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The effectiveness of the logarithm module equipped with a Jigsaw-type cooperative model in improving learning outcomes

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ABSTRACT

The teacher's job is to prepare learning plans, create modules, implement, assess, and evaluate. The fact that teachers don't have modules yet. As a result, the mean logarithmic learning outcome of 74.80 is below the standard of 75. It is urgent to research because there is a gap between theory, expectations, and reality. The aim is to produce a logarithmic module equipped with an effective jigsaw cooperative model. The method is the research and development (R&D), analysis, design, development, implementation, and evaluation (ADDIE) model. There were 32 high school subjects. Data collection techniques using needs analysis instruments, and assessment instruments for material experts, teachers, and students. Collect student pre-test and post-test data. Analysis technique by calculating the mean of all module components, the mean of pre-test and post-test, and interpretation of each module component. As a result, the mean scores of material experts, teachers, and students were obtained at 92.35%, 91.45%, and 95.81% in the very good category. It was found that the mean learning outcomes of students who used the module were 90.28 and the mean of students who did not use the module was 68.40, with a difference of 25.48. In conclusion, the logarithm module is practical, and effective, and can improve student learning outcomes significantly.

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1. INTRODUCTION

Schools hope that mathematics teachers ensure that students understand all mathematics material and obtain good learning outcomes [1]. The task of teachers in schools is to prepare learning implementation plans, compose modules, implement, assess, and carry out learning evaluations [2]. However, the fact is that many students have difficulty understanding mathematics material and their learning outcomes are below the minimum completeness standard [3]. The low mathematics learning outcomes are because many teachers do not develop teaching modules, so the learning process is less effective [4]. Another factor is that the learning model used is not appropriate [5]. In senior high school, there is a lot of math material that is considered difficult by students namely logarithms, integrals, trigonometry, derivatives, exponents, and trigonometry [6]. The results of observations in high school in 2022 are a minimum mean logarithmic score of 74.80 with a passing standard of 75.

Another fact, in analyzing the needs of high school mathematics teachers, is the need for a logarithm module because so far, a logarithm module has never been created and still relies on textbooks. Meanwhile, the textbooks used do not match the learning model. The logarithm material in textbooks is too difficult for students to understand so the model used is also less effective. Teachers hope that the logarithm module can improve student learning outcomes. Analysis of student needs also shows that there are teaching modules with the hope of presenting material that is easier to understand. Preparing modules is one of the most appropriate ways to overcome students' difficulties in obtaining mathematics learning outcomes [7]. The role of modules is very vital in helping students learn independently and in groups [8]. The compiled module must be equipped with a learning model [9]. The learning model that is suitable for logarithmic material is the jigsaw cooperative learning model [10]. The jigsaw cooperative model is a learning model that is often used in high schools in conveying mathematics material [11]. The advantage of the jigsaw cooperative learning model lies in the grouping of group discussion questions and independent practice questions [12], [13]. There is a gap between theory, expectations, and reality in the field with low student learning outcomes, so it is urgent to create a logarithm module as a solution to overcome the problems experienced by teachers and students. The research aims to produce a mathematics module on logarithm material equipped with the cooperative-type jigsaw model, to produce a module of practicality, and effectiveness, and to evaluate students' interest in learning logarithm material with the help of the jigsaw-type cooperative module and model.

2. RESEARCH METHOD

This research uses the analysis, design, development, implementation, and evaluation (ADDIE) research and development (R&D) method, namely analysis, design, development, implementation and evaluation [14]. The subjects were class X Senior High School 7 Bekasi, totaling 32 students. The instrument used as a product measuring tool has been validated and tested for reliability, the number of respondents who met $n = 2$, and the results were declared valid and reliable with a value of $\alpha = 0.05$ (one side), effect $size = 0.15$ (medium), and actual instrument power (medium) actual power or $1-\beta$ inferential statistical test value 0.95. The instrument used in this research was declared valid, normal homogeneous, and suitable for use as a research measuring tool and suitable for distribution as a measuring tool [15], in Figure 1 research flow.

