# Mathematics modules based on high level questions: How to improve teachers' high order thinking skill

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# Mathematics Modules Based on High Level Questions: How to Improve Teachers' High Order Thinking Skill

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**Abstract.** The aims of this research to produce a mathematics module based of the high-level question to improving high order thinking for middle school mathematics teachers that are valid and practical. This type of research is development research using research and development research methods (R&D), 4-D development models, namely: define, design, develop, disseminate. Research instruments include validation sheets and teacher response questionnaires. The data analysis technique used descriptive statistics. Based on the results of the study, it was proven that mathematics module based of the high-level question in increasing high order thinking for middle school mathematics teachers that was designed was valid and practical. The results of the validity of the module produced in the valid category (78%) and the results of the practicality test through the response questionnaire in the very practical category (84%). In conclusion, mathematics module based of the high-level question was valid and practical to use by teacher to improve teachers' high order thinking skill.

## INTRODUCTION

High order thinking skill (HOTS) is one of the abilities that must be possessed by students [1]. With the implementation of HOTS in learning, it will improve students' abilities so that they are able to adapt to the international world [2]. HOTS is a student's thinking ability at a higher cognitive level and includes the ability of representation, abstraction, creative thinking, and mathematical proof [3,4]. If students want to have HOTS, then they must be given appropriate mathematics learning [5,6]

To have high-level mathematical thinking skills cannot be obtained by students automatically, but there is a need for intensive exercises and in classroom learning the teacher must be able to improve students' thinking skills through the provision of high-level questions. High level questions are questions that require students to do something more than just remembering previously learned information, questions that require students to state an idea or definition in their own language [7]. Students who have HOTS will be able to work on high-level questions more quickly [8]. To develop students' mathematical thinking skills, teachers can use an indirect approach, in this approach the teacher facilitates students' mathematical thinking processes, including through the following activities: asking questions that are not open-ended so as to allow the emergence of ideas in students and the submission of non-leading questions. routines are high-level questions [8,9].

A professional teacher must meet a number of requirements, one of which is able to develop students' thinking skills including students' HOTS [10]. Because HOTS abilities are needed to meet the challenges of 21st century learning [11,12]. So, it is necessary to make various efforts to improve the ability of teachers' HOTS. Forms of effort that are being made include providing training on making questions that support HOTS [13,14]. It is believed that this form has drawbacks, for that we need another way to improve the teacher's ability to make questions that support HOTS.

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The use of modules in an effort to improve higher order thinking skills has been widely used by other researchers. The use of the module is able to improve mathematical critical thinking skills [15,16], mathematical representation skills [17] and mathematical creative abilities [18]. So, it is believed that the use of modules based on high-level questions can also be used to improve teachers' HOT abilities. The purpose of this study was to produce a mathematics module based on high-level questions to improve teachers' HOTS abilities. The research also carried out the process of designing modules based on high-level questions.

## METHOD

The method used in this research was research and development. The development design was implemented by 4-D development [19] model that included four stage of activity that is Define, Design, Development, and Disseminate. However, due to limited research time, the disseminate stage was not carried out.

The definition stage is carried out to determine and define the characteristics of Mathematics Module Based of the High-Level Question. This stage consists of face-to-face analysis, literature analysis, and teacher needs analysis. At this stage it has been found that the questions given by the teacher are always the same in characteristics as the textbooks owned by the students. The question is still in the nature of knowledge, understanding and the highest application. While the questions that analyze, evaluate and create are still lacking. As a result, these questions have not been able to train students' HOTS abilities. Furthermore, the teacher is still not able to make high-level questions that will help students' HOTS abilities. So it is necessary first to improve the teacher's HOTS ability. It is also known that the high-level problem-based math module will help the teacher in making high-level questions which in turn will increase the teacher's HOTS.

At the design stage, a prototype of Mathematics Module Based of the High-Level Question was made which consists of 4 parts. The first part describes the definition of HOTS, the second part describes the characteristics of HOTS, the third part describes the preparation of high-level questions and the fourth part describes the implementation of high-level questions. The questions in the module are adapted to the questions for grade IX middle school students.

At the development stage, the validity and practicality test of the high-level question-based mathematics module has been carried out. Validation tests carried out are content validity, construct validity and face validity. Module validation is carried out by experts. After making improvements according to expert advice, it is continued with the practicality test of the module. The practicality test was carried out by giving a response questionnaire to the teacher.

Data of validation was obtained using a questionnaire with five possible answers, namely a score of 0 for the "invalid" answer, a score of 1 for the "Invalid" answer, a score of 2 for the "fairly valid" answer, a score of 3 for the "valid" answer and a score of 4 for the "very valid" answer. The indicators on the questionnaire use product validity indicators as learning materials [20]. The scores which were obtained from each expert using the formula in eq 1. The results of the validity show the quality of interactive learning media which is then analyzed using the category of validity [21].

$$P = \frac{Total\ Score\ of\ all\ \ aspecs}{Maksimal\ score}\ x\ 100\% \quad (1)$$

Practical data were obtained using a questionnaire with four possible answers, a score of 1 for the answer "strongly disagree", a score of 2 for the answer "disagree", a score of 3 for the answer "agree" and a score of 4 for the answer "strongly agree". Indicators on the questionnaire use indicators of product practicality. The data from the teacher's responses through the collected questionnaires were then tabulated. The tabulation results for each item of the teacher's response questionnaire statement are calculated using the formula in Eq.1. The practicality was conducted to determine the usability mathematics module based of the high-level question analyzed using the practicality category [21].

