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Improving the Ability of Madrasah Aliyah Mathematics Teachers to Develop HOTS Questions through Training and Mentoring

Toheri[1], Arif Muchyidin[2]
[1,2]UIN Siber Syekh Nurjati Cirebon, Indonesia

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ABSTRACT

This study aims to enhance the ability of Madrasah Aliyah mathematics teachers to develop Higher-Order Thinking Skills (HOTS) questions through training and mentoring. This research employs a qualitative approach with a case study design involving 20 mathematics teachers. Data were collected through questionnaires, observations, and document analysis, then analyzed using thematic and descriptive statistics. The findings indicate that teachers' understanding of HOTS principles, reasoning levels, and question formulation steps after participating in the training significantly improved, with an average increase of 55–70% across key indicators. However, some teachers still struggled to integrate real-world contexts into the HOTS questions they developed. These findings highlight the importance of continuous professional development programs to strengthen teachers' competency in designing HOTS-based assessments. Further research is needed to explore the long-term impact of this training on student learning outcomes.

Corresponding Author:

Toheri
UIN Siber Syekh Nurjati Cirebon, Indonesia
Email: htoheri_okt@yahoo.co.id

1. INTRODUCTION

The 21st century demands students to be able to think at a high level. This capability is essential for academic success and is crucial in preparing students for real-world challenges and future careers. This ability is necessary for learning and also success in the workplace [1], [2], [3], [4]. The ability to think high has a variety of meanings that can be extracted into types of thinking, such as critical, creative, analytical, evaluating, creating, and problem-solving [5]. High-level thinking, translated from HOTS, according to the Ministry of Education and Culture, is characterized by the ability to use reasoning and logic to make decisions (evaluation), predict and reflect, as well as the ability to develop new strategies to solve contextual problems that are not routine [6]. Thus,

implementing HOTS in education is a curricular requirement and a strategic necessity to enhance students' cognitive flexibility and adaptability in an ever-changing world.

HOTS learning began to emerge in line with the improvement of changes in process standards and assessments in the 2013 curriculum. Process standards are geared towards achieving 21st-century competencies that consist of the ability to think critically, creatively, collaboratively, and communicatively. These competencies are vital for students to compete in the global era, where innovation and adaptability are key to success. This competency can be achieved if the learning and assessment process realizes high-level thinking skills [7], [8], [9], [10], [11]. In the formulation of David R. Krathwohl [12], high-level thinking skills refer to the dimension of the thinking process at the level of analyzing, evaluating, and creating ideas. In this context, HOTS questions are a curriculum requirement so that students acquire thinking skills over time [13]. Therefore, integrating HOTS-based questions into assessments is crucial to fostering independent and innovative learners.

According to the Ministry of Education and Culture, the elements involved in implementing HOTS are contained in eight National Education Standards (SNP): learning content, methodology, learning, teachers, student readiness, and facilities and infrastructure [14]. One of the elements contained in the national education standard is teachers. Teachers are the organizers of the learning environment and, at the same time, learning facilitators. As facilitators, teachers must deliver content and create meaningful learning experiences that enhance students' cognitive engagement. In addition to these roles, teachers have more specific roles, namely teachers as models, planners, forecasters, leaders, and guides towards learning centres [15].

Teachers, as planners, are obliged to develop educational goals into operational plans. These plans should align with students' cognitive development and be designed to stimulate high-level thinking [16]. General goals need to be translated into specific and operational goals. Teachers must involve students in planning to ensure relevance to their development, needs, and experience level [17]. Therefore, teachers must make students' high-level thinking skills a learning goal. This ability certainly needs to be developed during the learning process. Providing HOTS questions in learning and evaluation is a crucial way to achieve it, including mathematics learning. Students may struggle to effectively develop analytical and problem-solving skills without structured and well-designed HOTS-based questions.

However, reality shows that Indonesian students have relatively low mathematical literacy skills [6] in terms of a) understanding complex information, b) analyzing problems to be solved, c) using procedures and tools in problem-solving, and d) conducting investigations. This low literacy level highlights the need for more effective teaching strategies emphasizing critical thinking and problem-solving. This aligns with what Rahmawati [18] stated: Indonesian students still need to strengthen their integration of available information to conclude and generalize knowledge in a broader context.

