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DEVELOPMENTS OF MATHEMATICS LEARNING STRATEGY MODULES TO ENHANCE MOTIVATION AND HIGHER-ORDER THINKING SKILLS FOR STUDENTS AT UIN SYAHADA PADANGSIDIMPUAN

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Abstract

This study aimed to develop a mathematics learning strategy module to enhance students' motivation and higher-order thinking skills using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) framework within the Research and Development (R&D) paradigm. Conducted during the even semester of the 2022/2023 academic year, it involved fourth-semester students in the Mathematics Education Program at UIN Syahada Padangsidimpuan. Quantitative and qualitative data were collected through interviews, observations, questionnaires, tests, and expert validation. Instruments included a module validation sheet, a learning motivation questionnaire, and a higher-order thinking skills test. Data were analyzed using the Paired Samples Test. Results showed the module was well-implemented, with validation scores of 87.86% and 86.01%, categorized as "good." The module effectively improved students' motivation and higher-order thinking skills, with pretest and posttest scores of 52.38 and 79.19 (motivation) and 72.81 and 79.75 (higher-order thinking skills), both with significant improvements (sig. 0.000 < 0.05). This research recommends further implementation and development of the module using the ADDIE framework for enhancing mathematics learning strategies.

Keywords: mathematics learning; strategy module; motivation; higher-order skills

Abstrak

Penelitian ini bertujuan untuk mengembangkan modul strategi pembelajaran matematika guna meningkatkan motivasi dan keterampilan berpikir tingkat tinggi siswa menggunakan kerangka ADDIE (Analysis, Design, Development, Implementation, and Evaluation) dalam paradigma Penelitian dan Pengembangan (R&D). Penelitian dilakukan pada semester genap tahun akademik 2022/2023 dengan melibatkan mahasiswa semester empat Program Studi Pendidikan Matematika di UIN Syahada Padangsidimpuan. Data kuantitatif dan kualitatif dikumpulkan melalui wawancara, observasi, kuesioner, tes, dan validasi ahli. Instrumen yang digunakan termasuk lembar validasi modul, kuesioner motivasi belajar, dan tes keterampilan berpikir tingkat tinggi. Data dianalisis menggunakan Uji Sampel Berpasangan. Hasil penelitian menunjukkan bahwa modul diimplementasikan dengan baik, dengan skor validasi 87,86% dan 86,01% dalam kategori "baik". Modul ini efektif meningkatkan motivasi dan keterampilan berpikir tingkat tinggi siswa, dengan skor pretest dan posttest masing-masing 52,38 dan 79,19 (motivasi) serta 72,81 dan 79,75 (keterampilan berpikir tingkat tinggi), keduanya menunjukkan peningkatan signifikan (sig. 0.000 < 0.05). Penelitian ini merekomendasikan implementasi lebih lanjut dan pengembangan modul menggunakan kerangka ADDIE untuk meningkatkan strategi pembelajaran matematika.

***Kata kunci**: pembelajaran matematika; strategi modul; motivasi; keterampilan berpikir tingkat tinggi*

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Introduction

The education sector is advancing rapidly and every individual is expected to have adequate competence, attitude, and skills to compete in the global world (Mota & Cilento, 2020). Individuals with global competence experience a distinct advantage in the competitive landscape, particularly within the field of employment. According to Daskalovska et al. (2012), strong motivation should be ingrained in individuals, such as students to possess adequate abilities. Therefore, every students needs to have learning motivation as the foundation for attaining quality learning achievement or outcomes.

Motivation is a fundamental element needed by students in learning process (Jufrida et al., 2019; Kuswanto & Anderson, 2021; Tambunan et al., 2021; Tanti et al., 2020). The variable is the driving force within students that initiates learning activities and enables the attainment of objectives (Daskalovska et al., 2012; Özdemir, 2020; Gunobgunob-Mirasol, 2019). Furthermore, learning motivation is perceived as the drive to learn or engage in learning activities (Amin et al., 2022; Chue & Nie, 2016; Malkoc & Dal, 2021). This concept can also be defined as the inclination to apply cognitive and affective schemas to enhance outcomes (McGrew, 2022). Motivation assumes a crucial function in the context of learning, determining the level of intensity in students' efforts (Jufrida et al., 2019; Trigueros et al., 2020; Zulherman et al., 2023). Furthermore, it possesses the capacity to stimulate students toward learning, fostering effective processes that elevate academic achievements (Filgona et al., 2020). The concept can foster an optimistic attitude during learning process (McGrew, 2022) and higher-order thinking skills are also a significant factor influencing achievement.

