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Evaluating the Professional Competence of Indonesian Mathematics Teacher Candidates to Face 21st Century Education Challenges

Rivdya Eliza[1*], Nita Putri Utami[2], Rahmatul Wahid[3]

[1*,2,3]Tadris Matematika, Universitas Islam Negeri Imam Bonjol
Jalan Mahmud Yunus, Padang, West Sumatera Province, Indonesia
[1*]*rivdyaeliza@uinib.ac.id*; [2]*nitautami@uinib.ac.id*; [3]*rahmatulwahid5@gmail.com*

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Abstrak

Penelitian ini bertujuan untuk mengungkap sejauh mana kompetensi profesional calon guru matematika di Perguruan Tinggi Keagamaan Islam Negeri (PTKIN) di Indonesia dalam menghadapi tantangan pendidikan abad ke-21. Empat aspek kompetensi profesional yang dikaji meliputi: penguasaan kompetensi dasar pembelajaran, kreatifitas dalam mengembangkan pembelajaran, pengembangan keprofesian serta pemanfaatan teknologi informasi dan komunikasi (TIK) dalam mendukung pembelajaran. Data dikumpulkan melalui kuisioner kompetensi profesional, tes kemampuan matematika dan kemampuan berpikir matematis, serta wawancara dengan calon guru matematika dari lima PTKIN. Sampel penelitian terdiri dari 448 mahasiswa yang dipilih dengan teknik *proportional random sampling*. Hasil penelitian menunjukkan bahwa secara umum calon guru matematika PTKIN memiliki kompetensi profesional yang tinggi, yang menunjukkan kesiapan mereka dalam menghadapi tantangan abad ke-21. Namun demikian, masih diperlukan peningkatan kemampuan dalam menyelesaikan soal-soal *Higher Order Thinking Skills* (HOTs), yang mendorong kemampuan berpikir kritis dan kreatif siswa dalam pembelajaran matematika. Implikasi praktis dari penelitian ini menyarankan agar dosen dan institusi PTKIN melakukan evaluasi diagnostik awal guna mengidentifikasi kebutuhan dan hambatan spesifik dalam pengembangan profesional calon guru, khususnya dalam aspek analisis, evaluasi, dan sintesis berpikir.
Kata Kunci: HOTs; calon guru; kompetensi professional; matematika

Abstract

This study aims to reveal the extent of professional competence of prospective mathematics teachers at State Islamic Religious Universities (PTKIN) in Indonesia in facing the challenges of 21st century education. The four aspects of professional competence studied include: mastery of basic learning competencies, creativity in developing learning, professional development and utilization of information and communication technology (ICT) in supporting learning. Data were collected through professional competence questionnaires, tests of mathematical ability and mathematical thinking ability, and interviews with prospective mathematics teachers from five PTKIN. The research sample consisted of 448 students selected using proportional random sampling technique. The results showed that in general, PTKIN mathematics teacher candidates have high professional competence, which indicates their readiness to face the challenges of the 21st century. However, it is still necessary to improve the ability to solve Higher Order Thinking Skills (HOTs) questions that encourage students' critical and creative thinking skills in learning mathematics. The practical implications of this study suggest that PTKIN lecturers and institutions conduct an initial diagnostic evaluation to identify specific needs and obstacles in developing prospective teachers' professionalism, especially in the aspects of thinking analysis, evaluation, and synthesis.
Keywords: HOTs; prospective teachers; professional competencies; Mathematics

I. INTRODUCTION

In addition to literacy skills such as reading, writing, and arithmetic, the globalization era requires mathematics teachers to master other critical skills, namely critical, creative, and collaborative thinking skills (Nahdi, 2019; Mafidapuspadina et al., 2021; Malik, 2018; Irwandani et al., 2024). These skills, known as Higher Order Thinking Skills (HOTs), are crucial life skills for students to adapt effectively in society (Murwanto, Qohar, & Sa'dijah, 2022; Setyaningsih & Kustiana, 2023). Mathematics is an ideal medium to develop these skills.

In order to effectively foster HOTs in students, teachers must first have strong HOT competence. Mastering HOTs requires a strong foundation in Low Order Thinking Skills (LOTs), so that both levels of thinking become equally important in effective learning. Meeting these demands requires the readiness of prospective mathematics teachers, especially in terms of their professional competence (Nisa, 2023). This responsibility is also a concern of the Educational Personnel Education Institution (LPTK), which plays an important role in producing quality teachers. Improving the quality of prospective mathematics teachers to face the challenges of the 21st century is a top priority for LPTK throughout Indonesia (Diniaty et al., 2017; Nuraeni & Juandi, 2023).

