EDUMATIKA: *Jurnal Riset Pendidikan Matematika* *e-ISSN 2620-8911*
Volume 5, Issue 1, May 2022 *p-ISSN 2620-8903*

The Higher Order Thinking Skills of Mathematics Education Students at State Islamic Higher Education in Central Sumatera

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Abstract. Prospective mathematics teachers must possess various competencies, including higher-order thinking skills (HOTS), to tackle the challenges of the 21st century. In this study, the aim was to map the HOTS of Mathematics Education students at State Islamic Higher Education (PTKIN) in Central Sumatera. A descriptive quantitative study was conducted, which involved 310 Mathematics Education students from several institutions, namely State Islamic University of (UIN) Imam Bonjol Padang, State Islamic Institute of (IAIN) Batusangkar, IAIN Bukittinggi, UIN Sultan Syarif Kasim Riau, UIN Sultan Thaha Saifuddin Jambi, and IAIN Kerinci. The HOTS test was used to collect data. The results of the study revealed that the average high-order thinking skills of Mathematics Education students at PTKIN in Central Sumatera were relatively low. This outcome indicates that prospective mathematics teacher students at PTKIN may not be fully prepared to tackle the challenges of the 21st century. Therefore, the researchers suggest that appropriate learning methods be selected to improve the higher-order thinking skills of students, and that the content of various courses be increased to enhance the HOTS.

Keywords: Higher Order Thinking Skills; Mathematics Education Students; State Islamic Higher Education; Central Sumatera Study

Abstrak. Calon guru matematika harus memiliki berbagai kompetensi, termasuk keterampilan berpikir tingkat tinggi (HOTS), untuk menghadapi tantangan abad ke-21. Dalam penelitian ini bertujuan untuk memetakan HOTS mahasiswa Pendidikan Matematika di Perguruan Tinggi Keagamaan Islam Negeri (PTKIN) di Sumatera Tengah. Dilakukan penelitian deskriptif kuantitatif yang melibatkan 310 mahasiswa Pendidikan Matematika dari beberapa institusi yaitu Universitas Islam Negeri (UIN) Imam Bonjol Padang, Institut Agama Islam Negeri (IAIN) Batusangkar, IAIN Bukittinggi, UIN Sultan Syarif Kasim Riau, UIN Sultan Thaha Saifuddin Jambi, dan IAIN Kerinci. Tes HOTS digunakan untuk mengumpulkan data. Hasil penelitian menunjukkan bahwa rata-rata kemampuan berpikir tingkat tinggi mahasiswa Pendidikan Matematika PTKIN Sumatera Tengah relatif rendah. Hasil ini menunjukkan bahwa calon mahasiswa guru matematika di PTKIN mungkin tidak sepenuhnya siap menghadapi tantangan abad ke-21. Oleh karena itu, peneliti menyarankan agar dipilih metode pembelajaran yang tepat untuk meningkatkan kemampuan berpikir tingkat tinggi mahasiswa, dan konten berbagai mata kuliah ditingkatkan untuk meningkatkan HOTS.

Keywords: Kemampuan Berpikir Tingkat Tinggi; Mahasiswa Tadris Matematika; PTKIN; Sumatera Bagian Tengah

Available online at journal homepage:
http://ejournal.iainkerinci.ac.id/index.php/edumatika
Email: edumatika@iainkerinci.ac.id
DOI: https://doi.org/10.32939/ejrpm.v5i1.1273

EDUMATIKA: *Jurnal Riset Pendidikan Matematika* *e-ISSN 2620-8911*
Volume 5, Issue 1, May 2022 *p-ISSN 2620-8903*

INTRODUCTION

The education process must prepare a new generation to think logically, creatively, analytically, systematically, and critically, work together, and solve problems (Amalia & Hadi, 2021). Krulik and Rudnick proposed four levels of thinking skills, namely recall, basic, critical, and creative (Chuseri, Anjarini, & Purwoko, 2021). Therefore, state Islamic religious universities (PTKIN), which produce prospective teachers/graduates, should facilitate lectures in the classroom to achieve the educational objectives of the era 4.0 and the expected competencies.