Higher-order thinking skills are defined as critical and creative abilities to solve a problem. Individuals with these skills should be able to analyze, connect, break down, and interpret problems to obtain new solutions or ideas (Hujjatusnaini et al., 2022; Maryani et al., 2022; Yerimadesi et al., 2023). This concept transcends mere verbal memorization, including analytical, synthetic, and associative thinking, the formulation of conclusions, as well as the generation of creative and productive ideas (Azid et al., 2022; Afikah et al., 2022; Darling-Hammond et al., 2020; Setiawan et al., 2021).

A supportive aspect to ensure a smooth lecture is the availability of adequate facilities, specifically printed textbooks. In addition, books play a crucial role as learning media and a communication tool to convey important information to students (Nalantha et al., 2018; Suwartini et al., 2022; Rahmat & Yahya, 2022). Teaching materials serve as guidelines that direct all students activities in learning process and represent the competence substance learned by students (Hartini et al., 2018; Khoiriah et al., 2016; Ramdani et al., 2021; Rochman et al., 2017; Widarti et al., 2020). Therefore, books are essential to support understanding, improve reading interest, and enhance independence in students. The observed phenomenon indicates that textbooks concerning mathematics learning strategy, lack distinctiveness and are synonymous with general learning textbooks. The concepts are predominantly focused on general learning, while mathematics learning strategy should be consistent with the characteristics of the subject. Additionally, the content is primarily dominated by detailed conceptual, theoretical, and memorization-based material descriptions.

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Based on preliminary study in mathematics Education Study Program at Syahada Padangsidimpuan State Islamic University, students have limited mastery of this course and the teaching materials cannot be considered effective. This lack of mastery influences students when attending Learning Design and Micro Teaching courses. Many individuals struggle to understand mathematics Learning Strategy course due to insufficient and inadequate teaching materials to support the lecture process. Therefore, these issues can be addressed by developing teaching materials such as module to assist lecturers and students in learning.

Module is an important component in learning because it can help students obtain important information about learning materials. The existence of mathematics module that is made in easy language to understand, and interesting language, makes it easier for students to understand the concepts contained in the material that they must master. The mathematics module is expected to be useful in making it easier for students to learn and also make it easier for lecturers/teachers to implement mathematics learning. Therefore, it is necessary to develop a mathematics module that can help students to be able to learn independently.

There are already many learning modules, but they are still common. In this context, module to be designed specifically for mathematics learning strategy module based on the constructivism as part of cognitive theory. The constructivism builds knowledge originating from external sources and constructed by students. The theory views that thinking, reasoning, and problem-solving skills can occur when carried out independently, discovering and constructing knowledge. Lecture conducted in the constructivism is believed to be more meaningful, making the constructivism-based mathematics learning strategy module highly necessary. Considering these challenges, a proposed solution includes the creation of instructional materials explicitly designed to facilitate and train students. This method enhances their motivation and nurtures the development of higher-order thinking skills within mathematics Learning Strategy course.

Based on the problem above, the novelty of the module developed in this research is that this module is a mathematics learning strategy module. Thus, the objectives of this research are (1) to produce a valid and practical mathematics learning strategy module for mathematics education students and (2) to describe the validity and practicality of the mathematics learning strategy module on motivation and high-level thinking ability of students.