Recent studies have shown that professional and pedagogical competencies have a positive and significant contribution to student learning achievement, while social and personality competencies tend to have less effect (Astuti & Jailani, 2021). In addition, 21st-century learning requires teachers to master technology in order to utilize computers and make learning more effective (Tarihoran, 2019; Saputro et al., 2024). Studies also reveal that the competency profile of 21st century teachers in the aspects of creativity, communication, and critical thinking is still lower than the collaboration aspect (Abduh & Istiqomah, 2021), and there is an increase in participants' understanding of 21st century opportunities and challenges that can be applied to basic education (Malik, 2018; Yanuarto & Jaelani, 2021; Nahdi, 2019). These findings emphasize the importance of teachers' mastery of pedagogical, professional, personality, and social competencies, as well as their adaptability to technological developments.

However, research on prospective teachers found several challenges, such as high anxiety, difficulty in practicing theory, lack of manipulative skills, classroom management problems, and unpreparedness in implementing innovative pedagogical practices (Jarrah, 2020; Matorevhu, 2023). These obstacles are an important concern for LPTK in examining the process of preparing prospective mathematics teachers, especially regarding their readiness,

attitudes, competencies, and teaching practices.

In Indonesia, there are two types of LPTK, namely LPTK under the State Teacher Training College (PTKN) and LPTK under the State Islamic Religious College (PTKIN). The Mathematics Education Study Program at PTKIN was relatively recently established to meet the needs of mathematics teachers who have a good religious foundation and can integrate mathematics with Islamic teachings (Diniaty et al., 2017). Graduates of this study program are expected to fill the position of mathematics teachers in Madrasah Aliyah, Madrasah Tsanawiyah, and pesantren throughout Indonesia. However, research that focuses on improving the quality of mathematics study programs at PTKIN is still minimal.

Although previous studies have examined teacher competencies and educational challenges in general, there is still a lack of research that focuses on the professional competencies of prospective mathematics teachers, especially at PTKIN. Not many studies have specifically examined the extent of the readiness of PTKIN mathematics teacher candidates in facing the challenges of 21st-century learning, especially in the aspects of HOTs and professional development.

Based on this description, the problem formulations in this study are: "How is the professional competence of PTKIN mathematics teacher candidates in facing the challenges of 21st century learning?". Specifically, this study aims to: 1) describe the level of professional competence of prospective mathematics teachers at PTKIN, including in the aspects of mastery of material, pedagogy, mathematical thinking, and technology utilization. 2) analyze their readiness in facing the demands of 21st-century learning, especially in mastering HOTs-based questions. 3) Provide strategic recommendations for strengthening the curriculum and education programs for prospective teachers at PTKIN.

This study contributes to enriching the study of professional development of prospective teachers in Indonesia, especially in the PTKIN environment, which has unique characteristics and challenges. The findings of this study are expected to be the basis for policymakers at the institutional level to design training programs, curriculum strengthening, and competency evaluation that are more contextual and relevant to the challenges of the 21st century. Thus, this study not only provides a factual picture but also a conceptual basis for teacher education reform in PTKIN.

II. METHOD

This research is a reflection conducted through quantitative descriptive research whose results can describe the professional competence of PTKIN mathematics teacher candidates in answering the challenges of the 21st century. The population in this study was taken from all PTKIN mathematics teacher candidates, namely

Tadris Mathematics Final Semester (VII) students enrolled in the odd semester of the 2022/2023 academic year at Imam Bonjol State Islamic University Padang (UIN IB Padang), Sjech Djamil Djambek Bukittinggi State Islamic University (UIN SMDD Bukittinggi), North Sumatra State Islamic University (UIN SU), Sultan Thaha Saifuddin State Islamic University Jambi (UIN STS Jambi), and Kerinci State Islamic Institute (IAIN Kerinci). All of these universities are located on the island of Sumatra, Indonesia. The total population of the study was 448 students. Determination of the minimum sample size (*n*) was carried out using the Slovin formula (1960), so that 213 samples were obtained. The use of *the proportional random sampling* technique makes the sample taken by each university reflect the value contained in Table 1.

Table 1.
Number of samples taken at each university

No.	University	Sample (*n*)
1.	UIN SMDD	46
2.	UIN IB	30
3.	UIN SU	86
4.	IAIN Kerinci	18
5.	UIN STS	33

To obtain answers from the reflection, the research instruments of teacher professional competence were used in the form of questionnaires, test questions, and interview guidelines. The instruments were well prepared, consulted with experts, revised, and tested.

