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Development of a mathematics module on circle material based on the small group discussion model

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ABSTRACT

This research aims to produce a mathematics module on circle material based on the small group discussion model to improve learning outcomes. The fact is that there are 48% of students who get low mathematics learning outcomes. Another fact is that at the high school level, 62% of students in circle material scored below the minimum completeness criteria. Urgent development research was carried out to produce circular module products. The method in this research is research and development (R&D). The subjects and objects of the research were high schools and there were 32 students. Data collection techniques, material expert instruments, teachers, and student data were also obtained from the results of student pre-tests and post-tests. The data was analyzed by adding up all the assessment scores on the instruments adding up the test results and averaging the individual and classical scores. The results, and assessment of all module components by material experts, mathematics teachers, small group trials, and large group trials were 88.29%, 90.45%, 93.50%, and 92.10% in the very good category. The average score of students' post-test results is 87.50. Conclusion, this circle module can improve student learning outcomes significantly.

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1. INTRODUCTION

To ensure students obtain good mathematics learning outcomes, teachers must prepare modules, models, methods, and learning strategies in the classroom [1]. But the fact is that in senior high schools, there are still many teachers who have not compiled their material [2]. Most teachers do not prepare their material and use textbooks [3]. This is contrary to the theory that as a teacher it is obligatory to arrange material according to the basic abilities of its students [4]. The discrepancy between theory and field facts has an impact on student learning outcomes [5]. In 2022, students in high school are experiencing very serious problems in learning mathematics [6]. Another fact in the study [7] namely, in the circle material, 62% of students were found to be incomplete.

The facts above do not stand alone, this study conducts a needs analysis for teachers and students. The research asked teachers in senior high schools, what is the most difficult material for students in first-grade high schools to understand. The teacher's answer was circle material, then the research asked how many students did not pass the circle material. Teacher's answer, out of 32 students there were 14 students did not complete the circle material with an average completion score of 70. The researcher also asked whether the teacher had prepared his material. And none of the four teachers asked had prepared their material. The next question is, is a tool needed to help the process of learning the inner circle material in the form of a module? 100% of students who were asked the answer needed. The final question for the teacher is what learning model is needed and what has the teacher been using in teaching so far? The teacher's answer, small group discussion is a learning model that has been used in schools in teaching mathematics. From the analysis of student needs, it can be seen that the textbooks used have a high level of difficulty. Students hope that teachers organize material according to students' basic mathematical abilities. The students wanted a circle module as a learning aid. Based on this needs analysis, it can be seen that there are quite serious problems with the circle material. It is urgent to overcome this by developing a mathematics module on circle material. Compiling modules cannot be separated from the learning model used in school. The learning model used is the small group discussion model. The above analysis of student and teacher needs hopes that the logarithm module developed will be equipped with the small group discussion learning model used in high schools. To increase students' understanding, they need an appropriate learning model and small group discussions can improve understanding in mathematics lessons [8]–[10]. By looking at the theory, facts, and teacher expectations and the low student learning outcomes in circle material, the objectives of this study were to: i) find out the shape of the mathematics module in circle material equipped with a small group discussion model, ii) find out practicality and effectiveness circle material mathematics module equipped with a small group discussion model, and iii) find out the results of the evaluation of the circle material mathematics module equipped with a small group discussion model.

In developing the mathematics module for this circle material, this research follows the theory of the model [11]–[13] saying in developing a module that can be said to be practical and effective to help and improve student learning outcomes by following the development phase. There are three main stages, namely developing the module, conducting tests, and carrying out the module evaluation process. Each phase has steps. The first phase develops by analyzing the needs of teachers and students, setting goals, knowing the students' initial pre-test abilities, and compiling modules. The second phase is implementation or field trials by validating material experts and mathematics teachers, revising and improving the process in a structured manner, and implementing the learning process in class for students with the help of modules. The third phase is an evaluation by carrying out the module evaluation process, carrying out final revisions of the module, perfecting the module, carrying out the module analysis process and tests on students who use the module, production, and distribution on a small scale. This research aims to design a logarithm module equipped with a small group discussion, to find out the practicality and effectiveness of the module in improving understanding and learning outcomes of circle material.

2. RESEARCH METHOD

In this study, the method used is the research and development (R&D) method [14]. This method tests the feasibility, practicality, and effectiveness of the circle module with measuring instruments and tests [15]. The measuring tool used is an instrument and is given to material experts, mathematics teachers, and students [16]–[18]. The research subjects were high schools and the objects of the research were 10 tenth-grade students in the small group tryout and 32 tenth-grade students (classes B and C) in the large group tryout. Figure 1 shown the research flow starting from the define, design and develop, implementation, and evaluation stages.

