Journal of Education and Learning (EduLearn)
Vol. 18, No. 2, May 2024, pp. 588~597
ISSN: 2089-9823 DOI: 10.11591/edulearn.v18i2.21184

Preservice mathematics teacher knowledge of higher order thinking skills

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Article Info

Article history:

Received Aug 11, 2023
Revised Dec 11, 2023
Accepted Dec 22, 2023

Keywords:

Bloom's taxonomy
Higher order thinking
Mathematics
Preservice
Teacher

ABSTRACT

This study aims to describe preservice mathematics teacher knowledge of higher order thinking skills in terms of definition, Bloom's taxonomy level, curriculum, learning, and evaluation. This research is quantitative research with a survey method. and sample consisted of 248 preservice mathematics teachers in semesters VI - VIII of the Department of Mathematics Education, Nusa Cendana University, Timor University, and Wira Wacana Sumba University. The instrument used was a questionnaire about high order thinking skill (HOTS) which consisted of 105 statements. Data analysis used Likert's summeted rating, one sample test, Mann Whitney, Kruskall-Wallis tests, multiple linear regression test, and multivariate analyisis of variance (MANOVA) test. The results showed that the knowledge level of preservice mathematics teacher was in the good category. Based on gender differences, there was no significant difference in the average knowledge of preservice mathematics teacherabout HOTS, there was a significant difference in the average knowledge of preservice mathematics teacher about HOTS which is significant based on differences in academic ability and gender differences do not significantly affect knowledge about HOTS levels in Bloom's taxonomy, curriculum, and pedagogy while academic knowledge has a significant effect on HOTS knowledge of preservice teachers in almost all aspects except for pedagogy.

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1. INTRODUCTION

Higher-order thinking skill (HOTS) is a thinking skill based on the cognitive level of Bloom's taxonomy which includes three levels of ability, namely analyzing, evaluating, and creating [1]–[3]. Another opinion says that HOTS includes critical, reflective, creative, and meta-cognitive thinking skills [4], [5] and reflection to solve problems, make decisions, innovate and create things [6], [7]. Besides that, HOTS is an important part of creative and critical thinking, and creative thinking pedagogy helps students develop more innovative ideas, idealized perspectives, and imaginative insights. HOTS focuses on developing students' skills to effectively analyze, interpret, and evaluate existing information and create new ones [8]. Thomas and Thorne [9] states that HOTS is not just remembering existing facts or doing something based solely on existing examples but having a higher level of thinking, being able to work in complex situations, thinking non-algorithmically, being able to solve unexpected problems and create many answers or solutions.

HOTS facilitates open-mindedness to take risks, has curiosity, is interested in finding facts, makes plans and provides appropriate methods, has a systematic mindset, is thorough, thinks rationally based on facts, and is able to control oneself. By developing HOTS, a person is able to manage the knowledge acquired into long-term memory, able to adapt in dealing with various new problems so that it will foster attitudes and ways of thinking creatively towards more complex problems, and encourage the achievement of quality and globally competitive human resources [10]. HOTS development will improve the quality of thinking, skills, and values and be able to apply knowledge in solving problems and making decisions [11].

The importance of HOTS in current learning causes its implementation to be the most crucial policy [12]. This is the focus of the Ministry of Education and Culture of the Republic of Indonesia by implementing HOTS in classroom learning through the implementation of the 2013 curriculum [13]. HOTS in the 2013 curriculum is illustrated by the stages of scientific learning, access to colaboration, communication, critical, creative (4C) and basic knowledge competencies that access the cognitive aspects of Bloom's taxonomy to the highest level and basic competency skills that access psychomotor skills as an implication of knowledge about content.

The development of HOTS must begin with a supportive learning design, namely through student-centered active learning [14]–[16]. Active learning is a student-centered learning approach that involves students directly in the process and encourages students to take ownership of their own educational experiences anad enhance student freedom and independence by engaging students' responsibility [17]–[19]. In addition to learning that is packaged in the students center learning approach, assessment also has an important place in the development of HOTS. The assessment in the 2013 curriculum is also adopted from an international standard assessment model which in its application is expected to help improve students' HOTS [20]–[22]. Assessment in the 2013 curriculum uses authentic assessment, emphasizing improving students' thinking skills from low to high, using in-depth questions, not just rote memorization, and measuring student work processes, not just their work.