The professional competence questionnaire instrument was developed with four main aspects, namely 1) mastery of basic subject competencies, 2) creativity in developing learning materials, 3) professional development, and 4) utilization of information and communication technology (ICT) that supports learning. Each of these aspects is broken down into several indicators of positive and negative statements, totaling 25 items.

The revised results for the professional competence questionnaire, according to the experts in terms of content eligibility, are very valid (94%), for the language component is very valid (87%), for the presentation component is very valid (92%), and 4 for the graphic component is very valid (88%)%. The results of the questionnaire test conducted on the Tadris Mathematics class at UIN North Sumatra resulted in 25 valid items and obtained a high reliability value of 0.89. The results of this trial confirm that the professional competence questionnaire is valid and reliable, so that it is suitable for use in research.

For the test questions, consultation and revision from experts showed that the HOTs and LOTs questions in terms of feasibility: 1) content, very valid (90%), 2) language component, very valid (89%), presentation component, valid (83%), and graphic component, very valid (92%). After consultation, revision, and assessment of the instrument by *experts* were completed, the activity continued by testing the test questions—the results of the trial

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determined six questions that could be used. The six questions in question consist of LOTs questions that contain mathematical communication skills, mathematical reasoning skills, and mathematical connection skills, and HOTS questions, which contain creative thinking skills and critical thinking skills.

Prior to data collection, all participants were fully informed about the purpose, procedures, and voluntary nature of the study. Informed consent was obtained from each participant either verbally or in written form, ensuring that they understood their right to withdraw at any time without any consequences. The confidentiality and anonymity of all participants were strictly maintained throughout the research process. This study adhered to standard ethical principles in educational research and was conducted with respect to the rights and dignity of all participants.

Furthermore, after completing the research, the data from questionnaires and tests were processed, and the results were tabulated and presented in a proper format, including tables and similar visual aids. The data that has been presented well, then analyzed until it reaches the last stage, namely *verification*, namely making credible conclusions.

III. RESULT AND DISCUSSION

In this study, the reflection of professional competence of prospective mathematics teachers was traced from the mastery of basic subject competencies, the ability to develop learning materials creatively, the ability to develop professionalism, and the ability of teachers to utilize information and communication technology in supporting learning materials. These items are made in the form of statements developed in the questionnaire. The questionnaire data processing of the research results on the aspects described above can be seen in Table 2.

Tabel 2.
Results of Questionnaire Data on Professional Competence of Prospective Mathematics Teachers at PTKIN

Sample Class	Average value of professional competency aspects				Average	Criteria
	1	2	3	4		
UIN SMDD	83,88	83,15	76,09	80,84	80,99	High
UIN IB Padang	78,33	78,33	71,19	74,79	75,66	Medium
UIN SU	77,88	79,17	73,04	75,97	76,52	Medium
UIN STS Jambi	75,51	78,03	71,32	78,6	75,87	Medium
IAIN Kerinci	81,02	80,56	72,22	79,17	78,24	Medium
Average Value	**79,32**	**79,85**	**72,77**	**77,87**	**77,45**	Medium

Description:
1 : Mastering the basic competencies of the subject

2 : Develop learning materials creatively
3 : Professional development
4 : Utilize information and communication technology in supporting subject matter.

Processing of professional competence questionnaires results in a total average value of 77.45, and with this value, it is interpreted that the professional competence of prospective mathematics teachers from PTKIN is classified as moderate (Sugiyono, 2015). The findings of this study are in line with research conducted by Husaini (2018) and Wardoyo et al. (2020) that professional competence is an ability related to the mastery of learning materials broadly and deeply, which includes mastery of the scientific substance that overshadows the curriculum, as well as adding scientific insight as a teacher. The assessment of each aspect of measurement also provides a moderate value so that it can be concluded; (1) most prospective teacher students can master the basic competencies of subjects at the MTs and MA levels equivalent, (2) most prospective mathematics teacher students at PTKIN can develop learning materials creatively, (3) most students can develop their professionalism well and, (4) most prospective mathematics teacher students can utilize information and communication technology that supports subject matter. The explanation of each of the four aspects of the findings is as follows:

A. Mastery of basic subject competencies

Explanation of the first aspect: Professional competence is evident in the mastery of learning materials by prospective PTKIN mathematics student teachers. In this study, most PTKIN mathematics prospective teachers have mastered the basic competencies of the subject. In contrast, only a small number of students have not mastered the learning materials. During the interview, it was found that the cause of not mastering the learning material was the lack of preparation done beforehand. This finding is in line with findings from (Jarrah, 2020). (Yasin, 2022) states that mastery of learning materials by teachers will clearly affect the smooth running of learning activities.