## RESULT AND DISCUSSION

### The Structure and Content of Mathematics Module Based of the High-Level Question

The mathematics module based of the high-level question was developed with the aim of assisting teachers in making high-level questions. These high-level questions will improve the teacher's HOTS ability, which in the end will certainly increase the students' HOT ability [8]. The structure of this module can be seen in **Figure 1**.

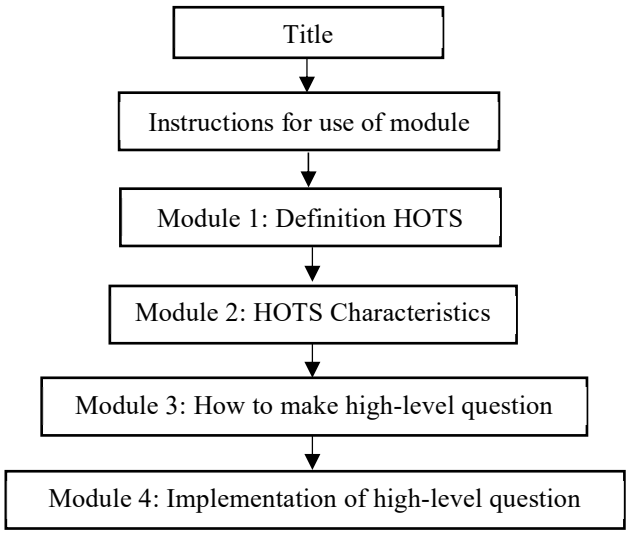


**FIGURE 1.** The structure of mathematics module based high-level question

Each part of the module consists of general explanations, learning activities and summaries. In addition, each section is always accompanied by examples of corresponding high-level questions. In the first part, it is explained about the definition of HOTS and the importance of HOTS for teachers. This is confirmed in Ministerial Regulation no. 22 of 2006 which states that increasing HOTS for mathematics teachers has become a priority in learning mathematics in schools. Next, in the second part, it is explained about the characteristics of the questions to practice HOTS. HOTS can be trained by presenting high-level questions [22].

In the third part, it is explained about how to make high-level questions. In this section there are two learning activities. The first learning activity, provides an understanding for teachers about high-level question indicators. Furthermore, in the second learning activity, train teachers in making high-level questions. High-level questions are created using innovative questions [3].

Furthermore, in the last section, it is explained about the implementation of high-level questions. In this section, the steps for compiling high-level questions are explained which consist of making grids, making questions with innovative questions and evaluating high-level questions.

## Validity of Mathematics Module Based of the High-Level Question

To determine the validity of interactive Mathematics Module Based of the High-Level Question, it is done by means of validation by experts. There are 3 experts who validate this module. Validation results can be seen in **Table I.** This result shows that the results of the validation of Mathematics Module Based of the High-Level Question for each category ranged from 60% - 80%. Overall interactive learning media is valid with a percentage of 78%. So, in general, Mathematics Module Based of The High-Level Question have met the quality criteria for the feasibility of a module. It can be interpreted that the content of the material or the substance of the module is in accordance with competency standards. The language used in the module is communicative and easily understood by teacher. As well as the use of teachers' high order thinking indicators can help teachers in preparing high-level.

## Practicality of Mathematics Module Based of the High-Level Question

To determine the practicality of the Mathematics Module Based on the High-Level Question, two aspects are used. These aspects are the implementation of learning and the ease of using the Mathematics Module Based on The High-Level Question. After giving a questionnaire to the teacher who made questions according to the practicality assessment aspect, the practicality of the Module Based of the High-Level Question was obtained in the very practical category, with an average value of 84%. In general, the Mathematics Module Based on the High-Level Question is very easy to use in improving teachers' HOTS abilities. The systematic and detailed presentation of material in the module makes it

easy for teachers to understand the material provided. The module also shows that high-level questions do not always have complicated or difficult answers [23].

**TABLE I.** Mathematics module based of the high-level question validation test results

| No | Indicators | Expert | | | Sum | Max Score | % | Category |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | | | | |
| 1. | Content validity | 34 | 30 | 31 | 95 | 120 | 79 | Valid |
| 2. | Construct validity | 19 | 18 | 19 | 56 | 72 | 78 | Valid |
| 3. | Face validity | 10 | 8 | 8 | 26 | 36 | 72 | Valid |
| | Summary | 63 | 56 | 58 | 177 | 228 | 78 | Valid |

## CONCLUSION

The results of this development research indicate that the Mathematics Module Based of the High-Level Question is valid and practical. Validity is obtained in the valid category after being validated by 3 experts. While practicality is obtained in the very practical category (84%). Thus this module already has good quality and has easy to use by teachers.

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