Method

This study was categorized as Research and Development (R&D) using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model. The ADDIE model was chosen because the development process was systematic, effective, efficient and interactive so that the evaluation results of each phase of development were obtained. The model was suitable and consistent with the characteristics of developing module and other manipulative materials (Ilhamuddin, 2019). The development of the mathematics learning strategy module was carried out through several stages, namely (1) Analysis. Before proceeding with module development, the first stage was analysis conducted as part of the initial observation. The process included assessing the needs of lecturers and students regarding the developed module. The analysis of students' needs was conducted to understand their cognitive development in problem-solving and enhance their

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learning motivation. (2) Design. The activities in this stage included creating module needs map, determining module structure, preparing study instruments, and validation by experts. (3) Development. The activities included module writing and validation by material and media experts. (4) Implementation. This stage tested the developed module on fourth-semester students in mathematics Education Study Program at Syahada Padangsidimpuan State Islamic University. (5) Evaluation. This stage assessed the quality of the developed module based on content feasibility, presentation, and language. Additionally, it analyzed the effectiveness of module in enhancing motivation and higher-order thinking skills of students.

The study was conducted in the second semester of the academic year 2022/2023, from January to June 2023. The data obtained were both quantitative and qualitative, collected using techniques such as interviews, observations, questionnaires, tests, and validation by material and media experts. The instruments included module validation sheet, learning motivation questionnaire, and a test of students' higher-order thinking skills to measure validity, effectiveness, and practicality.

Observations were also conducted to obtain necessary data for the needs analysis, providing a factual overview of the needs during ongoing learning sessions. Furthermore, the questionnaires were distributed to 16 fourth-semester students in mathematics Education Study Program at Syahada Padangsidimpuan State Islamic University. Students' needs regarding the learning strategy module were identified. The questionnaires included statements concerning the indicators of learning motivation, while the tests comprised open-ended questions adapted to the indicators of higher-order thinking skills, such as seeking answers, analyzing, and drawing conclusions.

Results and Discussion

Results

The development of the mathematics learning strategy module includes 5 stages of the ADDIE model. In the analysis stage, data are obtained through interviews with lecturers and a literature review of journals. The results show various issues in the classroom learning implementation, including learning process not proceeding as intended due to failure to integrate subjects according to established principles and conducting activities in line with real-life situations. Generally, classroom learning only implements lower-order thinking aspects such as remembering, understanding, and applying. Higher-order thinking aspects like analyzing, synthesizing, and evaluating are rarely applied. Students are only given materials without learning variations such as forming small groups to design a project. This method can enhance critical thinking, creative thinking, problem-solving, decision-making, or higher-order thinking skills. Based on the analysis, students struggle with solving mathematics problem. A suitable step is to create the mathematics learning strategy module.

In the design stage, activities are conducted based on the analysis to design module and assessment instruments. These include mapping module's needs and content, determining the structure, preparing assessment and study instruments, as well as validation by experts. The design plan for the mathematics learning strategy module is outlined as follows. In the development stage, the focus is on developing module and assessment instruments in the form of stimulating questions

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to encourage higher-order thinking processes. The aspects considered are: 1) module should encourage students to develop their reasoning abilities and evaluate the problems in the field, and 2) teaching materials should stimulate thinking processes to create and consider alternative answers to each problem. These aspects formed the basis for developing the mathematics learning strategy module as the characteristic of higher-order thinking skills (HOTS). After development, module needs to be validated to assess its feasibility and should be declared valid before proceeding to the study. The summary of validation results by experts is presented in Figures 1 and 2.

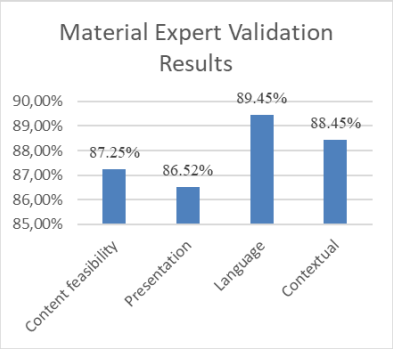

Figure 1. Material Expert Validation Results

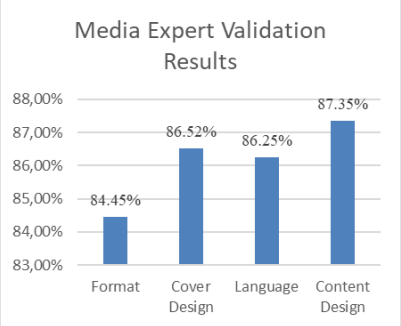

Figure 2. Media Expert Validation Results

Based on Figure 1, mathematics learning strategy module is validated by validator I regarding the material aspects, including content feasibility, presentation, language, and context at 87.25%, 86.52%, 89.25%, and 88.45% with a total mean value of 87.86% in highly feasible category. Based on Figure 2, mathematics learning strategy module is validated by validator II regarding the media aspects, including format, cover design, and content design at 84.45%, 86.25%, and 87.35% with a total mean value of 86.01% in highly feasible category.