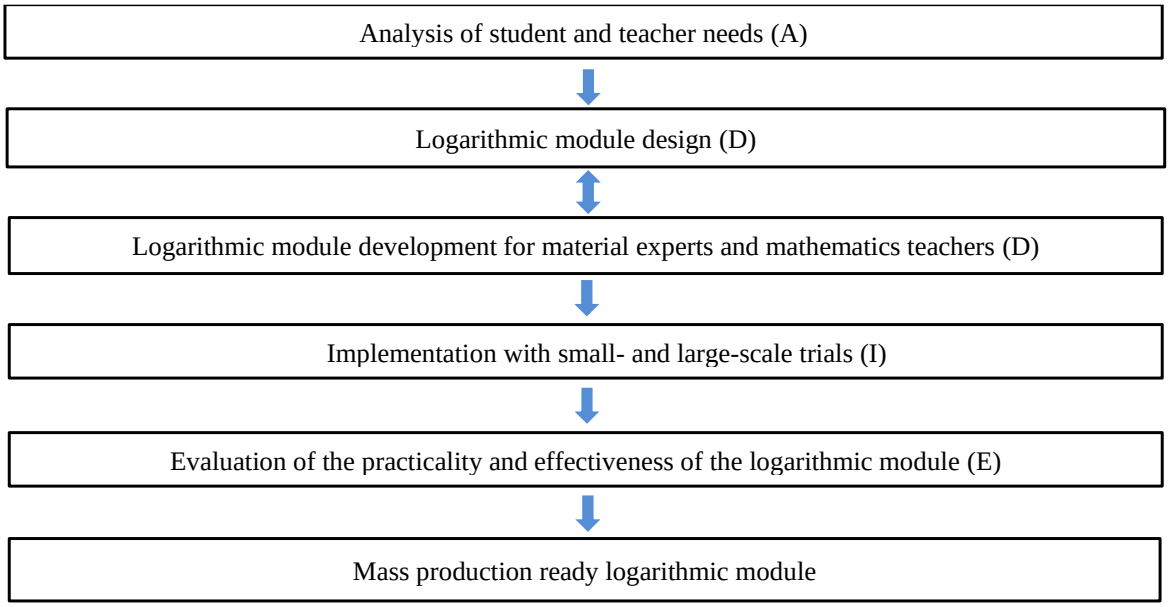

Figure 1. Logarithmic module development flow

Data collection techniques, the initial stage of analyzing student and teacher needs. The second stage is designing a logarithm module equipped with the jigsaw cooperative model. The third stage of developing the logarithm module. At this development stage, the researcher gave the logarithm module product to two material experts and three mathematics teachers assessed and provided input on the module that had been

designed. Figure 1 shows that the module was not tested on students before the module was declared valid and appropriate by material experts and mathematics teachers. Material experts and mathematics teachers were given instruments as tools to measure the feasibility of the logarithm module. The fourth stage is the implementation of the logarithm module by testing students on a small scale and testing on a large scale. The number of students on a small scale is ten students and the number of students on a large scale is 32 people. Samples were selected randomly from various classes. In selecting good samples in product trials, it is best to use random sample selection [16]. In small-scale trials, data, information, and assessment of module instruments are provided as a basis for improving the logarithm module. Next is a large-scale trial. Before implementing the logarithm module, a pre-test was given to measure the abilities of both classes. Next, the lesson teaches logarithm material with different treatments, one class is given the logarithm module and the other class is not given the module. At the end of the lesson, the researcher gave a post-test to both classes and provided module assessment instruments and learning interest instruments.