Teachers are critical factors in students' abilities. Students' success or failure in achieving HOTS is inseparable from what the teacher does during learning and assessment. However, the application of the Higher Order Thinking Skills (HOTS) model in

mathematics subjects in Senior High School / Madrasah Aliyah, which was felt to be too tricky, received many responses from examinees and went viral on social media. This reaction suggests that students were not adequately prepared to tackle HOTS questions, indicating a gap in the instructional approach used by teachers.

The policy of implementing the HOTS model questions is intended to train students to think critically, creatively, and analytically. However, HOTS principles have not been fully applied when compiling exam questions. Based on Bagus Mustakin's experience in assisting in implementing the 2013 curriculum as a National Instructor and School Supervisor, most teachers have not been able to plan and develop HOTS learning [13]. The 2018 Teacher Competency Test (UKG) results show that the average score (pedagogic and professional competence) is 57.84 for Cirebon Regency and 62.44 for Cirebon City. These statistics indicate a significant gap in teachers' ability to integrate HOTS-based assessments effectively into their teaching practices. Therefore, training and assisting subject teachers in making HOTS questions is necessary. In line with Kusumawardhana, the application of the HOTS model questions in the National Exam needs to be balanced with improving the ability of teachers and students in the teaching and learning process [19]. Implementing HOTS-based assessments may not yield the expected learning outcomes without sufficient teacher training and support.

2. METHOD

Research Design

This study employed a qualitative case study approach to examine the effectiveness of training and mentoring in improving mathematics teachers' ability to develop Higher-Order Thinking Skills (HOTS) questions. The case study design was chosen to provide an in-depth understanding of teachers' experiences, challenges, and progress throughout the intervention. This approach allows researchers to explore the real-life impact of professional development programs on teachers' pedagogical competencies in an authentic educational setting.

Participants and Sampling

The study involved 20 mathematics teachers from various Madrasah Aliyah schools in Cirebon. Participants were selected using purposive sampling, as they had never previously participated in HOTS training conducted by either the Ministry of Education and Culture or the Ministry of Religious Affairs. The teachers taught Grades X, XI, and XII, ensuring diverse instructional levels. Purposive sampling was used to target educators who could benefit the most from HOTS-focused training, thereby maximizing the study's practical implications.

Research Instruments

Three primary research instruments were used to collect data:

1. Questionnaires – A combination of closed-ended and open-ended questions was designed to evaluate teachers' prior knowledge, perceptions, and confidence in developing HOTS questions before and after the training. Two mathematics education

experts validated the questionnaire and tested for reliability using Cronbach's Alpha, yielding a reliability coefficient of 0.85, indicating high internal consistency.

2. Observation Sheets – These were used to record teachers' participation, engagement, and challenges during training sessions. Observations focused on interaction patterns, question formulation processes, and teachers' ability to apply HOTS principles in real time. This instrument provided qualitative insights that complemented the quantitative questionnaire data.
3. Document Analysis – The researchers reviewed and analyzed HOTS questions created by teachers, assessing their alignment with HOTS criteria, including cognitive levels, stimulus characteristics, and question indicators. This analysis helped determine whether teachers could effectively translate theoretical knowledge into practical assessment tools.

Data Collection Procedure

The data collection process was conducted in three phases:

1. **Pre-training assessment:** Participants completed a questionnaire to assess their prior knowledge of HOTS and question development.
2. **Training and mentoring sessions:** Teachers received intensive guidance on identifying competencies, creating question grids, and designing contextual HOTS questions. Observations were made to record interactions, engagement, and challenges.
3. **Post-training evaluation:** Participants were asked to develop HOTS questions based on the training, which were analyzed for quality and alignment with HOTS criteria. A post-training questionnaire was administered to measure changes in understanding.

Data Analysis

The data obtained were analyzed using thematic analysis for qualitative responses and descriptive statistics for quantitative data.