Mathematics learning strategy module is quite good and the concepts are presented in a well-structured manner to understand the material sufficiently. However, there is a deficiency in the presentation of references, requiring the inclusion of sources from the past decade. In terms of language, the sentences used should exhibit appropriateness, clarity, and ease of comprehension in the proper Indonesian language, harmonizing with the emotional maturity level of students. Regarding contextual assessment, there is a connection between the material and the current situation. An additional suggestion from the validator is to include an explanation of mathematics learning strategy compared to existing module (Figure 1). The results indicate that the design is consistent with module size standards according to ISO and the paper format since the layout is appropriate. For the cover design, the title font size should be more focused and proportional, while

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the title color needs to contrast with the background. The font used inside module should be simpler, easy to read, and attractive, and the physical appearance should capture the attention of students. As for the content design, the presentation within module is quite good. Furthermore, the content should present the meaning of the studied object in the field. It is important to convey content that engages and captivates readers, with a particular emphasis on students (Figure 2).

Based on the validation results of mathematics learning strategy module to enhance motivation and higher-order thinking skills of students at Syahada Padangsidimpuan State Islamic University, the developed module is highly valid and good. The assessment shows that module can be used with minor revisions by considering the feedback and suggestions provided to enhance its quality. The results indicate that the produced module has been tested for quality and deemed highly valid.

Based on Figures 1 and 2 regarding the opinions of validators 1 and 2, the developed module is categorized as highly feasible or valid. Therefore, the subsequent step is the trial phase. Module without the minimum criteria for being good was considered for product revision and the trial phase was carried out after declaring the developed module as valid. However, the inputs and comments from validators 1 and 2 should be used as the basis for revision. The trial was conducted with 16 fourth-semester students in mathematics Education Study Program at Syahada Padangsidimpuan State Islamic University. The mathematics learning strategy module was thoroughly applied to students for study purposes.

Evaluation is carried out to refine module after the development process, trial phase, and product study have been completed. Posttest results, measuring students' motivation and higher-order thinking skills, also contribute to the considerations for improving and refining the developed product. Figure 3 shows an evaluation of responses to the use of the mathematics learning strategy module.

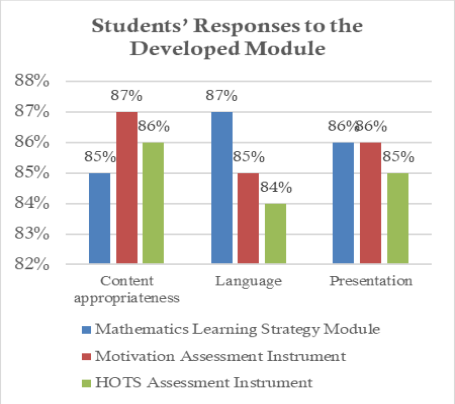

Figure 3. Students' Responses to the Developed Module

Based on Figure 3, the use of mathematics learning strategy module and the assessment instruments is equally categorized as excellent or highly feasible based on content feasibility, language, and presentation. Module is highly feasible for further development and use in mathematics education.

Module's Development from its Impact on Motivation

After the development process, students engage in learning process using module. To measure their motivation and higher-order thinking skills, motivation and higher-order thinking skills

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assessment instruments are used. However, to observe the extent of improvement in usage, an analysis is conducted on the data or values obtained by students before and after using module. The data on motivation before and after using module can be seen in the following Table 1.