Data analysis technique by calculating the mean. Needs analysis data is presented in the form of a bar chart. Then the instrument assessment is the mean. The instrument is rated based on a 1-5 Likert scale. This instrument is also equipped with a logarithm module assessment rubric that is valid and reliable. Table 1 shows the value that must be given by material experts, mathematics teachers, and students. Meanwhile, Table 2 shows a valid interpretation and feasibility of the logarithm module based on the total score [17].

$$\text{PS} = \frac{\text{ATV}}{\text{MV}} \text{x } 100\% \quad (1)$$

Information: PS=Percentage of success (%); ATV=Accumulated total value; and MV=Maximum value. The data obtained in Table 1 is then measured by the interpretation of the score as in Table 2:

Table 1. Assessment of module instruments [18]

Score weight	Alternative Answers
5	Very good
4	Good
3	Enough
2	Not good
1	Not very good

Table 2. Module interpretation

Interpretation	Presentation (%)
Not very good	0-19
Not good	20-39
Enough	40-59
Good	60-79
Very good	80-100

The practicality of the module is measured by student assessment instruments and effectiveness is measured by students' classical learning completion during the post-test and the difference in post-test scores of students who use the logarithm module and students who do not use the logarithm module [19]. Table 3 shows a measuring tool for assessing student learning outcomes and interpretation of the total score.

$$\text{MCTS} = \frac{\text{TSO}}{\text{MS}} \text{x } 100\% \quad (2)$$

Information: MCTS=Mean classical total score; TSO=Total score obtained; and MS=Maximum score.

Table 3. Interpretation of classical completeness [20]

Interpretation	Presentation (%)
Not very good	0-20
Not good	21-41
Enough	42-62
Good	63-83
Very good	84-100

3. DISCUSSION AND CONCLUSION

The research results show that the mathematics module on logarithm material equipped with the cooperative-type jigsaw model has been proven to be practical and effective in assisting the learning process and improving student learning outcomes. The findings in this study are in line with previous research [21], [22]. The module developed must be validated, tested for practicality, and tested for effectiveness.

3.1. Needs analysis

The following are the results of the analysis of student needs. In Figure 2, it can be seen that out of 32 students, 24 students had difficulty with logarithm material. This finding is in line with this opinion [23], [24] the material that must be developed is difficult. Figure 3 shows that 14 students disagree with and 1 person strongly disagrees. Figure 4 shows that 56.25% of students have difficulty understanding the model in the material used. Figure 5 shows as many as 26 students whose learning outcomes in logarithm material are below the passing standard. The low student learning outcomes are caused by models and methods, and Figure 6 shows that as many as 30 students are expecting logarithmic modules that are equipped with models and methods. The teacher needs analysis. The results of interviews with coding researchers are as in Table 4. In the students' pre-test, the mean score obtained was 34.21, while the standard for completing logarithm material was 75.