2.1. Data collection

Data collection with instruments and tests. Instruments were given to material experts, mathematics teachers, and students. The instrument is used to measure the feasibility, practicality, and effectiveness of the circle module. The indicators measured are the construction of the module, the suitability of the material with the learning implementation plan, the way the module is presented, and the completeness of the small group discussion model. The assessment instrument is given along with the module that has been designed. The results of material expert validation and mathematics teacher validation became the basis for testing the circle module with students in small groups and large groups. Small-group trials and large-group trials on students are the final data for drawing conclusions based on the results of students' assessments of the instruments and post-test results [20]–[22]. Research [23]–[25] that the development of learning modules requires small group trials and trials and conducting tests at the final stage on students.

2.2. Data analysis technique

The circle material mathematics module begins with an evaluation of the circle expert module assessment and then evaluates the assessment of the teacher and students. Instruments that have been validated are averaged and interpreted. Product analysis and evaluation are carried out to determine feasibility and measure the practicality of the resulting circle module [26], [27]. Data were analyzed on a Likert scale of points 1 to 5, tabulated, calculated, and averaged in percentage form. Interpretation of Table 1 is used to measure the results of assessments by material experts, mathematics teachers, and students.

Instruments are collected and grouped based on scores. The pre-test and post-test results of small group students were analyzed by collecting the scores obtained by the students and averaging them [28], [29]. This trial was carried out in two stages, small scale and large scale. Before the learning process, a pre-test is carried out first, and after the learning process is complete, a post-test is carried out [30]. Practicality indicators can be seen from the instruments distributed to students.

The practicality and effectiveness of the circle module are measured by individual learning completion and classical completion. Increasing student learning outcomes before using the module (pre-test) and after using the module (post-test) is the basis for measuring classical completeness [31]. To determine individual learning mastery, it is calculated using (1).

$$KI = \frac{X}{X_{Max}} x\ 100\% \quad (1)$$

Information: KI is individual learning mastery, X is total score obtained by students, and X_{Max} is maximum number of scores.

Students are said to have completed their studies if the percentage of students' correct answers is above 70. Classical completion can be calculated using (2). Table 2 is an interpretation of measuring the practicality and effectiveness of the circle module. The pre-test and post-test learning results were averaged classically and adjusted the average value to the minimum mathematics completeness criterion value, namely 70.

$$KB = \frac{NS}{N} x\ 100 \quad (2)$$

Where, KB is classical abilities, NS is number of marks obtained by students and N is many students.

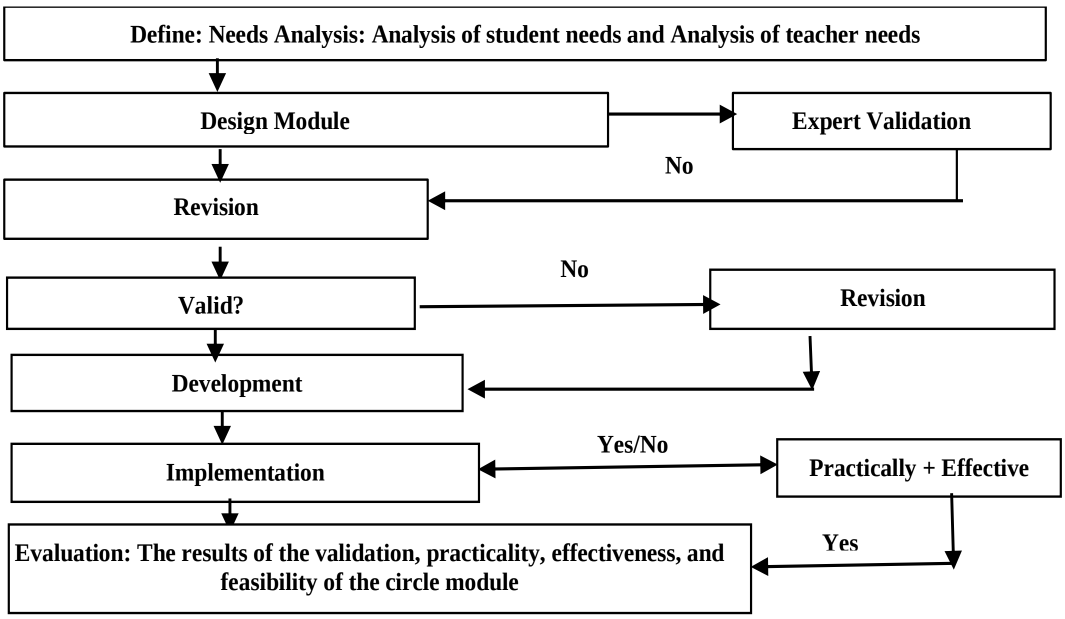

Figure 1. Research flow [19]