Meanwhile, Wardoyo et al. (2020) state that teachers who can master learning materials will lead students to achieve maximum learning goals. (Haris, 2019) also states that there is a very urgent relationship between mastery of subject matter and the learning achievements that students will achieve. Without this relationship, it is impossible for the learning objectives that have been set to be achieved together by teachers and students. To meet the needs of mastery of learning materials, Nisa (2023) suggests that prospective teachers and mathematics

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teachers themselves practice doing continuous problems with materials that are considered new so that the ability of prospective teachers and teachers can be developed to a higher level (Matorevhu, 2023)

Furthermore, from the mastery of the material to be taught, information about the mathematical abilities (LOTs) and higher-order thinking skills (HOTs) of PTKIN mathematics teacher candidates can be extracted. The assessment with the appropriate scoring rubric resulted in descriptive data of LOTS test scores covering communication, reasoning, and connection skills presented in Table 3.

Table 3.
Descriptive results of LOTs ability of prospective teacher students from PTKIN

Univ.	LOTS			Total $\sum x_i$	Average $\bar{x}$
	Connection (x_1)	Reasoning (x_2)	Communication (x_3)		
UIN STS	96,93	85,1	76,88	258,91	86,30
IAIN Kerinci	96,36	85,88	78,94	261,18	87,06
UIN SU	84,72	67,56	78,85	231,13	77,04
UIN SMDD	97,85	76,54	86,44	260,83	86,94
UIN IB	60,04	70,42	86,54	217	72,33
Total	435,9	393,5	407,65	1237,05	412,35
Average	87,18	78,7	81,53	247,41	82,47

Although HOT's ability is a critical issue that must be faced in the 21st century, LOT's ability is a fundamental mathematical ability that must be possessed first to facilitate mastery of HOTs. If connected to Bloom's taxonomy, the cognitive aspects related to LOTs are: knowledge-understanding and application (Eliza et al., 2022). In this study, the LOTs aspects studied are: communication, reasoning, and connection skills. These three abilities are interconnected with each other. (Anggraena, 2019) Mathematics is not just about being known, but it also contains procedures that have interrelated ideas and the process of reasoning. These interrelated ideas refer to one of the abilities, namely, mathematical connection. Meanwhile, reasoning ability is a thinking process adopted to generate statements and reach conclusions on the problem being solved, which does not always use formal logic and is not limited to evidence (Lithner, 2008; Utomo et al., 2020). The higher the level of reasoning possessed by students, the faster the process of achieving learning indicators (Anggraena, 2019). Communication is a classroom activity that offers the possibility for students to develop a deeper understanding of the mathematics they learn (Riyadi et al., 2018).

Good communication skills will show the extent of exploration of thinking and understanding that can be done in learning mathematics (Dewi & Afriansyah, 2018; Luritawaty, 2019).

In Table 3 above, on average, the mathematical connection ability of prospective mathematics teachers from 5 PTKIN is 87.18, the average reasoning ability is 78.7, while the average communication ability of 5 PTKIN is 81.53 Each of these averages reflects the LOTs ability of prospective mathematics teachers from PTKIN which is high, so it can be concluded that prospective mathematics teachers have good mathematical abilities. The paragraphs below will further review these mathematical abilities.

The connection ability, with an average of 87.18, shows that 1) in lectures, prospective teachers from 5 PKTIN have been provided with lecture materials that show the relationship between the mathematical concepts taught. For example, when discussing quadratic equations, prospective teachers gain insight into how this concept is applied in physics. For example, the concept of the quadratic equation is used to calculate the trajectory of a thrown object. Thus, students can understand that mathematics has a wide application. 2) Students have been introduced to real-world problems that are challenging and relevant to their interests. For example, students can be invited to learn how calculus is used in economics. This approach is in line with constructivist learning theory, which emphasizes the importance of meaningful and relevant learning (Piaget, 1970). 3) Students can work collaboratively to solve complex problems, which require integrating various mathematical concepts. According to Blumenfeld et al. (1991), this approach can increase students' motivation and understanding of the material studied. 4) Students enjoy a learning environment that supports discussion and collaboration. Through group discussions, students can help each other identify the relationship between concepts and how to apply them. This strategy also helps students who may have different perspectives in understanding certain concepts. 4) Students get constructive and specific feedback related to their mathematical connection skills. For example, lecturers can point out how the solutions provided by students can be further developed by integrating other relevant concepts. Black and Wiliam (1998) assert that quality feedback is an important element in effective learning.