Mathematics is an essential part of national education and underlies the development of various other fields of science. It is built from basic concepts and then developed into more complicated concepts, requiring higher-order thinking skills or HOTS (Higher Order Thinking Skills) (Mahfuddin & Caswita, 2021). Newman and Wehlage proposed that higher-order thinking skills enable students to distinguish ideas or concepts clearly, argue well, solve problems, construct explanations, hypothesize, and understand complex things more clearly (Ansari & Abdullah, 2020). Higher-order thinking skills focus more on mental activities in solving non-routine problems or high-level difficulties (Hadi & Faradillah, 2020). HOTS can be interpreted as a thinking process that includes parsing material, criticizing, and creating solutions to problem-solving (Mailani, 2018).

HOTS refers to the ability to critically and creatively seek connections, manipulate and transform knowledge and experience in making decisions to solve problems (Dinni, 2018). Critical thinking has three different meanings: critical thinking as problem-solving, critical thinking as evaluation, and critical thinking as a combination of evaluation and problem-solving (Gradini, 2019). HOTS is one of the processes in students' thinking at a high level of cognitive development. It is developed from various concepts and methods as well as learning taxonomies such as the problem-solving method, Bloom's taxonomy, and the taxonomy of learning, teaching, and evaluation (Ismafitri, Alfan, & Kusumaningrum, 2022).

The primary goal of HOTS is to improve students' thinking patterns at a higher level, particularly their ability to think critically in receiving various information, think creatively when solving problems and making decisions in complex situations (Fitriani, Bakri, & Sunaryo, 2017). According to Nirmala and Ratnawati (Pasandaran & Kartika, 2019), higher-order thinking skills rely on logic rather than memorizing formulas, resulting in better concept mastery and the ability to solve more complex mathematical problems. HOTS skills include problem-solving, creative thinking, and critical thinking. These skills are fundamental in solving mathematical problems, particularly in non-routine problems that require creativity and critical thinking skills (Lailly & Wisudawati, 2015). HOTS allows students to process information effectively and efficiently (Hadi, 2021) and expand their thinking through the high-level questions given (Kenedi, 2018).

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Higher-order thinking skills have benefits in learning. The benefits are that learning will be more effective, teachers' intellectual abilities will increase in developing HOTS, and teachers will be required to prepare non-routine questions for students. HOTS will continuously develop the teacher's evaluation abilities so that learning is more effective, and each student will have different problem-solving abilities despite facing the same problem (Listiani & Sulistyorini, 2021). Thus, students are expected to have the ability to solve HOTS questions. Students who have HOTS abilities must be able to remember formulas, be able to understand questions and apply them and be able to analyze mathematical problems. Not only that, but students are also able to evaluate work results and create new creations (Winarso, 2014).

HOTS needs to be developed at all levels of education, including at the tertiary level, especially for student educators. HOTS someone can practice his ability to connect mathematical ideas and expand his thinking through the high-level questions given (Sujadi, Kurniawati, & Wulandari, 2020). Mathematics Education students need this ability to understand high-level mathematical concepts at the Higher Education level. Students can use different approaches to solving problems so that a thinking process occurs. The thinking process in mathematics is inseparable from the ability of Higher Order Thinking Skills. (Rahayuningsih & Jayanti, 2019). More than that, students as prospective teachers need to have a good mastery of HOTS to guide their students in developing HOTS in the future (Dosinaeng, Leton, & Lakapu, 2019). Furthermore, educators play an essential role in optimizing HOTS in daily tests, end-of-semester assessments, and school exams (Widana, 2017). It is intended to be able to train and know the categories of students' higher-level thinking skills (Herutomo & Masrianingsih, 2019).