- **Thematic analysis** was used to identify recurring themes in teachers' perceptions, challenges, and improvements in developing HOTS questions. The analysis involved coding the data, grouping similar responses, and interpreting key findings.
- **Descriptive statistics** were used to compare pre- and post-training questionnaire responses, measuring improvements in teachers' knowledge of HOTS question formulation. A paired-sample t-test was conducted to determine whether there was a significant difference in teachers' understanding before and after the mentoring program.

To improve the validity and reliability of the findings, data triangulation was applied by comparing questionnaire results, observation notes, and document analysis of HOTS questions. Additionally, member-checking was conducted by discussing findings with selected participants to confirm accuracy and interpretation.

Findings

An essential aspect of teacher competency development is the suitability of the training focused on the needs of teachers in the field. The condition of the teacher crew is

related to the teacher's insight and understanding of HOTS, which is necessary to design the goals and reinforcement. The teachers' needs for HOTS were analyzed through the provision of questionnaires and FGDs. A quantitative questionnaire is needed to identify the percentage of teachers who need HOTS and FGD training and to identify expectations for the training. The questionnaire instruments used to obtain initial condition data are as follows:

Table 1. Number and percentage of correct answers

No	Indicator	Before	
		F	%
1	HOTS assessment principles	5	25
2	Types of Knowledge	16	80
3	Stimulus characteristics	15	75
4	Characteristics of HOTS questions	4	20
5	Reasoning level	5	25
6	Steps to compile HOTS Questions	7	35

The data in Table 1 shows that teachers understand the types of knowledge and the characteristics of the stimulus. However, they do not understand the principles of HOTS assessment, the characteristics of HOTS, the level of reasoning according to the Ministry of Education and Culture, and the steps needed to prepare HOTS questions. This is because they have never participated in training on HOTS, either held by the Ministry of Education and Culture or the Ministry of Religion at the local, regency, provincial, or national levels.

3. RESULTS AND DISCUSSION

3.1. Description of training and mentoring

Preparing HOTS questions is important to foster students' critical and logical thinking skills. The Regional Office of the Ministry of Religion in the city/district, as an institution that oversees teachers at the MI, MTs, and MA levels, has an important role in improving the competence of teachers in their area. Improving the competence of teachers in writing HOTS questions that are still unfamiliar requires encouragement and motivation from the institutions that oversee them, one of which is the Regional Office of the Ministry of Religion in the city/district.

The activity to improve teachers' ability to compile HOTS questions is through training by bringing in university resource persons. The activity implementation is designed for two sessions; each meeting lasts 8 hours. The activity began by gathering all teachers to get a general briefing from the head of the Regional Office of the Ministry of Religion about the importance of writing HOTS questions. The model of training activities is carried out through 10 (ten) stages, namely: (1) brainstorming/brainstorming lectures and questions and answers about the concept of writing HOTS questions, (2) doing homework in the form of 1 subjective question and one objective question, (3) deepening the concept of HOTS, (4) writing one objective question and one subjective question individually, (5) forming a group consisting of 5-8 teachers and exchanging questions with each other, (6) each teacher studying based on the instruments that have been provided, (7) the group selects the most HOTS questions and ranks them starting from HOTS, MOTs, and LOTs,

(8) presentations by each group based on the results of the analysis, (9) other groups provide responses related to HOTS or not questions, (10) reinforcement from resource persons for each group.

The deepening of the HOTS concept was carried out with lectures, questions, answers, and examples as illustrations that were carried out in the morning; the class was still not hot. Participants were more conducive, as seen by their calmness and attention to explanations and questions from the speakers. Some of the materials discussed are the definition of HOTS, the characteristics of HOTS, the dimensions of the cognitive process, cognitive levels, and the steps to compose HOTS questions. This activity was carried out for approximately 50 minutes. Independent work is done to correct problems that have been done from home using the instructions given. Participants who brought laptops worked on the questions on the laptop, while those who did not bring a laptop could work on paper. For 1 (one) hour, each individual prepares or improves one objective question and one subjective question, with an additional time of about 20 minutes to compile or improve the problem. Cooperation and mutual questions between participants occurred well; small discussions with right, left, or front and back were visible. Group work whose formation is based on subjects is carried out for about 90 minutes. Each group consists of 5-8 people whose grouping is based on the proximity of seats. Group members exchange questions about their work in one group. This activity aims to determine participants' level of understanding when making HOTS questions, namely by assigning participants to study questions that other participants have made.