Furthermore, in Table 3, for the reasoning ability of mathematics teacher candidates from 5 PTKIN, the average score is 78.7. This score is quite good and cannot be separated from: 1) an active and collaborative learning approach taken by prospective mathematics teacher students that emphasizes discussion, debate, and group work, so that it can hone students' reasoning skills. 2) The provision of

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sufficient provision from lecturers so that students can have an analytical way of thinking, which is an important point in improving student reasoning. 3) a learning environment that supports students' reasoning skills. Interaction with classmates from diverse backgrounds and perspectives can broaden students' understanding of a problem. The combination of an active learning approach, the influence of competent lecturers, technological advances, and a supportive environment is essential in improving students' reasoning ability. (Astin, 1993) states that meaningful learning occurs when students are allowed to engage in an active process of constructing their own knowledge, which leads to the development of reasoning and critical thinking skills.

Along with the above, Table 3 for mathematical communication skills obtained an average score: 81,53. Through the acquisition of this score, it can be interpreted that prospective mathematics teacher students are trained to explain concepts using language that is easy to understand, both orally and in writing. According to Ball & Bass (2003), good mathematical communication is the key to helping students understand and convey mathematical ideas effectively. The ways prospective mathematics teacher students have approached this include 1) engaging in a structured learning approach that incorporates various strategies, such as group discussion. In discussions, students are trained to express opinions, listen to other people's ideas, and collaborate in solving problems. Cole et al. (1978) state that social learning, including group discussions, strongly supports the development of cognitive and communication skills. 2) working on tasks that encourage students to write detailed mathematical explanations, such as compiling reports or making presentations on the solution of a problem. This activity helps students practice the use of precise mathematical terms and structure arguments logically. 3) Using technology in lectures. Tools such as GeoGebra or other interactive applications allow students to create visualizations that help them convey concepts more clearly. These visualizations not only improve the understanding of prospective mathematics teachers at PTKIN but also facilitate communication with audiences who have different levels of understanding. 4) Evaluating and receiving specific feedback is very important in improving mathematical communication skills. (Black & Wiliam, 1998) emphasizes that effective feedback can help students identify weaknesses and improve the way they communicate. 5) Recognize the benefits of mathematical communication skills in real life. For example, these abilities are essential in professions that require collaboration or presentation of complex data. By understanding the relevance of mathematical communication, students will be more motivated to hone these skills. 6) Develop a growth mindset in students,

so that they are confident to keep trying and improving the way they communicate. (Nopermen, 2024; Mangels et al., 2006) emphasize that a growth mindset can encourage individuals to see mistakes as part of the learning process and keep trying to get better. By focusing on these strategies, students' mathematical communication skills can be significantly improved, opening up wider opportunities in their education and career as future mathematics teachers.

From the results for connection, reasoning, and mathematical communication skills, prospective mathematics teacher students already possess sufficient capital to develop good HOTs. For a description of the HOTs test results of prospective mathematics teachers from PTKIN, see Table 4:

Table 4.
Descriptive results of HOTs skills of prospective teachers from 5 PTKINs

Univ.	HOTS		Total $\sum y_i$	Average $\bar{y}$
	Critical (y_1)	Creative (y_2)		
UIN IB	49,81	44,59	94,40	47,20
UIN SU	54,5	70,69	125,19	62,60
UIN	81,33	78,86	160,19	80,10
UIN SMDD	66,72	75,71	142,43	71,22
IAIN Kerc.	76,63	79,45	156,08	78,04
Total	328,99	349,3	1090,64	363,55
Average	65,798	69,86	218,128	72,71

Table 4 shows that the average HOTs score from PTKIN is 72.71. The study shows a clear gap between the mastery of LOTs and HOTs among PTKIN mathematics teacher candidates, with HOTs being significantly lower. This pattern is due to the traditional learning culture where students are exposed to more procedural tasks and formula-based exercises. One participant said, "*We usually learn by memorizing formulas and solving routine problems. So, if the question is slightly different, I often get confused*." Another added, "*If the exercise questions are not the same as what the lecturer taught, I don't know where to start*." These responses reflect a heavy reliance on examples provided by the lecturer and a lack of opportunity to engage in open-ended or reasoning-based questions.

Moreover, students reported difficulty in articulating their mathematical thinking. As one student stated, *"During microteaching, I knew the answer, but I got nervous and unsure when I had to explain it to others."* This suggests that the development of critical and creative thinking, as well as mathematical communication, remains under-emphasized in PTKIN teacher training programs. The absence of tasks that require students to synthesize information,

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justify methods, or explore multiple solutions further limits HOT's growth.

Compared to studies in non-PTKIN institutions, where inquiry-based and reflective pedagogies are more common (Yulindaputri & Sutrisno, 2023), PTKIN students appear to have fewer structured opportunities to develop higher-order skills. Therefore, these findings call for curriculum adjustments and instructional innovations in PTKIN, ensuring that HOTs are embedded systematically through both coursework and practicum. Strengthening HOTs is crucial for preparing future mathematics teachers to facilitate 21st-century learning environments.