Higher-order thinking skills have numerous benefits in learning, including increased effectiveness in learning, improved intellectual abilities of teachers in developing HOTS, and the need for teachers to prepare non-routine questions for their students. HOTS can continuously develop a teacher's evaluation abilities, making learning more effective, and help students to develop different problem-solving abilities when facing the same problem (Listiani & Sulistyorini, 2021). Therefore, students are expected to have the ability to solve HOTS questions, which requires them to remember formulas, comprehend questions, and apply them, and analyze mathematical problems. Moreover, students with HOTS abilities can evaluate their work results and create new creations, demonstrating their high-level thinking skills (Winarso, 2014).

The development of HOTS is essential at all levels of education, including the tertiary level, especially for student educators. HOTS can help students to practice their ability to connect mathematical ideas and expand their thinking through high-level questions (Sujadi, Kurniawati, & Wulandari, 2020). Mathematics education students require this ability to understand high-level mathematical concepts at the higher education level, and they can use different approaches to solve

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problems, which prompts a thinking process. The thinking process in mathematics is closely related to the ability of Higher Order Thinking Skills (Rahayuningsih & Jayanti, 2019). Furthermore, students who are prospective teachers need to have a good command of HOTS to guide their students in developing HOTS in the future (Dosinaeng, Leton, & Lakapu, 2019). Additionally, educators play a crucial role in optimizing HOTS in daily tests, end-of-semester assessments, and school exams (Widana, 2017). The purpose is to train teachers and identify the categories of students' higher-level thinking skills (Herutomo & Masrianingsih, 2019).

Thus, it is crucial for universities to help students develop their HOTS abilities. Studies have revealed that many mathematics teachers in high schools are not familiar with HOTS (Pratama & Retnawati, 2018). Additionally, 59% of teachers from seven districts studied encountered difficulties in delivering HOTS-oriented learning materials, while 79% had trouble designing and evaluating HOTS questions (Rapih & Sutaryadi, 2018). This is concerning as teachers play an essential role in developing students' abilities. Moreover, according to the PISA survey, students' thinking skills in Indonesia are still considered low as they require more training to solve HOTS-oriented questions or assignments (Annizar, 2020; Saetban, 2021).

Based on the above review, it is crucial to conduct further research on the HOTS abilities of Mathematics Education students at PTKIN. Therefore, this study aims to analyze the ability of Mathematics Education students throughout Central Sumatera in solving HOTS problems. The study's results are expected to serve as a reference to help students master HOTS, as well as to contribute to campus policies that prioritize HOTS-based courses to produce qualified prospective teacher graduates.

METHOD

This study utilizes a descriptive quantitative research approach. The population of the study consists of all final semester students, specifically semester VII of Mathematics Education students at State Islamic Higher Education (PTKIN) in Central Sumatera, including students from UIN Imam Bonjol Padang, IAIN Bukittinggi, IAIN Batusangkar, UIN Sultan Syarif Kasim Riau, UIN Sultan Thaha Saifuddin Jambi, and IAIN Kerinci. Due to the large population, a sample was obtained using the cluster random sampling technique, resulting in one class from UIN Imam Bonjol Padang, three classes from IAIN Bukittinggi, two classes from IAIN Batusangkar, five classes from UIN Sultan Syarif Kasim Riau, one class from UIN Sultan Thaha Saifuddin Jambi, and one class from IAIN Kerinci. The eligible number of students from the six PTKINs was 310, as shown in Table 1.

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Table 1. Details of The Samples

State Islamic Higher Education	Student Group	Number of Students
UIN Imam Bonjol	A	30 students
UIN Sultan Syarif Kasim Riau	A	16 students
UIN Sultan Syarif Kasim Riau	B	24 students
UIN Sultan Syarif Kasim Riau	C	20 students
UIN Sultan Syarif Kasim Riau	D	22 students
UIN Sultan Syarif Kasim Riau	E	22 students
UIN Sultan Thaha Saifuddin Jambi	A	16 students
IAIN Bukittinggi	A	30 students
IAIN Bukittinggi	B	30 students
IAIN Bukittinggi	C	30 students
IAIN Batusangkar	A	21 students
IAIN Batusangkar	B	22 students
IAIN Kerinci	A	27 students
Total	13 Groups	310 students

The research was conducted during the odd semester of the 2021/2022 academic year. The testing procedures were carried out by the respective colleges. For universities that held face-to-face classes, the test was administered in person and supervised by data collectors, who were lecturers teaching in the class. For universities that were still conducting online classes, the test was administered via a Zoom meeting and supervised by the respective lecturer to ensure that the results obtained were based on the abilities of each student.