Table 1. Normality Test Results for Data on Students' Learning Motivation

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Pretest of Learning Motivation	.215	16	.046	.906	16	.101
Posttest of Learning Motivation	.150	16	.200*	.943	16	.385
***. This is a lower bound of the true significance.**						
a. Lilliefors Significance Correction						

Based on Table 1, the Sig. values for pretest and posttest are 0.101 > 0.05 and 0.385 > 0.05, respectively. Therefore, the normality test for the data of pretest and posttest on learning motivation follows a normal distribution.

Table 2. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest of Learning Motivation	52.38	16	10.436	2.609
	Posttest of Learning Motivation	79.19	16	7.705	1.926

Table 2 indicates that the number of pretest and posttest data for learning motivation is 16 students, with mean values of 52.38 and 79.19, respectively. Therefore, there is a difference in the pretest and posttest mean values of the variable when using the developed module.

Table 3. Paired Samples Test

		Paired Differences			
		Mean	95% Confidence Interval of the Difference		Sig. (2-tailed)
			Lower	Upper	
Pair 1	Pretest-Posttest of Learning Motivation	-26.813	-32.251	-21.374	.000

Based on Table 3, the Sig. value (2-tailed) is 0.000 < 0.05. The decision-making basis in the Paired Samples t-test concludes that Ho is rejected and Ha is accepted. Therefore, there is a significant difference between the pretest and posttest mean values of students' learning motivation when using the developed module. Table 5 shows that the "Mean Difference" value between pretest and posttest is 26.813, calculated as 79.19-52.38 = 26.813. Furthermore, the range of this difference is -32.251 to -21.374 (95% Confidence Interval of the Difference Lower Upper).

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Module's Development from Its Impact on Students' Higher-Order Thinking Skills

To observe the extent of improvement in usage, an analysis is conducted on the data or values obtained by students before and after using module. The data on Higher-Order Thinking Skills before and after using module can be seen in the following Table 4.

Table 4. Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Pretest of Higher-Order Thinking Skills	.134	16	.200*	.960	16	.656
Posttest of Higher-Order Thinking Skills	.211	16	.055	.914	16	.133
***. This is a lower bound of the true significance.**						
a. Lilliefors Significance Correction						

Table 4 shows that the Sig. values for pretest and posttest are 0.656 > 0.05 and 0.133 > 0.05, respectively. Therefore, the normality test for the data of pretest and posttest on higher-order thinking skills using the mathematics learning strategy follows a normal distribution.

Table 5. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest of Higher-Order Thinking Skills	72.81	16	4.246	1.062
	Posttest of Higher-Order Thinking Skills	79.75	16	4.219	1.055

Based on Table 5, the number of pretest and posttest data for higher-order thinking skills is 16 students with mean values of 72.81 and 79.75, respectively. Therefore, there is a difference in the mean values of the variable when using the developed module.

Table 6. Paired Samples Test

		Paired Differences			
			95% Confidence Interval of the Difference		Sig. (2-tailed)
		Mean	Lower	Upper	
Pair 1	Pretest - Posttest of Higher-Order Thinking Skills	-6.938	-8.278	-5.597	.000

Table 6 shows that the Sig. value (2-tailed) is 0.000 < 0.05. Based on the decision-making basis in the Paired Samples t-test, Ho is rejected and Ha is accepted. Therefore, there is a significant difference between the pretest and posttest mean values of students' higher-order thinking skills when using the mathematics learning strategy module. Table 8 shows that the "Mean Difference"

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value is 6.938, calculated as 79.75-72.81 = 6.938 and the range is -8.278 to -5.597 (95% Confidence Interval of the Difference Lower Upper).

Discussion

Several aspects of higher-order thinking skills have been implemented in teaching, but the application is not optimal. Students are perceived to lack critical thinking during learning, rarely ask questions, pose low-level questions, maintain a passive theoretical stance, and struggle with data analysis. Based on the interview, experimental activities are infrequently performed, with the majority of instruction centering on mathematics problem-solving. The efforts can be supported by conducting learning activities through direct experiences (Costa, 2015; Peebles & Mendaglio, 2014; Nor et al., 2023; Tambak et al., 2022). This method has a positive impact on students, in line with Darling-Hammond et al., (2020) and Lok & Hamzah, (2021) where a more conceptually connected learning experience increases the effectiveness of the process.