Based on Table 4, the higher-order thinking skills (HOTs) of prospective mathematics teachers from the PTKIN studied are divided into two aspects, namely critical thinking and creative thinking. According to Table 3, the 5 PTKINs sampled exhibit varying levels of critical thinking skills: 1 PTKIN (UIN IB) has low skills, 1 (UIN SU) has moderate skills, and 3 (UIN Jambi, UIN Kerinci, and UIN Bukittinggi) have high skills. However, when averaged, the critical thinking skills of PTKIN mathematics teacher candidates are still in the medium category, so it can be concluded that this critical thinking ability is still at a level that needs to be improved.

At the university level, critical thinking skills are an essential component, especially in mathematics. It enables students to analyze, evaluate, and solve problems logically and systematically. By strengthening technical and higher-order thinking skills in mathematics learning, prospective teachers can be better prepared to face the growing demands of education and increasingly sophisticated technology in this digital era (Yanuarto & Jaelani, 2021), and prospective teachers are also helped to develop analytical skills, problem-solving, and quality teaching in the context of mathematics learning (Irwandani et al., 2024; Siahaan et al., 2023).

In a journal written by Olivia et al. (2024), critical thinking is defined as: 1) a process of making decisions that have reasons based on consideration of available evidence from contextual aspects contained in the situation and concepts concerned, and 2) an activity to decide what to do, when, where, why, and how to do it. (Tilaar, 2011) asserts that critical thinking is important to develop in education because: 1) provides an opportunity for the full development of the student's personality because students feel respected for their rights, 2) is the ideal goal of education in preparing students for their adult life, 3) traditional ideals to be achieved through the learning of exact and natural sciences and other subjects, 4) is something that is needed in a democratic life. The teacher's ability to teach plays a significant role in developing critical thinking skills in students, providing flexibility for students to reconstruct, interpret, and express ideas that students have (Jarrah, 2020). Based on the

explanation above, it can be concluded that critical thinking skills will grow and develop more in an environment where there is always curiosity in the process of solving problems. Critical thinking helps prospective mathematics teachers in developing analytical skills, problem-solving, and quality teaching in the context of mathematics learning (Irwandani et al., 2024; Siahaan et al., 2023).

However, students often show limitations in critical thinking skills. Some things that can cause this low ability include: 1) there is still a learning approach that focuses too much on memorization and procedures without a deep understanding, which can hinder the development of critical thinking skills. Prospective mathematics teacher students may be able to solve routine problems, but have difficulty when faced with problems that require analytical and evaluative thinking (Nopermen, 2024). To overcome this problem, a problem-based learning model can be applied to encourage students to be actively involved in solving real problems. By facing complex situations, students are trained to think analytically and evaluate solutions in depth (Wardani, 2023). 2) The lack of exposure to challenging problems that require high-level reasoning causes students to be unaccustomed to critical thinking. As a result, they tend to memorize material and formulas rather than understanding concepts in depth (Herman et al., 2024). To overcome this, giving challenging non-routine problems can train students to develop critical thinking skills, as well as help them get used to various types of problems and their solution strategies (Wardani, 2023) (2). 3) Low motivation to learn and a negative attitude towards mathematics are also obstacles. Internal factors such as lack of interest and willingness to learn also play a role in inhibiting the development of critical thinking skills (Lahacila et al., 2024). In this context, lecturers have an important role to play in creating a supportive and challenging learning environment. 4) providing specific and constructive feedback on students' thinking process, not just the final result. This helps them understand their strengths and areas for improvement in critical thinking (Engliana & Ekarina, 2024). 5) Finally, creating a classroom atmosphere that encourages curiosity, tolerance for mistakes, and appreciation for students' efforts in critical thinking is essential (Lahacila et al., 2024). By implementing these strategies, lecturers can help students develop critical thinking skills that not only improve academic performance but also prepare them to face complex challenges in the real world.

At the same time, from the data in Table 4, it was found that for creative thinking skills, 1 PTKIN obtained low criteria, and 4 PTKIN obtained high criteria. On average, all PTKIN mathematics teacher candidates are in the medium category. In other words, prospective mathematics teachers from LPTK PTKIN have not maximized in

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distinguishing ideas or ideas clearly, arguing well, not maximizing problem solving, constructing explanations, hypothesizing, and understanding complex things to be clearer (Jumri & Damara, 2020),(Widodo, 2021).