Table 1. Interpretation of circle module product validity

Persentase (%)	Interpretation
0-20	Not worth using
21-40	Lots of improvements and not worth continuing
41-60	Well worth continuing and has lots of improvement
61-80	Slight improvement and is worth using
81-100	There is no repair and the product is very usable

Table 2. Classification of product practicality and effectiveness

Persentase (%)	Interpretation
$n \leq 20$	Very impractical and effective
$21 < n \leq 40$	Impractical and effective
$41 < n \leq 60$	Quite practical and effective
$61 < n \leq 80$	Practical and effective
$81 < n \leq 100$	Very practical and effective

3. RESULTS AND DISCUSSION

This research produces a mathematics module product on circle material which is equipped with a small group discussion learning model in high school. The product has been designed, and validated by experts, and mathematics teachers and tested on students. The circle material math module product is produced by going through the following steps.

3.1. Analysis of the needs of mathematics teachers and students

When the needs analysis was carried out, this research asked students about mathematics material that was considered difficult, 62% answered circle material. Of the 32 students, there were 14 whose grades on circle material were below standard. The books used are still textbooks, even though students expect teachers to compile lesson modules as the main source. Students argue that the books they use are difficult to understand, this is one of the causes of their low learning outcomes. Students also expect the material to be designed according to the learning implementation plan and adjusted to the assessment standards prepared by the teacher. Apart from students, teachers' needs are also analyzed. Teachers need accuracy and appropriate methods in teaching circle material. Teachers hope that there will be modules that follow the basic abilities of the students being taught. Requires concepts and methods that are easily accepted by students. Teachers think that student learning outcomes in circle material are quite low, there are 48% of students get grades below standard. This teacher needs analysis intersects with the results of the student needs analysis. The teacher believes that the modules that have been prepared can be taught using a group discussion model. This is by the opinion [32]–[34] that the developed module must be equipped with the learning model used.

3.2. Design circle module

At the design stage, following the analysis of teacher and student needs for circle material. The circle module begins with a description of the material, and designing the objectives of the material. The module content consists of the main title, learning activities equipped with example questions, summaries, group discussion questions, and independent practice questions. In designing the circle module, it is prepared to be validated by material experts and mathematics teachers. In validating this module, material experts are asked to provide input and validate the feasibility of the module that has been designed. Material expert validation lasted for 5 weeks. The validation results from material experts obtained a percentage of all aspects of 88.29% with very good interpretation. This interpretation means that the circle module is worthy of being tested on students. Before testing it on students, the research also gave the circle module to high school mathematics teachers to validate and assess all aspects of the module. Mathematics teacher validation lasted for 4 weeks. The mathematics teacher gave a score in the last revision of 90.45%. The score given by the mathematics teacher to the circle module product is in the very good category. It is recommended that modules that have been validated be tested on students by providing the module as a learning aid for circle material. Improving learning outcomes cannot be separated from module tools that have been validated by experts and teachers in their fields [35], [36].

3.3. Development circle module

At this development stage, researchers tested the circle material module product on students. The first stage of testing was carried out on students on a small scale. This trial was run for 4 weeks. Researchers teach circle material by providing circle modules as an aid to the learning process. After the learning process was completed for 4 weeks, this research gave an exam in the form of circle test questions, these questions were taken from the textbook that students had been using in the learning process. As a result, the average classical score obtained by students was 86.78 and this score was above the specified standard, namely 70. At this small group trial stage, the research also provided instruments for students to assess the modules they had used. There were 93.50% scores given by students with very good interpretation. This can be interpreted that the mathematics module on circle material can help students understand circle material and the module can improve student learning outcomes. This increase in student learning outcomes is in line with this opinion [37], [38] that modules are designed and provided to assist students in understanding the material improve learning outcomes and are more independent in obtaining results.