The research instrument used to collect data was the Higher Order Thinking Skills (HOTs) test. The HOTs questions were designed using a grid that included the material being tested, question indicators, cognitive levels, and the HOTs aspects/components being tested. The materials tested included trigonometry, geometry, statistics, probability, derivatives, matrices, and integrals. The HOTS test item grid can be seen in Table 2.

Table 2. Grid of Higher Order Thinking Skills (HOTS) Questions

Grade	Material	Question Indicators	Question Number	Cognitive Level	HOTS Components
X	Geometry	Design the relationship between the surface area and volume of a cylinder	1	C4	Creative Thinking
XI	Statistics	Solve the average value problem	2	C4	Problem-Solving
	Probability	Solve permutation problems	3	C4	Critical Thinking
	Derivative	Solve the solution of extreme function problem	4	C4	Creative Thinking
			5	C4	Critical Thinking
XII	Matrix	Solve matrix inverse problems	6 and 7	C4	Problem-Solving
	Integral	Deduce the solution of the trigonometric integral	8 and 9	C5	Critical Thinking

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The Higher Order Thinking Skills test assesses cognitive levels of analysis (C4), synthesis (C5), and creativity (C6) as well as HOTs aspects such as problem-solving, critical thinking, and creative thinking. The assessment is conducted using an analytic rubric that is divided into three scoring rubrics for problem-solving, critical thinking, and creative thinking. The rubric used to assess problem-solving skills is shown in Table 3.

Table 3. Problem-Solving Skills Rubric

Code	Indicators	Scale			
		1	2	3	4
Problem Solving 1	Understanding the problem	Understanding the problem incorrectly	Understanding the problem correctly and incompletely	Understanding the problem correctly and less completely	Understanding the problem correctly and completely
Problem Solving 2	Planning the solution	Planning the solution incorrectly	Planning the solution correctly and incompletely	Planning the solution correctly and less completely	Planning the solution correctly and completely
Problem Solving 3	Solving the problem according to plan	Solving problems according to plan incorrectly	Solving problems according to plan correctly and incompletely	Solving problems according to plan correctly and less completely	Solving problems according to plan correctly and completely

To ensure the validity of the Higher Order Thinking Skills (HOTS) test, three mathematics experts were invited to validate the instrument. These experts assessed the instrument's content feasibility, linguistic, presentation, and graphic components, and provided valuable criticisms, inputs, and suggestions. Following the experts' feedback, the HOTs questions were revised. The validators' average score for the HOTS item validity was 89.93, indicating a very valid instrument. This suggests that the instrument was appropriately designed according to existing theories and guidelines (Arikunto, 2015).

Additionally, a try-out was conducted with 36 fifth-semester Mathematics Education students at UIN Imam Bonjol Padang during the 2021/2022 academic year. The results showed that only nine of the 13 questions could be used in the research class. Four questions were excluded due to their analysis, difficulty index, discriminating power, and acceptance criteria. Therefore, the tested questions consisted of three problem-solving skills questions, two creative thinking skills questions, and four critical thinking skills questions.

The reliability of the HOTS test was also confirmed through the try-out results. To determine the HOTS category of the students, the mean values and standard deviations were used in accordance with the score category developed by Saraswati and Agustika (2020).

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RESULTS AND DISCUSSION

Table 4 presents a brief overview of the research findings on the Higher Order Thinking Skills (HOTS) of six State Islamic Institutes (PTKINs) in Central Sumatra. The results suggest that, on average, Mathematics Education students have a moderate level of HOTS. Among the PTKINs, UIN Sultan Thaha Saifuddin Jambi obtained the lowest average HOTS score, while IAIN Bukittinggi obtained the highest.