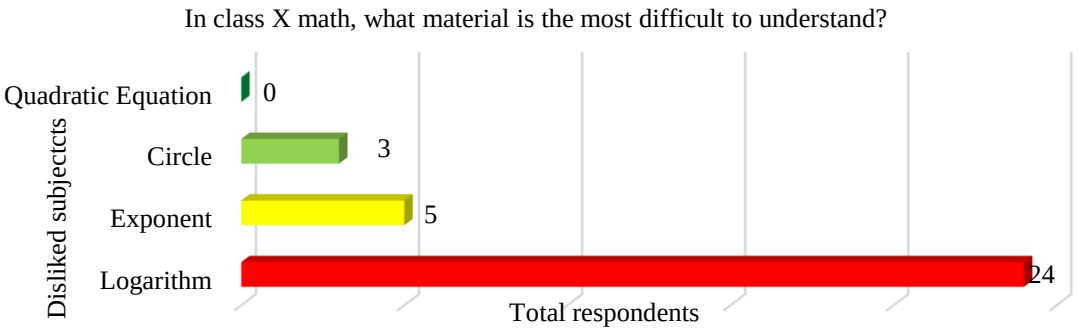

Figure 2. Material considered difficult

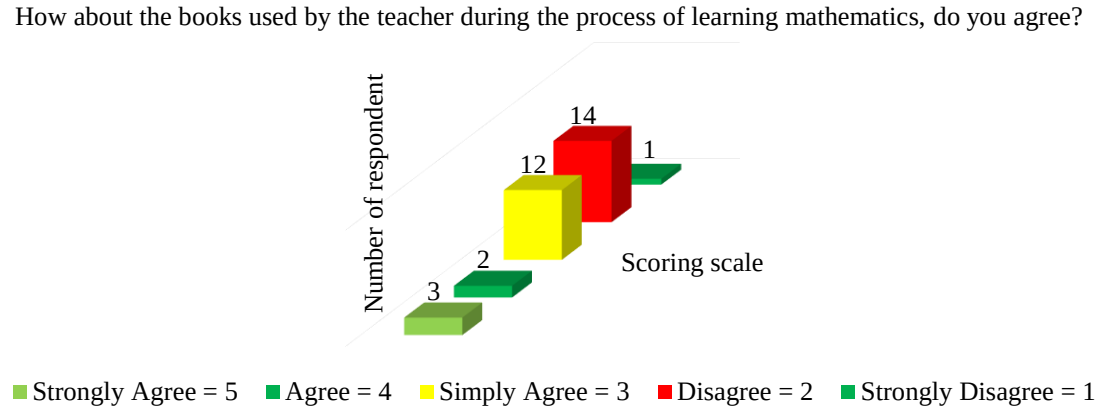

Figure 3. The books given did not meet the expectations of the students

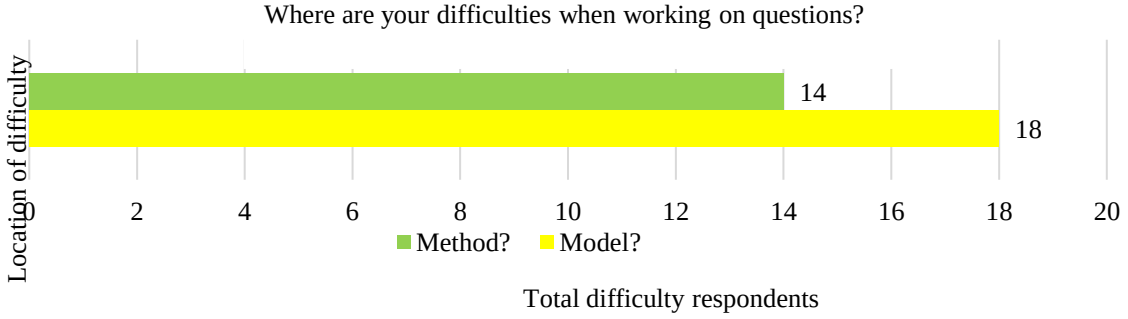

Figure 4. Location of student difficulties

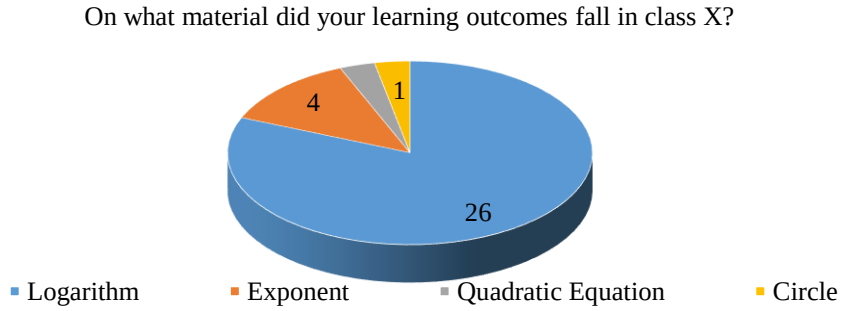

Figure 5. Low material learning outcomes

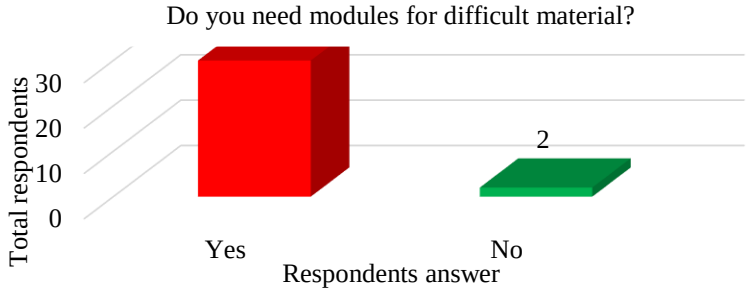

Figure 6. Number of students who need modules

Table 4. Results of needs analysis through interviews with teachers

Teacher Answer	Research Questions and Teacher Answers				
	1	2	3	4	5
	What do you think about the books students are currently using?"	Have you prepared material modules that are considered difficult by your students?	Do you need to make modules that are on the difficulties and low learning outcomes of your students?	Do you use learning models when teaching?	What material do you need to make the capital?
Teacher 1	The level of difficulty is high	Never	Yes	The learning model used when teaching mathematics so far is the cooperative model	Logarithm
Teacher 2	Still far from expectations	Never	Yes	Using a cooperative model	Logarithm
Teacher 3	Still needs to be rearranged	Never	Yes	Using a cooperative model	Logarithm
Teacher 4	Still needs to be rearranged	Never	Yes	Using a cooperative model	Exponent

3.2. Design

This research designed a logarithm module using the Jigsaw cooperative learning model. It was equipped with material, and example questions that were easy to understand and by the analysis of students' needs. This module is also accompanied by practice questions that can be done in groups according to the Jigsaw cooperative model and at the final stage of the module content there are practice questions that can be done independently.

3.3. Development