This finding presents a significant challenge for prospective mathematics teachers from PTKIN, who must improve their creative thinking skills (Jumri & Damara, 2020). Prospective mathematics teachers with creative thinking abilities will have an impact on their daily creativity, including in teaching. It is essential to emphasize to prospective PTKIN Mathematics teachers that creative teaching methods can be more motivating, and the purpose of fostering creativity is to enhance the quality of education (Huda & Tandiayuk, 2017).

For this reason, specific ways need to be done so that prospective mathematics teachers can hone their abilities to become creative teachers in teaching, namely: providing innovative teaching practices through environmental conditioning that supports creativity, maintaining an open attitude, and reflecting (Craft, 2003). Prospective PTKIN mathematics teachers can develop a plan for the learning process and continue to think about the presentation of the learning process that involves students (Maulidah et al., 2021). The planning of the learning process in question includes 1) the use of learning approaches that provide freedom for students to explore new ideas. Teaching methods that are too rigid tend to limit students in developing innovative solutions (Nopermen, 2024). In addition, the lack of learning activities that involve solving open problems can inhibit student creativity in finding various solution approaches (Wardani, 2023). 2) motivating students that creative thinking skills are indispensable in the 21st century. 3) Providing tasks that trigger exploration and innovation, such as research-based projects or problem-solving tasks that require unique approaches (Lahacila et al., 2024), will hone students' creative thinking skills. 4) conditioning the learning environment that encourages students to express ideas without fear of being wrong, to build confidence in creative thinking (Lahacila et al., 2024).

B. Develop learning materials creatively

Explanation of the second aspect: Teachers are considered professional if they can express their creative ideas and develop their knowledge to facilitate a smooth and successful learning process. Judging from the questionnaire data presented, prospective mathematics teachers from UIN SMDD and IAIN Kerinci are at a very high level (Sugiyono, 2015), with acquisition scores of 83.15 and 80.56, respectively. The rest of UIN IB (78.33), UIN SU (79.17), and UIN STS Jambi (78.03) are at a high level (Sugiyono, 2015). The overall average of these 5 PTKIN is 78.24 and is classified as high. This finding suggests that prospective mathematics teachers from

PTKIN have mostly been able to develop learning materials creatively. Creative ways that are usually done are by; 1) linking learning materials with daily activities or relevant knowledge, 2) designing learning in such a way that is in accordance with the character of the students and the material being taught and 3) providing learning media that can make it easier for students to understand the learning taught (Oktiani, 2017), (Fitriyani et al., 2021). 4) using varied learning approaches that are integrated with the needs and characteristics of students. Contextual approach, use of technology, problem-based learning, collaborative learning, and use of multimedia are some of the strategies that can be applied to improve the quality of learning materials. With creative and relevant materials, students will not only be more interested in learning but also be able to understand and apply knowledge in a deeper and more meaningful way. Developing learning materials creatively is also supported by the new paradigm of mathematics learning in using constructivism, and the development of thinking skills, the selection of methods or media that can support and develop student creativity, and the understanding of all mathematics teachers about the essence of learning Mathematics itself (Haris, 2022).

C. Develop professionalism

For the aspect of developing professionalism, the target in this study is the efforts that prospective mathematics teachers continuously make to *upgrade* their performance. Professional development will always place teachers and prospective mathematics teachers at the forefront as agents of change in education and learning. This professional development is related to the concept of lifelong learning, where learning is needed throughout life in response to various forms of social change, the development of science and technology (Riza et al., 2022). By continuing to learn and upgrade their teaching abilities, teachers can provide excellent service for all students they teach. Teachers who are always ready to learn throughout their professional development are called learner teachers. Lifelong learning also includes pedagogic and andragogic concepts, which are obtained from life experiences that have been lived, so that it can be done anytime and anywhere (Andiyanto, 2018)

In this study, it was found that in the 5 PTKINs that were sampled, the aspect of developing professionalism was in the medium criteria. Most of the prospective mathematics teachers have developed their professionalism well. This finding is supported by the average value processed from the results of the questionnaire distributed, which is 72.77, and comes from the following institutions: UIN SMDD (76.09), UIN IB (71.19), UIN SU (73.04), UIN STS Jambi (71.32), and IAIN Kerinci (72.22). These results are also reinforced by interviews conducted, where PTKIN

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mathematics teacher candidates are mostly fond of practicing with materials that are considered new, and these exercises are felt to be useful for further self-development. Many prospective teacher students also aspire to continue to a higher level or master's program (S2). Student mathematics teacher candidates from PTKIN are also aware of the Teacher Working Group (KKG) and Subject Teacher Conference (MGMP) to share experiences in the learning process with colleagues. Continuous learning can also be achieved by developing digital competencies, conducting classroom action research, and enhancing pedagogical literacy and understanding. Student teachers also reflect on the strengths and weaknesses in their scientific insights (Tanjung et al., 2020).