The research findings imply that there is still a need for Mathematics Education students in PTKINs across Central Sumatra to be exposed to more HOTS questions during lectures. This aligns with previous research conducted by Rafiq et al. (Badjeber & Purwaningrum, 2018), which suggests that a consistent and ongoing process is required to train and familiarize students with solving HOTS questions.

Table 4. HOTS Average of Mathematics Education Students

State Islamic Higher Education	Students HOTS Average
UIN Imam Bonjol	40,05
UIN Sultan Syarif Kasim Riau	43,42
UIN Sultan Thaha Saifuddin Jambi	35,56
IAIN Bukittinggi	65,68
IAIN Batusangkar	54,27
IAIN Kerinci	43,55

The research findings suggest that Mathematics Education students in PTKINs across Central Sumatra have a relatively moderate level of Higher Order Thinking Skills (HOTS). This serves as a crucial guideline for tertiary institutions to choose appropriate teaching methods that are related to the curriculum. If this issue remains unaddressed, it may negatively impact the competency of PTKIN graduates, who may find it difficult to teach HOTS questions at school and solve HOTS questions during job applications. This finding is consistent with previous research, which has shown that many teachers lack confidence in the concept of HOTS and are not well-prepared to teach or assess this skill (Schulz & FitzPatrick, 2016). These results are further supported by Retnawati's (2018) research, which indicates that teachers have limited knowledge of HOTS and their ability to improve students' HOTS, solve HOTS-based problems, and measure student HOTS is still inadequate. Similar findings were also reported by Driana and Ernawati (Badjeber & Purwaningrum, 2018), who found that elementary school teachers needed a better understanding of HOTS.

Therefore, it is essential to implement more training activities and measurement of students' higher-order thinking skills. Otherwise, it will significantly impact the development of student HOTS. The following discussion provides an overview of the HOTS per ability for each PTKIN.

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Problem Solving Skills

Based on the guidelines for scoring rubrics for mathematical problem-solving skills, the average scores for each indicator of problem-solving skills were obtained. The results showed that students in all PTKINs in Central Sumatera still struggle with problem-solving questions. Specifically, the average score for understanding the problem was 38.15, for planning a solution it was 51.73, and for solving the problem according to plan it was 48.29. The lowest indicator among all universities was the ability to understand the problem, which suggests that students need more training to become comfortable answering questions systematically.

The problem-solving skills varies among the six PTKINs in Central Sumatera, with three PTKINs having low problem-solving skills, two PTKINs having moderate skills, and one PTKIN having high problem-solving skills. Research has shown that students with low problem-solving abilities tend to struggle with following the indicators of problem-solving skills, while those with high abilities tend to excel in solving problem-solving problems according to the problem-solving indicators. Therefore, it is crucial to familiarize students with problem-solving questions.

Previous research offers a potential solution by developing teaching materials for mathematics statistics courses that integrate Islamic nuances and problem-solving syntax (Utami, 2019). The syntax involves understanding the problem, planning problem-solving, doing calculations, and checking back. These teaching materials can potentially help students improve their problem-solving abilities. Overall, the low scores on the problem-solving indicators underscore the need for more training and guidance to enhance students' problem-solving skills in PTKINs throughout Central Sumatera.

Table 5. Students' Average Score of Problem-Solving Skills

Indicators of Problem-Solving Skills	Question Number			Total	Average
	2	6	7		
Understanding the problem	0,39	0,25	0,61	1,25	0,42
Planning for solution	2,81	2,56	1,31	6,68	2,23
Solving the problem according to the plan	2,78	2,53	0,86	6,17	2,06

Based on Table 5, it is evident that most students still have difficulty in understanding the problem, as the average score is relatively low. However, there are some students who have been able to achieve the highest score of 4. For planning the solution, most students have shown a moderate level of competency, as indicated by the average score of 2.23. The assessment of the answer sheets shows that many students have received a score of 2 or 3, indicating that they can plan the solution to a certain extent. The third indicator, solving problems according to plan, has an average score of 2.06, which means that most students have been able to solve problems and are classified as moderate.