The material expert requested for module validation is the mathematics coordinator. The module has been assessed as appropriate and valid by material experts followed by validation by mathematics teachers. The following is Table 5 which shows the validation results before and after the revision of the logarithm module.

Table 5. Logarithmic module development results

Logarithmic module before validation	Weeks	Logarithmic module after validation
https://shorturl.at/bXJak	1	https://shorturl.at/cT7Zh
https://shorturl.at/2CGfR	2	https://shorturl.at/w3ukp
https://shorturl.at/2CGfR	3	https://shorturl.at/2UDzK
https://shorturl.at/XMszf	4	https://shorturl.at/MW0Qg
https://shorturl.at/XMszf	5	https://shorturl.at/2CYDu

In Table 6, the material expert assessment for the module component indicators is 92.22% with a very good interpretation. The module is suitable for testing on a small scale, for the construction indicator the value is 90.50% with very good interpretation, for the accuracy and conformity indicator 92.48% with very good interpretation, for the presentation indicator it is 94.45%. The mean value of all components of the material expert assessment is 93.60% in the very good category and is suitable for testing.

Table 6. Results of material expert validation instrument assessment

Number	Indicator	Presentation (%)	Category
1	Module Components	92.22	Very Good
2	Construction	90.50	Very Good
3	Suitability	92.48	Very Good
4	Presentation	94.45	Very Good
Average		92.35	Very Good

In Table 7 Indicators of module content feasibility, the mean value is 92.55%, and the module language design indicator is 92.44%. The module design method indicator is 93.44%. In sub-material indicators 90.45%. On contextual indicators 90.30%. The mean value of all indicators is 91.45% in the very good category. This value shows that the logarithm module equipped with the cooperative jigsaw is very suitable for use.

