics teaching module oriented to the scientific approach is declared feasible. The results of this analysis are in line with research conducted by (Januarti et al., 2023) which stated that the physics teaching module oriented towards a scientific approach developed on static fluid material was declared valid by experts. Furthermore, the results of research by (Ulya et al., 2023), on the development of a physics teaching module with a scientific approach to static electricity material met the valid criteria for use in learning.

Practitioner Responses to Physics Teaching Modules Oriented towards a Scientific Approach

Practitioner responses to physics teaching modules oriented towards a scientific approach include aspects of content feasibility, presentation feasibility, language feasibility, and graphic feasibility. The results of the analysis of practitioners' responses to physics teaching modules oriented towards a scientific approach can be seen in Table 2 below.

Table 2. Results of Practitioner Assessment of the Physics Teaching Module Oriented to the Scientific Approach

Rated aspect	Average Score Achievement	(%)	Category
Content Eligibility	3.56	88.96	Very Practical
Feasibility of Presentation	3.60	90.05	Very Practical
Language Eligibility	3.63	90.63	Very Practical
Graphic Feasibility	3.58	89.58	Very Practical

The physics teaching module oriented towards a scientific approach that was declared valid by experts was then given to practitioners to assess the implementation and usefulness of the developed teaching module. Practitioners in this study were 12 high school Physics teachers. Among them, 3 Physics teachers came from SMAN 13 Makassar and 9 Physics teachers came from several high schools that were members of the MGMP Physics SMA group throughout Makassar City. The practicality of the developed scientific approach-oriented Physics teaching module can be seen from the results of the practitioner responses in Table 2. The results of the practitioner response questionnaire analysis concluded that 12 practitioners on average gave a very good rating to the scientific approach-oriented Physics teaching module. The results of this analysis are in line with research conducted by (K Dewi et al., 2020); (Kartika et al., 2023); (Sahrianti et al., 2021), which stated that the development of scientific approach-oriented physics learning media on momentum and impulse materials was declared practical to use. Research conducted by (Hidayat et al., 2021); (Abdullah et al., 2024); (Putri & Jayanta, 2023), on the development of physics teaching modules with a scientific approach to static electricity material stated that the developed modules can be declared valid and received positive responses from students, as well as very positive responses from teachers.

Effectiveness of Physics Teaching Modules Oriented to Scientific Approach

The effectiveness of the Physics teaching module oriented to a scientific approach is seen based on the improvement of the science process skills of 34 class X students of SMAN 13 Makassar. To obtain the effectiveness of the Physics teaching module oriented to a scientific approach, an analysis of the improvement of students' science process skills was carried out using the N-gain score equation. The results of the N-Gain analysis can be seen in Table 3 below.

Table 3. Percentage of Students' N-Gain Scores on Science Process Skills Test

Criteria Interval	Category	Frequency	(%)
$0.7 < g \leq 1.0$	High	10	27.03
$0.3 < g \leq 0.7$	Medium	23	62.16
$0.0 < g \leq 0.3$	Low	1	2.70
Amount		34	100

Based on the N-Gain score in Table 3, there are 10 students who experienced an increase in the high category. There are 23 students who experienced an increase in the medium category and 1 student who experienced an increase in the low category. The improvement of students' science process skills can be clearly seen in the following Figure 2:

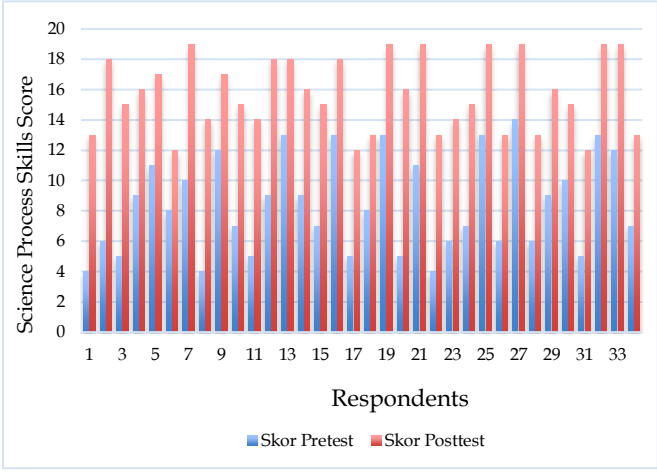

Figure 2. Pretest and Posttest of Process Skills

Student Science

The science process skills test was given to students before (pretest) and (posttest) after learning using the Physics teaching module oriented towards a scientific approach. Based on Figure 2, it can be seen that as many as 34 students experienced an increase in science process skills after the application of the physics teaching module oriented towards a scientific approach. Using a scientific approach by raising topics encountered in students' daily lives into the material is able to train students' science process skills. This is supported by research conducted by (Ellizar et al., 2018); (Kamila et al., 2024) which states that there is a large influence of the scientific approach-based teaching module on improving students' science process skills. Furthermore, the effectiveness of using the physics teaching module oriented towards a scientific approach is categorized based on the interpretation of the effectiveness of the gain score in the form of a percentage (%). The results of the N-Gain score analysis can be seen in Table 3 below:

Table 3. Percentage of Effectiveness of N-Gain Score of Students' Science Process Skills

Percentage (%)	Category	Frequency	Percentage (%)
g ≤ 55	Not Effective	8	23.53
g ≥ 56	Effective	26	76.47
Amount		34	100

Based on Table 3, it can be seen that there are 8 students in the ineffective category with a percentage of 23.53 and there are 26 students in the effective category with a percentage of 76.47%. According to (Bhakti et al., 2023); (Khuzaimah et al., 2022); (Haryanto et al., 2021), it is said to be effective if the average percentage of the N-gain score obtained is in the range of ≥ 56%. From the results of this percentage, it can be concluded that the physics teaching module oriented to the scientific approach that was developed is effective for use in the learning process. There are several factors that influence these results, including students paying less attention when following the learning process, students only memorizing formulas without understanding the concept properly and students do not have great motivation in following the Physics learning process. In addition, the physics teaching module oriented to the scientific approach that was developed is limited to only 1 main material, so that students are limited in developing their science process skills (Wola et al., 2023); (Mushani, 2021). Based on several research references relevant to this study, it can be concluded that the physics teaching module oriented to the scientific approach is declared effective with the increase in students' science process skills (Sumanti et al., 2023); (Sudirman et al., 2023); (Baeng et al., 2022). So that the physics teaching module oriented to the scientific approach has a positive impact on Physics learning for class X at SMAN 13 Makassar.

Conclusion

Based on the results of the research and trials, it can be concluded that the results of the validity test of the content of the physics teaching module oriented to the scientific approach to improve students' science process skills have met the valid criteria so that it is suitable for use. Then, for the practitioner's assessment of the physics teaching module oriented to the scientific approach that was developed, it is in the very practical category. This shows that practitioners gave a positive response to the physics module oriented to the scientific approach that was developed. Meanwhile, the effectiveness of the use of the physics teaching module oriented to the scientific approach was obtained from the analysis of students' science process skills using the N-Gain score which is in the effective category. This means that there is an increase in the science process skills of class X students of SMAN 13 Makassar, and the teaching module that was developed can be declared effective for use in the learning process.

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Author Contributions

P. C. C. L. conceptualized the research idea, research method, and analyzed the data. H and K. A 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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