Each individual studied the questions based on the worksheets the resource person had prepared. Some indicators of the study of multiple choice questions (objective) are material, writing construction, and language consisting of 20 statements (Puspendik, 2017). The material analysis used 8 (eight) statements related to the suitability of questions and indicators, did not contain elements of SARAPPPK (ethnicity, religion, race, intergroup, pornography, politics, propaganda, and violence), the use of attractive stimulus, the level used in the measurement, the answers implied in the stimulus, homogeneous answer choices, and the existence of one correct answer from the alternative answer choices. The instrument for studying the construction of writing uses 9 (nine) statements related to the clarity of the subject of the question, the subject of the question does not give any clues, the question is free from double negative statements, the illustration is clear and functional, it does not use the choice of correct answers for all, the choice of answer numbers is arranged in order from large to small or vice versa, the question items do not depend on other answers. The language study instrument consists of 4 statements: by the standard language, not using the local language, questions using communicative sentences, and choosing answers not to repeat the same word/group of words unless they are a unit. The indicators of the analysis of the description (subjective) questions are the same as the objective study instruments: the material, the construction of writing, and the language. The study instrument for describing the statement was less, namely 13 statements. In general, the content of the study instrument is the same; the difference is more in the construction or structure of the question, including related to alternative answer choices. Group discussions were held after each group member studied about friends in his group.

The determination of the most HOTS to the most LOTs or below is done by discussion in each group. Each individual explained the results of his study to the group, and the members commented on each other and chose the questions that were considered HOTS or not. The group chose the questions considered the HOTS to be presented in class.

Class discussions were held with each group presenting the results of their study, represented by 2 (two) people per group. The total number of groups is 11 (eleven), and the present groups are 7 (seven). Based on the results of the presentation, it can be seen that all groups feel that the questions they are working on are HOTS, but according to the characteristics of the HOTS questions, the questions presented are not HOTS. Some of the criteria for HOTS questions are (1) the existence of illustrations in the form of stories (readings), tables, pictures, or others, (2) illustrations implicitly provide answers, (3) transfer from one concept to another, (4) associate concepts with factual information in the field.

3.2. Impact of Change

a. Participant Understanding

After participating in all stages of the activities carried out, the teachers' understanding has changed significantly, as shown in table 1 below:

Table 2. Increased Participant Understanding

No	Indicator	Before		After		Increased
		F	%	F	%	%
1	HOTS assessment principles	5	25	16	80	55
2	Types of Knowledge	16	80	19	95	15
3	Stimulus characteristics	15	75	18	90	15
4	Characteristics of HOTS questions	4	20	17	85	65
5	Reasoning level	5	25	19	95	70
6	Steps to compile HOTS Questions	7	35	20	100	65

Based on Table 2 above, the most significant increase is in understanding the HOTS reasoning level according to the Ministry of Education and Culture, which is 70%. Meanwhile, the lowest increase was in the types of knowledge and stimulus characteristics by 15%. This low increase is because their initial understanding of this is quite good.

b. Participant Attitude

The participants' enthusiasm during the activity is increasing, marked by an average increase for each stage of the training. The participants, mathematics teachers, experienced increased attitudes, such as perseverance in participating in training, activities such as asking questions and discussing, the ability to cooperate, and responsibility in doing assignments. This can be shown in the following diagram:

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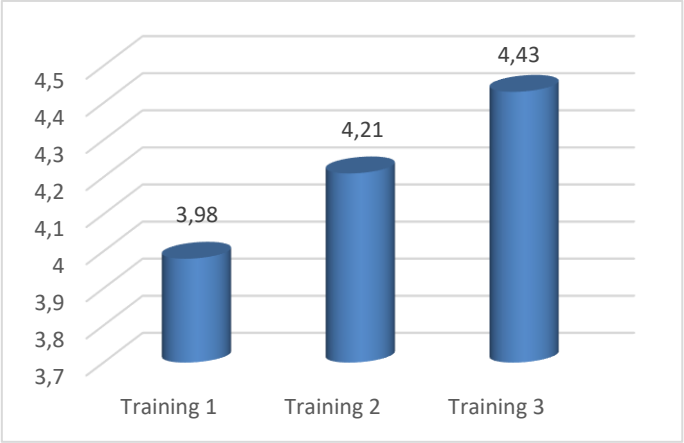