D. Utilize information and communication technology to support subject matter.

The rapid development of science and technology is one of the reasons for teachers to immediately adapt, innovate, be creative, and critical in carrying out their duties to organize learning activities (Yanuarto & Jaelani, 2021; Susantini et al., 2022). The utilization of technology to support learning is inseparable from the demands of the 21st Century, where a teacher's professional competence can also be seen from their ability to adapt to technological developments (Zebua, 2023). This is in line with research conducted by Manalu et al. (2022) and Susantini et al. (2022), which states that information and communication technology must be utilized as a learning medium to support the professional competence of a teacher in the 21st Century. Technology can be used to develop deeper learning that is not limited to a single situation.

The research findings in Table 1 show that, on average, the result is 77.45 with moderate criteria. This figure was obtained from UIN SMDD (80.99), UIN IB (75.66), UIN SU (76, 52), UIN STS Jambi (75.87), and IAIN Kerinci (78.24). This shows that mathematics teacher candidates from PTKIN have utilized technology in learning. However, of course, this utilization still has to be improved. Prospective mathematics education teachers need to understand that good digital literacy and higher-order thinking skills can help them teach mathematics more effectively and innovatively (Yanuarto & Jaelani, 2021). For example, the use of virtual reality (VR) or augmented reality (AR) in learning can create an immersive learning experience. Meanwhile, artificial intelligence (AI)-based technologies can be used to create adaptive learning materials that match students' abilities.

Prospective mathematics teacher students from PTKIN can practice developing digital-based teaching materials that are flexible and attractive. Prospective mathematics teachers can: 1) use interactive presentation software such as

Prezi or Powtoon to explain abstract concepts when developing teaching materials. 2) Integrate educational videos from platforms such as YouTube or create digital teaching materials that students can access at any time. These teaching materials can broaden multicultural insights so that students' understanding of the world is much more developed.

IV. CONCLUSION

Based on the findings from the five PTKIN institutions, prospective mathematics teachers have demonstrated strong mastery of teaching materials and proficiency in lower-order thinking skills (LOT), such as reasoning, connection, and communication. They also showed good progress in developing teaching materials creatively, demonstrating professionalism, and utilizing technology in learning. These competencies, although generally good or high, contrast with the relatively low development of higher-order thinking skills (HOTS), especially critical and creative thinking

To address this gap, lecturers are advised to implement active learning strategies, encourage metacognitive reflection, use open-ended and problem-based tasks, and integrate digital technologies that enhance cognitive engagement. PTKIN institutions also have a strategic role in supporting HOTS development by offering professional development for lecturers, designing HOTS-oriented curricula, ensuring access to digital and academic resources, and developing learning environments that value inquiry, innovation, and collaboration.

This study recognizes its limitations. Data was collected from only five PTKIN institutions, which may not be representative of the wider geographical and institutional diversity across Indonesia. Furthermore, the reliance on self-reported reflections introduces potential bias and subjectivity in the results. Therefore, future research should consider longitudinal studies that observe the development of professional competence and HOTS over time, using more diverse data sources and a wider sample to increase validity and generalizability.

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AUTHORS' BIOGRAPHY

Dr. Rivdya Eliza, S. Si, M. Pd

Born in Padang, August 07, 1978. Until now, I have been teaching in the Tadris Mathematics Study program, Faculty of Tarbiyah and Keguruan Sciences, State Islamic University (UIN) Imam Bonjol, Padang. S1: Studies in Mathematics, Bogor Agricultural University, graduated in 2003; S2: Studies in Educational Technology, Bogor Agricultural University. MIPA Education; S3 studies in the Mathematics Education Study program, Concentration of Mathematics Education UNP, Graduated in 2019. The research interests are mathematics education, prospective mathematics teachers, Realistic Mathematics Education, HOTs, and Problem-Based Learning.

Nita Putri Utami, M. Pd

A lecturer in the Mathematics Education study program at the Faculty of Tarbiyah and Teacher Training, Imam Bonjol Padang, since 2017. Her research focuses on developing learning tools, improving the quality of mathematics learning in schools, and in higher education, plus any significant academic achievements.

Rahmatul Wahid, S. Pd, Gr.

A graduate of the Mathematics Education Study Program at the State Islamic University of Padang with cum laude predicate in 2023. He has also completed his Teacher Professional Education in 2024. His current research interests include approaches to mathematics learning and developing student abilities at various levels and fields of education. His publication topics include approaches to mathematics learning, analysis of mathematics learning difficulties, and higher education