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The student answer sheet illustrates that those who score high have successfully solved all indicators of problem-solving skills. In contrast, students with low scores could only understand the problem, but they failed to proceed to the next indicator of problem-solving skills. These results suggest that there is still a significant gap between the competency of students with high problem-solving abilities and those with low abilities. Therefore, it is necessary to provide appropriate training and teaching materials to help students improve their problem-solving skills and understanding of the problem (Widada et al., 2019).

Critical Thinking Skills

The average scores for the three indicators of critical thinking skills were calculated for all PTKIN. For the indicator of formulating problems, the average was 39.15. For providing arguments, the average was 50.72, and for taking action, the average was 49.13. The lowest indicator for all universities is the ability to formulate problems. Overall, the results indicate that many students still need to improve their critical thinking skills.

Table 6. Students' Average Score of Critical Thinking Skills

Indicators of Critical Thinking Skills	**Question Number**				**Total**	**Average**
	3	**5**	**8**	**9**		
Fluency	1,11	0,22	0,06	0,44	1,83	0,46
Elaboration	1,47	2,06	0,92	0,86	5,31	1,33
Flexibility	0,78	1,86	1,14	0,42	4,19	1,05

Table 6 indicates that the fluency indicator has an average of 0.46 for all questions. This means that many students are still unable to demonstrate fluency in answering questions and score 0, but there are some students who scored 4. Overall, the fluency indicator is categorized as low. The elaboration indicator has an average of 1.33, which implies that most students require assistance in elaborating their answers to questions. The assessment of answer sheets for elaboration is mainly in the range of 0 and 1, which is also categorized as low. Similarly, the flexibility indicator has an average of 1.05, and most students are unable to answer questions according to the flexibility indicator, which is also categorized as low. Therefore, it can be concluded that all critical thinking skill indicators are still low.

It is noteworthy that the student answer sheet for critical thinking skills depicts that students who received high scores have accurately solved all indicators of critical thinking skills. Conversely, students who received low scores could only answer questions based on the elaboration indicator and required assistance to proceed to the next indicator. In Central Sumatera, four PTKINs have low critical thinking skills, one PTKIN is moderate, and one PTKIN is classified

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as high. Compared to problem-solving skills, critical thinking skills are relatively better across all PTKINs.

In conclusion, while some students have demonstrated a higher level of critical thinking skills, the overall average across all PTKINs is still low. Students require assistance to improve their fluency, elaboration, and flexibility skills when answering questions (Zylich, 2020). Nonetheless, there is an indication of improvement in critical thinking skills compared to problem-solving skills across all PTKINs.

Creative Thinking Skills

The study on creative thinking skills utilizes three indicators: fluency, elaboration, and flexibility. For Mathematics Education students in PTKIN Central Sumatera, the average fluency indicator is 18.34, while the elaboration and flexibility indicators have averages of 52.17 and 46.76, respectively. It can be concluded that all indicators are still categorized as low or moderate, with the fluency indicator being the lowest.

The creative thinking skills of each campus is reflected in the overall results. IAIN Kerinci has an average creative thinking skills of 23.39, which is considered low. Two questions on creative thinking skills were included in the research class, and the results indicated that both questions could be effectively tested. Each question comprises three indicators of creative thinking skills: formulating problems, providing arguments, and drawing conclusions and actions. Compared to problem-solving and critical thinking abilities, creative thinking skills has a relatively higher average value.

In conclusion, the average indicators of creative thinking skills for Mathematics Education students in PTKIN Central Sumatera are still in the low to moderate categories. However, creative thinking skills has a higher average value compared to problem-solving and critical thinking skills. The table below presents the average indicators of creative thinking skills.