Figure 1. Development of Participant Activities

In addition, an increase was also experienced for each indicator, as shown in the following figure:

Figure 2. Activity Progress by indicator

Based on Figure 2 above, five indicators are the focus of the assessment, namely perseverance in participating in training (X1), activities such as asking questions (X2) and discussing (X3), the ability to cooperate (X4), and responsibility in doing assignments (X5), with P1, P2, and P3 respectively training 1, 2, and 3.

Based on the above indication, the most significant increase in the responsibility indicator (X5), from an average of 3.65 on the first day to 4.15 on the second day and 4.65 on the third day. This increase is due to the work on training tasks that are increasingly interesting for participants. The assignment on the first day is related to understanding the worksheet and preparation procedure, and the assignment on the second day is related to analyzing essential competencies and preparing the grid. In contrast, the third day is related to the practice of preparing HOTS questions.

c. Results of Practice in Preparing HOTS Questions

The skill of compiling math HOTS questions is the main target of the training activities. Some of the teachers' work in the practice of preparing HOTS questions can be presented as follows:

BASIC COMPETENCIES ANALYSIS FORM FOR HOTS

Class: X
Kind: Required

No	Basic Competencies	Level Cognitif	Stimulus	Abilities that are TESTED	Stages of Thinking
3.1	Interpreting the equations and inequalities of absolute values of a single-variable linear form with linear equations and inequalities	C4, C5	Presented data on the water discharge of a river in normal weather and abnormal weather changes	Determining absolute value equations Determining the minimum and maximum water discharge	Determining absolute value equation modelling Using reasoning to determine water discharge
4.1	Solving problems related to the equations and inequalities of absolute values of a single-variable linear form				
3.2	Define and explain the solution of one-variable rational and irrational inequalities	C4, C5	Presented math score data	Determine the average value Determining the highest and lowest values Identifying inequality	Using reasoning to solve the created problem model From these solutions, it is possible to develop an inequality model
4.2	Solve problems related to the rational and irrational inequalities of one variable				
3.3	Compose a three-variable linear equation system of contextual problems	C5, C6	Presented price data on three types of rice mixtures	Determining the price of each type of rice	Define mathematical modelling Using reasoning to solve the created problem model From this solution, it is possible to determine the equation model
4.3	Solving contextual problems related to three-variable equation systems				

Figure 3. Class X Group Work Results

The X class group identifies the Basic Competencies (KD) that can be developed using their HOTS questions. They are confident that all KDs, namely analysis and evaluation, can be developed using their HOTS questions with cognitive levels four and 5.

BASIC COMPETENCIES ANALYSIS FORM FOR HOTS

Class: XI
Kind: Common

No	Basic Competencies	Level Cognitif	Stimulus	Abilities that are TESTED	Stages of Thinking
3.9	Analyze the relationship between the function's first derivative with the maximum value and the minimum value, as well as the monotony of the function and the slope of the tangent of the curve.	C4, C5	It is presented with two sheets of wrapping paper with different dimensions and prices and will be used to wrap a box-shaped gift with a rectangular base of known volume.	Determining the surface area Determine the cost of wrapping a gift Comparing the cheapest costs	Determine the mathematical modelling of a square base whose volume is known. Using reasoning to solve a mathematical model that has been created From the settlement that has been made, it is concluded that the minimum price must be paid from the two wrapping paper options so that the wrapping paper is neatly wrapped
4.9	Using the first derivative of a function to determine the maximum point, minimum point and interval of the monotony of the function, as well as the slope of the tangent and normal line of the curve, are related to contextual problems.				
3.2	Describe two-variable linear programs and their solution methods using contextual problems.	C4, C5	Served a cake and explained the ingredients needed to make the cake	Define small material expenditures and profit from large sales	Define mathematical modelling Using reasoning to solve a mathematical model that has been created

Figure 4. Class XI Group Work Results

The XI class group also identified the Basic Competencies (KD) that could be made with their HOTS questions. They are confident that all KDs can be made HOTS questions with cognitive levels 4 and 5, namely Analysis and Evaluation.