To support the implementation of HOTS, an appropriate strategy is needed in the learning process to develop HOTS. According to Collins [23], there are several steps that teachers need to take to develop student HOTS, including: i) Teaching HOTS specifically using instructions, where teachers must tell students what they have to do not just teach concepts; ii) Conducting debriefing and class discussion, in which the teacher must prepare question items that are able to encourage students' HOTS and provide classical discussion time to train students' argumentation skills; iii) Teaching concepts explicitly, where students are trained to connect the concepts they have learned and use them to make questions; iv) providing scaffolding, namely the teacher helps students in finding concepts and answering questions. However, in certain conditions the teacher also provides opportunities for students to study independently; and v) Teaching HOTS on an ongoing basis, where teachers can use strategies, such as teaching skills through real contexts, varying the contexts in which students apply acquired skills, emphasizing higher-level thinking, making conclusions, analyzing components, and solving problems. In addition, teachers need to change learning methods to be more innovative. The innovative method in question is student-centered learning and solve the problem. In addition, teachers need to change learning methods to be more innovative. The innovative method in question is student-centered learning and solve the problem. In addition, teachers need to change learning methods to be more innovative. The innovative method in question is student-centered learning [24] using constructivism theory, and providing opportunities for students to explore their abilities in problem solving activities [25] and using innovative learning models.

The successful development of HOTS requires the teacher's knowledge of HOTS itself, which is related to an understanding of the HOTS level in Bloom's taxonomy, the 2013 curriculum, learning, and evaluation that are characterized by HOTS since preservice teachers. Several studies have shown that there are still many misconceptions about HOTS by teachers and preservice teachers. Research Samo [26] on the conception of future mathematics teachers about HOTS in Bloom's taxonomy shows that preservice mathematics teachers still misunderstand the concept of HOTS in Bloom's taxonomy. They still incorrectly identify the types of lower-order thinking skills (LOTS) and HOTS questions. In addition, they still emphasize the differences in the types of LOTS and HOTS questions based solely on differences in problem difficulty, types of calculation or proof questions, conceptual or contextual, and basic or advanced thinking concepts. They also still incorrectly categorize the application's cognitive level in the bloom taxonomy as HOTS. Similar results were found by Rianasari and Apriani [27] that preservice teacher knowledge about HOTS and their ability to design HOTS-based problems is still very low. They have not been able to relate HOTS problems to the cognitive demands of Bloom's taxonomy. They also tend not to be able to formulate non-routine problems and are only able to formulate application problems that are commonly found. Retnawati *et al.* [25] also conducted research to find out the description of teachers' knowledge about HOTS. The results of his research show that teachers' knowledge of HOTS, their ability to improve students' HOTS, solve HOTS-based problems, and their ability to measure students' HOTS is still low. As for Abdullah *et al.* [28] identify the level of knowledge and practice of HOTS teachers' implementation of mathematics focusing on aspects of curriculum, pedagogy, and assessment. The results of his research show that the level of HOTS knowledge and practice in the assessment aspect is very low. In addition, they also found that there was a relationship between the level of teacher knowledge and HOTS implementation practices in all aspects.

Some of the research results above have described the knowledge of teachers and preservice mathematics teachers about HOTS. However, the picture presented is still not comprehensive regarding all aspects related to HOTS, namely definition, cognitive level in Bloom's taxonomy, curriculum, pedagogy, assessment, and identification of HOTS-characterized questions. Therefore, the significance of the research that distinguishes this research from previous studies is that this study describes the knowledge of preservice teacher students about HOTS using analysis on aspects of HOTS definition, cognitive level on Bloom's taxonomy, curriculum, pedagogy, and assessment, as well as a review of academic knowledge and gender which are the differentiating factors between preservice teachers.

2. METHOD

This research is quantitative research with a survey method. This research is directed to answer the question of how the knowledge of preservice mathematics teacher of higher-order thinking skills is used as initial information for the purpose of increasing, developing, and improving the learning process in mathematics education department. The population in this study were preservice mathematics teacher in semesters VI - VIII of the Department of Mathematics Education, Faculty of Teacher Training and Education, Nusa Cendana University; Department of Mathematics Education, Timor University; and Department of Mathematics Education, Faculty of Teacher Training and Education, Wira Wacana Sumba University. The sampling technique used for this study was cluster random sampling with each sample group taken at random with a minimum sample target of 200 preservice mathematics teacher students. This instrument consists of an interview guide and a measurement instrument on HOTS consisting of 105 statements related to definition, level HOTS in Bloom's taxonomy, curriculum, pedagogy, assessment, and level of HOTS questions. The grid is presented in Table 1 (see Appendix).

The research instrument was validated theoretically by two experts and tested empirically on 30 samples outside the research sample to obtain empirical validity and reliability. The results of the theoretical validation indicated that there were several editorial improvements to the statement sentences in the survey so as not to confuse the research sample, while the results of empirical validity testing at the 5% level of confidence obtained an r count > 0.192, thus the statement item was declared valid and the Cronbach's alpha value > 0.6 so that the item statements are declared reliable. Data analysis used Likert's summeted rating, which divided the level of knowledge into four categories, tested one sample to test the hypothesis that the level of teacher knowledge was in the good category.