Table 7. Recapitulation of the results of the mathematics teacher validation instrument assessment

Number	Indicator	Presentations (%)	Category
1	Eligibility of Module Content	92.55	Very Good
2	Writing Language Design	92.44	Very Good
3	Design Method	93.44	Very Good
4	Contextual	90.45	Very Good
5	Evaluation Instrument	90.30	Very Good
Average		91.45	Very Good

3.4. Implementation

Implementation of small group trials. The mean post-test score of small group students after the learning process was completed was 89.10, in the very good category because it was above the standard of 75. Then continued with large-scale trials. Before the learning process took place, the researcher first gave pre-test questions. In Figure 7, of the 32 students who took the post-test, a mean score of 90.28 was obtained in the very good category. This module has a positive impact on student's progress in learning. The pre-test and post-test scores also showed a very significant increase, the pre-test mean was 34.21 and the post-test mean was 90.28 post-test with a difference of 56.07.

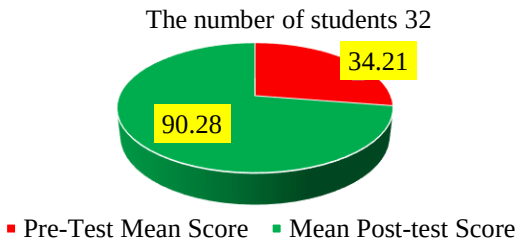

Figure 7. Comparison of pre-test and post-test results on logarithmic material

3.5. Assessment and evaluation

In Table 8, students rated the instrument for all module indicators as very good with a total mean score of 95.81%. Figure 8 shows that students' interest in studying the logarithm module is very high. Figure 9 shows that there is a significant difference between the class of students who use the logarithm module and the class of students who do not use the logarithm module.

Table 8. Recapitulation of large-group student assessments of the logarithmic module instrument

Number	Indicator	Presentations (%)	Category
1	Module Components	95.31	Very Good
2	Chart	97.18	Very Good
3	Presentation	93.58	Very Good
4	Module Writing Language	97.20	Very Good
	Average	95.817	Very Good

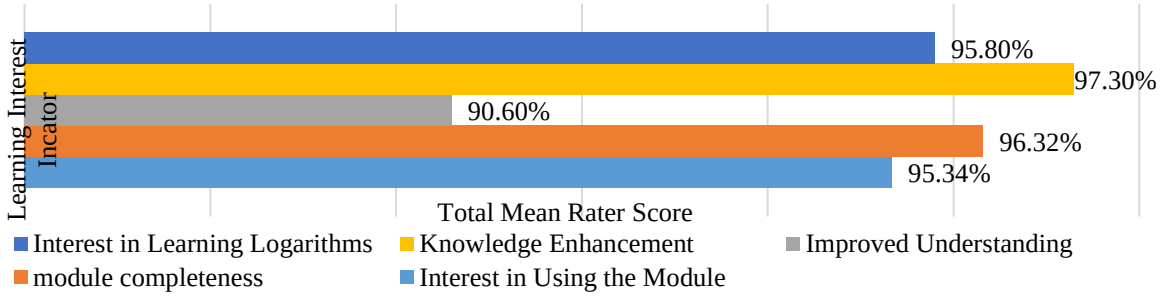

Figure 8. Learning interest assessment

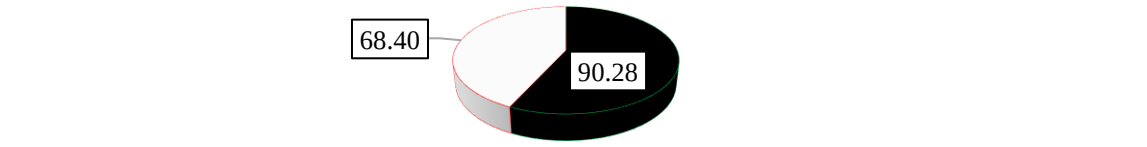

Figure 9. Learning outcomes of students who use and do not use the logarithmic module

3.6. The form of the logarithmic math module material is equipped with the cooperative jigsaw model

It was found that the concepts and forms of mathematics modules on logarithms were easier for students to understand. This finding is in line with the research results [25] To improve students' understanding and knowledge, teachers must have modules designed and validated by experts. This logarithm module has been validated for one month by mathematicians and mathematics teachers. In the designed module, many changes were found during validation. Material experts and teachers asked to change the material concept, suggesting that examples of questions be created for each sub-material, to make it easier for students to understand question literacy. The teacher also provides input on the learning model used, namely cooperative type jigsaw, and provides suggestions for revising the questions used as practice questions in the form of discussions and adapting them to the model. This finding is in line with previous findings that the questions developed must be adapted to the model used [26]. The mean validation value from experts and mathematics teachers for all module indicators is 92.35% and 91.45% with very good interpretation for use as a tool for the mathematics learning process on logarithm material.