BASIC COMPETENCIES ANALYSIS FORM FOR HOTS

Class: XII
Kind: Common

No	Basic Competencies	Level Cognitif	Stimulus	Abilities that are TESTED	Stages of Thinking
3.1	Describe distances in space (between points, points to lines, and points to planes)	C4	Given a space building (props) and wool yarn as a line Pay attention to the classroom occupied.	Determining the distance between points to planes Determine the distance between fields to fields	Determining the position of a point in the field Finding a point projection against a field Determining between the field and the field Draw a line that connects the planes so that it forms a line AB that is perpendicular to the two planes so that it is known that the length of AB is the distance between the plane and the plane.
4.1	Define distances in space (between points, points, and lines, and points to planes)				
3.2	Determine and analyze the size of concentration and distribution of data presented in the form of frequency distribution tables and histograms		Given height data in the classroom to manage distribution tables and data	Create and analyze frequency distribution tables	Sorting student scale data from smallest to highest Define the range Define multiple classes
4.2	Troubleshoot related issues				

Figure 5. Class XII Group Work Results

The results of the work of the class XII group are no different from those of other groups. According to this group, essential competencies can be included in HOTS questions. However, this group focuses on cognitive level 4, namely analytical skills. Based on the results of this work, it can be said that the participants can already identify KD, which can be done with HOTS questions and their stimulus. The participants could also identify the skills tested along with the stages of thinking used to solve the problem.

The next stage in preparing HOTS questions is to make a question grid based on previous KD identification results. These grids are made in tables to make checking the consistency between the existing components easier. This form is made in 8 columns consisting of 1) Number, 2) KD, 3) Material, 4) Class/Semester, 5) Question indicators, 6) Cognitive Level, 7) Question Form, and 8) Question Number.

After the grids are made, the next step is to make a question based on the grids that have been made before. The following are examples of some math HOTS questions that participants have successfully compiled. The results below show that the X class group has succeeded in making HOTS questions by providing stimuli according to those contained in the grid. However, the preparation of indicators is still not related to the context of the questions.

Teachers' expertise in creating math problems based on higher-order thinking skills (HOTS) is significant in improving the quality of learning and preparing students to face future challenges. Teachers proficient in designing HOTS questions can help students develop critical, analytical, and creative thinking skills essential to solving complex problems. According to Brookhart [20], HOTS questions encourage students to remember and understand concepts and to analyze, evaluate, and create innovative solutions. This

aligns with the taxonomy of Bloom's revision by Anderson and Krathwohl [21], emphasizing the importance of high-level cognitive abilities. Research by Zohar and Dori [22] also shows that teaching focusing on HOTS can improve students' conceptual understanding and critical thinking skills in mathematics. Therefore, teachers' expertise in creating HOTS-based questions is crucial to creating a dynamic and challenging learning environment and preparing students to become critical and creative thinkers.

Training in making math problems based on higher-order thinking Skills (HOTS) is essential for teachers to improve the quality of learning and students' critical thinking skills. HOTS-based questions encourage students to analyze, evaluate, and create, which are essential skills in facing the challenges of the 21st century [23], [24], [25], [26], [27]. According to Anderson and Krathwohl (2001), HOTS involves a high level of cognitive ability that includes analysis, synthesis, and evaluation, which is essential for the intellectual development of students. In addition, Brookhart's [19] research shows that applying HOTS to math problems can improve students' conceptual understanding and ability to solve complex problems. Therefore, training teachers to create HOTS-based questions enriches their teaching methods and prepares students for critical and creative thinking, which is in high demand in real life and the world of work.