The effectiveness and feasibility of this mathematics learning strategy module are attributed to the accuracy of the design in line with the fundamental needs. Therefore, learning module has been systematically designed and tailored to these needs, providing an opportunity to develop thinking skills. The desires developed are strong motivation and higher-order thinking skills. Module containing appealing illustrations, concepts, and visual examples can cultivate creative and imaginative thinking skills (Kurnianto & Haryani, 2020; Le, 2023; Rintayati et al., 2020).

This study includes several stages, with the first commencing with analyzing the needs of students in mathematics Education Study Program at Syahada Padangsidimpuan State Islamic University. The concept proceeds with the development of the mathematics learning strategy module, followed by validation, limited trial, study implementation, and data analysis. The use of module can enhance students' motivation and higher-order thinking skills. This intends to increase learning motivation and accustom students to engage in higher-order thinking, thereby equipping them with good problem-solving abilities.

The development of mathematics learning strategy module can enhance motivation and higher-order thinking skills. This is consistent with Asikin et al., (2019) and Rintayati et al., (2020) that possessing higher-order thinking skills enables individuals to learn, reason accurately, think creatively, make decisions, and solve problems. Furthermore, the variable can enhance various competencies, such as problem-solving abilities. This theory is in line with Albay (2019) that students can distinguish ideas or concepts clearly, argue effectively, solve problems, construct explanations, hypothesize, and understand complex matters through higher-order thinking skills. Based on these opinions, problem-solving abilities can be nurtured by designing learning using the mathematics learning strategy module.

In the study process, the use of learning strategy module significantly influences learning activities. Learning becomes more productive, specifically in sociocognitive interactions, such as asking questions, cooperation, and group discussions among students. This leads to increased curiosity, improved ability to explain concepts resulting from discussions, successful completion of tasks and exercises, as well as enhanced enthusiasm for solving problems (Firoozi et al., 2017; Mundelsee & Jurkowski, 2021; Iancu, 2014; Näykki et al., 2021). These positive influences

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directly contribute to the enhancement of their higher-order thinking skills and learning outcomes (Iancu, 2014).

The success of this study is supported by Amali et al., (2022), where the assessment of higher-order thinking skills benefits students by increasing learning motivation. This connects classroom materials to real-world contexts to increase the meaningfulness of learning. Furthermore, the assessment can improve learning outcomes to think creatively and critically. The assessment enhances students' learning outcomes to compete nationally and internationally (Kurniawan et al., 2021; Nowlan et al., 2023). Moreover, the developed module and its relationship with the variables are supported by Mohamed & Lebar, (2017) and Saputri et al., (2019). The assessment includes critical, logical, reflective, metacognitive, and creative thinking, non-routine and non-algorithmic problem-solving, analysis, evaluation, and concept formation, as well as critical thinking, brainstorming creativity, mental representation, rule application, reasoning, logical thinking, and higher-level thinking. Therefore, the developed module inherently incorporates problem-solving abilities to think at higher level. The development of the mathematics learning strategy module can also enhance motivation and higher-order thinking skills among students.

Conclusion

In conclusion, the development of mathematics learning strategy module using the ADDIE procedure was designed to improve motivation and higher-order thinking skills of students. The mean values of motivation for the pretest and posttest were 52.38 and 79.19, respectively. Therefore, there was a difference in the pretest and posttest mean values of the variable using the developed module descriptively and statistically. The mean values of higher-order thinking skills for the pretest and posttest were 72.81 and 79.75, respectively. There was also a difference in the pretest and posttest mean values of the variable using the developed module. From the validation results by validators 1 and 2 as the material and media experts, the mathematics learning strategy module was valid with mean values of 87.86% and 86.01% in the 'good' category. This signified that module was suitable for enhancing motivation and higher-order thinking skills among fourth-semester students in mathematics Education Study Program at Syahada Padangsidimpuan State Islamic University. For further researchers, it is necessary to review more the effectiveness of the product.

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