3.7. Logarithmic module practicality

The logarithm mathematics module developed in this research is very practical. Based on Table 6, validation of mathematics material experts gave an assessment of all module components and methods used, a mean of 92.35% with very good interpretation. It was found that the validation results for mathematics teachers in Table 7 were very good, with a mean of 91.45% for all components with very good interpretation. The score given by students for module component indicators was 97.30%, concept indicators were 90.11%,

material presentation methods were 92.44%, and language design was 90.88%. All components of this module are considered to be in the very good category and are very practical in the process of learning logarithm mathematics. This finding is in line with [27] The module developed is said to be practical if it is assessed as very good by experts, teachers, and students.

3.8. The effectiveness of the logarithmic module

The mathematical module on logarithms developed was found to be practical, effective, and able to improve learning outcomes. The learning outcomes obtained by students were a mean of 90.28. Even though the score previously obtained using the module had a mean of 34.21 with a difference between the pre-test and post-test of 56.07. This confirms that modules developed with the correct development process can improve student learning outcomes significantly [28]. The process of applying logarithm material was carried out in both classes. One class uses the logarithm module and one class does not use the logarithm module. The mean score obtained by the class that did not use the module was 64.80, while the mean for students who were given the logarithm module was 90.28. The mean difference between students who use the module and those who do not use the module is 25.48. By discovering this logarithm module, teachers can use it as a basis and alternative in overcoming students' difficulties with logarithm material. In this study, students assessed that all components were considered very well. The finding is that the logarithm module equipped with the cooperative-type jigsaw model is very effective in binding understanding. This is in line with previous development research which stated that the product was effective if it was also equipped with a model [29].

3.9. Students' interest in learning mathematics in logarithmic material

Findings on learning outcomes were obtained by small group students with a mean of 89.10. A high mean value indicates that students' interest in studying logarithm material with the help of the module is very high. This finding is in line with the opinion [30] that modules that are well-designed and go through a correct validation process can increase student interest in learning. From Figure 7 you can see the students' responses to the interesting instrument. It was found that 95.80% of students were interested in logarithm material, 97.30% increased student knowledge, 90.60% increased understanding, 96.32% mastery of module material, and 95.34% student interest in using the module. Students' interest in learning mathematics in logarithm material is very good if assisted by using the logarithm module. The jigsaw-type cooperative model used in the module is also able to improve students' understanding and knowledge well, this can be seen in Figure 7, 90.60% of the jigsaw-type cooperative model can increase students' knowledge and understanding of logarithm material. [31] that the model developed in the module must be able to increase students' knowledge and understanding.

4. CONCLUSION

This research concludes that the mathematics module on logarithms is practical, and effective and can increase understanding, and knowledge and improve student learning outcomes. Validation by material experts and mathematics teachers gave very good ratings. The product has been tested on students in small groups and large groups. Student assessment of the module instrument with interpretation is in the very good category. The learning outcomes obtained by students are also quite high. The mean difference is very significant between students who use the logarithm module and students who do not use the logarithm module during the learning process with a mean of 25.48. The high difference in mean learning outcomes in the two classes confirms that the module developed in this research can be used as a tool to streamline the learning process, increase understanding, and improve learning outcomes. The research implies that the module has been used by teachers to assist the learning process. The weakness of this research is that the product has not been tested on a mass scale. Experimental research of larger quantities is needed before mass production.

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