3.3. Discussion

The findings of this study indicate that the mentoring and training program significantly improved Madrasah Aliyah mathematics teachers' ability to develop HOTS questions. Before the training, many teachers struggled with essential aspects of HOTS question formulation, including understanding the principles of HOTS assessment, reasoning levels, and constructing question indicators. The post-training evaluation demonstrated a notable increase in teachers' comprehension, with the highest improvement in their ability to determine reasoning levels (70%) and construct practical HOTS-based assessments (65%). These results align with previous studies [20], [22] that emphasize the importance of targeted professional development in enhancing teachers’ ability to integrate high-order thinking skills into their teaching practices.

Despite these improvements, some challenges remain, particularly in aligning HOTS questions with real-world contexts. The findings revealed that while teachers successfully structured questions according to the provided grids, many could not incorporate contextual indicators effectively. This limitation suggests that training programs should emphasize not only the technical aspects of HOTS question development but also strategies to contextualize these questions in ways that are meaningful to students. Studies by Tanujaya et al. [24] and Zana et al. [23] highlight that HOTS-based assessments are most effective when they reflect real-life scenarios, allowing students to apply critical thinking skills beyond the classroom.

Another crucial aspect observed during the mentoring sessions was the role of active learning strategies in professional development. Teachers who engaged in collaborative discussions, peer reviews, and hands-on activities showed more substantial improvement than those who passively attended lectures. This finding aligns with research by Cleovoulou [7] and Hamzah [10], which emphasizes that interactive and experiential

learning approaches lead to better knowledge retention and skill acquisition among educators. The effectiveness of collaborative learning in teacher training suggests that future professional development programs should incorporate structured peer feedback and group-based problem-solving sessions to maximize learning outcomes.

Furthermore, the impact of the mentoring program extends beyond individual teacher competency to overall classroom instruction quality. As Rahmawati [17] and Mustakim [12] noted, Indonesian students have historically struggled with mathematical literacy, particularly in problem analysis and reasoning. This study addresses a fundamental gap in student learning by equipping teachers with the skills to design HOTS-oriented questions. However, long-term studies are needed to evaluate whether these improvements in teacher competence translate into measurable gains in student performance, as emphasized by Anderson and Krathwohl [21].

Given these findings, several recommendations can be made for future professional development initiatives. First, training should be extended beyond essential HOTS question development to include real-world application strategies, ensuring students can relate assessment materials to everyday experiences. Second, ongoing support mechanisms such as follow-up mentoring, peer coaching, and online learning communities should be established to reinforce learning. Lastly, further research should explore the longitudinal impact of HOTS-based teacher training on student learning outcomes, particularly in different educational contexts. By implementing these improvements, educational institutions can better support teachers in fostering critical and creative thinking skills among students, ultimately preparing them for the challenges of the 21st century.

4. CONCLUSION

This mentoring program has successfully enhanced Madrasah Aliyah mathematics teachers' understanding and skills in developing HOTS questions. The training provided a structured approach to question formulation, including identifying competencies, designing question grids, and integrating appropriate stimuli. As a result, teachers demonstrated significant improvement in their ability to create HOTS-based assessments, particularly regarding reasoning levels and cognitive complexity. These findings highlight the effectiveness of professional development programs in equipping teachers with the necessary competencies to foster higher-order thinking skills among students.

However, some challenges persist despite these improvements, particularly in contextualizing HOTS questions. Many teachers struggle to relate their questions to real-world scenarios, limiting their ability to develop assessments encouraging deep analytical and problem-solving skills. This suggests that future training should focus on the technical aspects of HOTS question development and strategies for making assessments more relevant to students' daily lives.

The results of this study emphasize the need for continuous and intensive teacher training on HOTS implementation. Future professional development programs should incorporate interactive learning methods, collaborative problem-solving, and real-world applications to maximise teacher competency. Additionally, follow-up mentoring and peer

support networks should be established to ensure teachers receive ongoing guidance in implementing HOTS-based learning and assessment strategies.

In light of these findings, further research is recommended to evaluate the long-term impact of HOTS-based teacher training on student learning outcomes. A longitudinal study could provide deeper insights into how improvements in teacher competency translate into measurable gains in students' critical thinking and problem-solving abilities. By addressing these areas, educational institutions can better support teachers in fostering high-order thinking skills, ultimately preparing students for the demands of the 21st century.

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