Table 7. Students' Average Score of Creative Thinking Skills

Indicators of Creative Thinking Skills	**Question Number**		**Total**	**Average**
	1	**4**		
Formulating the problem	1,25	0,89	2,14	1,07
Providing Arguments	0,89	3,19	4,08	2,04
Drawing conclusions and actions	1,00	3,14	4,14	2,07

The results of the assessment indicate that many students still struggle with formulating problems, with a considerable number receiving a score of 0 or 2. This suggests that the ability to formulate problems is still relatively low among students. In contrast, the indicator for providing arguments received a higher average score of 2.04, with many students demonstrating the ability to

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attempt and refine their answers, placing this indicator in the moderate category. Similarly, the indicator for taking conclusions and actions had an average score of 2.07, also placing it in the moderate category. The provided image shows that students with high scores were able to correctly answer questions according to the standard indicators, receiving a score of 4. On the other hand, those with low scores still require assistance to progress to the next indicator.

Based on the field research results, the critical thinking skills of mathematics students at UIN Sultan Thaha Saifuddin Jambi is the lowest, followed by creative thinking skills, and problem-solving skills is the highest. UIN Sultan Thaha Saifuddin Jambi has the lowest HOTS among the 6 PTKINs in Central Sumatera. For HOTS of Mathematics Education students at UIN Imam Bonjol Padang, the problem-solving skills is the lowest, followed by creative thinking skills, and critical thinking skills is the highest. UIN Imam Bonjol Padang has the second lowest HOTS among the 6 PTKINs in Central Sumatera. At UIN Sultan Syarif Kasim Riau, the ability to solve problems is the lowest, followed by creative thinking skills, and critical thinking skills is the highest. UIN Sultan Syarif Kasim Riau has the third lowest HOTS among the 6 PTKINs in Central Sumatera.

In contrast, IAIN Bukittinggi has the highest HOTS among the 6 PTKINs. For Mathematics Education PTKIN students throughout Central Sumatera, their HOTS is still relatively low, meaning that it is challenging to solve HOTS questions. Therefore, it is essential to distinguish ideas or concepts clearly, argue well, solve problems, construct explanations, and understand complex matters more clearly to improve HOTS abilities (Widodo & Kadarwati, 2013).

The discussion presented above shows the analysis of HOTS of Mathematics Education PTKIN students. In response, several solutions are suggested to improve their HOTS abilities. Firstly, each PTKIN, particularly the Mathematics Education study program, should include courses that discuss HOTs theory in learning and mathematics material with HOTs level (Pratama & Retnawati, 2018). Secondly, lecturers should choose strategies and lecture methods that facilitate students in developing HOTs discovery learning (Indira, Zulkardi, & Sanova, 2019), Realistic Mathematics Education (Anggraini & Fauzan, 2020), blended learning (Siregar & Manurung, 2020), Problem Based Learning (Putra, et al., 2021), and many others. These solutions can help students improve their critical thinking, creative thinking, and problem-solving abilities.

CONCLUSION

In conclusion, the study shows that the average HOTS of Mathematics Education students in PTKIN Central Sumatera is moderate, with problem-solving skills being the highest and critical thinking and creative thinking abilities being the lowest. To improve the HOTS of Mathematics Education students in PTKINs, several suggestions can be made. First, lecturers should choose suitable teaching methods to enhance students' HOTS. Second, this research can be used as a

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reference to revise, reduce, and add courses in the curriculum that can improve students' HOTS abilities. Finally, the results of this study can be used as a reflection of the readiness of prospective mathematics teachers in the 21st century. Overall, this study highlights the importance of developing students' HOTS in mathematics education. By implementing appropriate teaching methods and curriculum revisions, PTKINs can improve the HOTS of Mathematics Education students and better prepare them for the challenges of the 21st century.

ACKNOWLEDGEMENT

We would like to express our gratitude to the entire academic community of UIN Imam Bonjol Padang, UIN Sultan Thaha Saifuddin Jambi, UIN Sultan Syarif Kasim Riau, IAIN Bukittinggi, and IAIN Batusangkar, and IAIN Kerinci for their invaluable contribution in data collection for this research. We also extend our appreciation to Prof. Dr. I Made Arnawa, M.Sc., Prof. Dr. Yerison, M.Si., and Sepridoni, M.Pd., Ph.D., for their assistance in validating the research instruments. This research was successfully competed in 2021 and received funding from Litapdimas through the Decree of the Rector of UIN Imam Bonjol Padang Number 698 of 2021.

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