3.4. Implementation

At the large group trial stage, this research taught circle material to students with the help of modules and a small group discussion model. There are two classes where circle material is taught, one class is taught with the help of the circle module and the other class is taught circle material without the help of the module. The two classes are class 10B which is given modules, and class 10C is not given modules. Before teaching circle material, pre-test questions were first given to both classes. Class 10C pre-test results with an average of 38 and class 10B with an average of 32. Class 10B which obtained the lowest average score in the pre-test was taught and given the circle module as a learning aid, while class 10C was taught the material circle but not given the circle module. The learning process for circle material in both classes was 4 weeks and ran smoothly according to the small group discussion learning model. At the final stage of learning, the researcher gave a test to the two classes that had been taught to measure the post-test. The results obtained, for classes that use the circle module, get an average score of 87.50 and for classes that do not use the module, they get an average score of 64. This is by the opinion [39]–[41] that students who are assisted by modules will have better learning outcomes than students who are not assisted by modules.

3.5. Evaluation

The evaluation results show that the average difference between the test results of students who use the circle module and the learning results of students who do not use the module is 23.50. From the results of the analysis during the implementation of circle material learning, the learning process shows that students who were not given the module experienced problems and this resulted in difficulty in solving questions. Meanwhile, when students are given the module when they encounter obstacles and difficulties in circle problems, students can see the module as a learning aid. The module evaluation results distributed to small group students were 93.50%, and large group students were 92.10%. The difference in learning outcomes obtained by students during the post-test shows that there is a significant difference between students who were assisted by the module and students who were not assisted by the module. In terms of improving the learning outcomes of students who use the circle module during learning, students who are assisted by the module experience a significant increase. In the pre-test class 10B obtained an average score of 32 and in the post-test an average of 87.50. This finding is a fairly high increase with an average difference of 55.50.

3.6. Discussion

3.6.1. The circle module form is equipped with a small group discussion model

The shape of the circle material math module produced in the final stage. This module has gone through a validation process from material experts, math teachers, students during small group trials, and students during trials in larger groups. The results obtained fall into the very good category. This module is also able to significantly improve learning outcomes and has a much better difference than the learning outcomes of students who do not use this circle module. This finding is in line with the opinion [41], [44] mathematics material that is prepared, assessed, and tested has a positive impact on understanding and improving student learning outcomes.

3.6.2. The practicality and effectiveness of the circle module

The practicality and effectiveness of the module show high scores and excellent interpretation. The material expert gave an average score for all module components of 88.29%, the mathematics teacher gave a score of 90.45%, the score of the small group students was 93.50% and the score of the large group students was 92.10%. The effectiveness of the circle module is measured by learning outcomes. Student learning outcomes during the post-test for class 10 B were 87.50 and class 10 C was 64. Students who were given the circle module during learning scored much higher than students who were not given the module. This difference can be seen from the average score for the two classes of 23.50.

3.6.3. The results of the evaluation of the circle material mathematics module

The evaluation results show that the difference in test scores between students who use the circle module and students who do not use the module is 23.50. The results of the analysis during the learning process show that students who were not given the module experienced problems when repeating the examples taught, while students who were given the module when they experienced problems could see the module as a tool. The evaluation results of the instruments distributed to material experts, teachers, small-group students, and large-group students were interpreted as very good. A comparison of the learning outcomes obtained by students in the post-module shows that there is a significant difference between students who were taught circle material with the help of the module and students who were not helped with the module. In terms of improving learning outcomes, students who were guided using the circle module experienced significant improvements. In the pre-test class 10B got an average score of 32 and in the post-test, they got an average score of 87.50. In this case, there was a significant increase of 55.50.

4. CONCLUSION

One new product was found, namely the derivative module which was equipped with a cooperative learning model that had been developed and was suitable for use as a supporting tool for the process of learning mathematics in derivative material at the high school level. The circle module equipped with the small group discussion model received a high average score for all indicators and module components. The assessment is given by material experts, mathematics teachers, and students and is in the very good category. In small group trials, the score given by students was 93.50% and the score given by students during trials on a larger scale was 92.10% in the very good category. Research has positive implications for mathematics learning, especially in circle material. The assessors said that this circle module was very good in terms of the language of presenting the module, contraction of the module, example questions that were easy for students to understand, and the learning model used was exactly as expected by teachers and students. The advantage of this circle module is that the module has been tested on students and the average score obtained is very good with a score of 87.50. The average student score shows that the circle module that has been prepared can be understood and can improve student learning outcomes significantly. The weakness of this research is that the resulting module product has only been tested at the Bekasi 11 State School and has not been tested on a mass scale.

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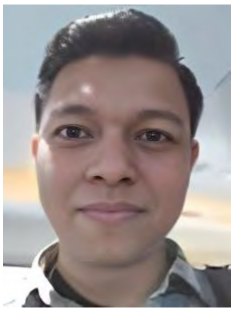

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