3. RESULTS AND DISCUSSION

Research activities were carried out in June-July 2021 with a research sample of 248 students. The students who were used as the research sample were students in semester VI and above with the consideration that in terms of learning experience there was already quite a lot of material studied in lectures and already had sufficient provisions to carry out field experience program. The research results are tabulated and analyzed according to the needs of the research objectives. The research questionnaire is divided into five components that measure understanding of HOTS from definition to identification of HOTS-characterized questions. The questionnaire consists of two main parts, namely the respondent's biodata and 105 statements related to the knowledge of preservice mathematics teachers about HOTS. The profiles of respondents are presented in Table 2.

The data in Table 2 provides an overview of the profiles of research respondents from 3 different universitiesthe biggest frequency was Nusa Cendana University students with 58.06% and dominated by women around 70.97%. Questionnaire data was mapped based on student background and analyzed descriptively with the aim of categorizing the knowledge level of preservice mathematics teachers about HOTS based on Likert's summeted rating. Descriptive statistics for the knowledge of preservice mathematics teachers about HOTS are presented in Table 3.

The maximum score of the questionnaire is 420 while the minimum score is 105, thus the range value for each category is 63. The knowledge level of preservice mathematics teachers is divided into 5 levels with the lowest level (very poor) with a score in the range 105 - 168 to the highest (very good) in the score range 357 - 420. There were 188 preservice teacher who had good knowledge of HOTS and 55 preservice mathematics teachers who had very good knowledge of HOTS. There were no preservice mathematics teachers who had poor knowledge of HOTS. The categorization of knowledge levels of preservice mathematics teachers about HOTS is presented in Figure 1.

Table 2. Profile of respondents

Background	Category	Frequency	%
Origin university	Nusa Cendana University	144	58.06
	Timor University	69	27.82
	Discourse hero	35	14.12
Gender	Man	72	29.03
	Woman	176	70.97
Semester	VI	102	41.12
	VIII	108	43.54
	X	38	15.34
Grade point	< 2.75	12	4.83
	2.75 - 2.99	48	19.35
	3.00 - 3.25	83	33.46
	3.26 - 3.49	59	23.79
	> 3.50	46	18.54

Table 3. Descriptive statistics

Descriptive statistics		Knowledge value
N	Valid	248
	Missing	0
Means		338.806452
Std. error of means		1.455641
Median		341
Mode		353
Std. deviation		22.923452
Variances		525.484655
Range		150
Minimum		265
Maximum		415

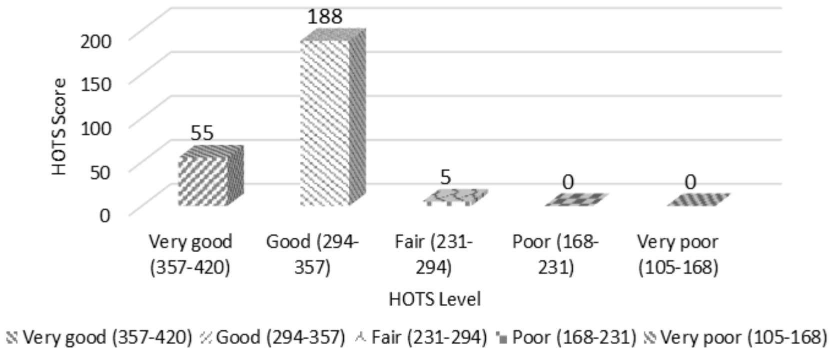

Figure 1. The HOTS knowledge level of preservice math teachers

The results of measuring HOTS knowledge in Table 4 apply to samples taken randomly from the population. To analyze the condition of knowledge about HOTS in the population, a one-sample statistical test was carried out, which was preceded by an analysis prerequisite test, namely the data normality test. The normality test results are presented in Table 4.

Table 4. Normality test for knowledge of preservice mathematics teachers about HOTS

	Tests of normality					
	Kolmogorov-Smirnov			Shapiro-Wilk		
Knowledge	Statistics	df	Sig.	Statistics	df	Sig.
	0.058	248	0.040	0.989	248	0.045

The test results in Table 4 show the significance (sig.) Kolmogorov-Smirnov is 0.040 <0.05, thus it can be concluded that the data comes from a population that is not normally distributed. Furthermore, testing one sample using the Chi Squared test with the hypothesis:

- H_0: knowledge level of preservice math teachers = 231
- H_1: knowledge level of preservice mathematics teachers ≠ 231

With basis for decision making if the asymp value is significant < 0.05 then H_0 is rejected and vice versa. The test results are presented in Table 5. The test results in Table 5 show 000 < 0.05, thus it can be concluded that H_0 is rejected and H_1 received, which means level knowledge of preservice mathematics teachers≠231. If we look at the average and distribution of knowledge levels in Table 5, we can conclude that the knowledge level of preservice mathematics teachers is greater than 231.

Table 5. Test of one sample knowledge of preservice mathematics teachers about HOTS

Test statistics	Category
Chi-square	216,444a
df	2
Asymp. Sig.	0.000

3.1. Differences in average knowledge of preservice mathematics teachers about HOTS

The description of the knowledge of preservice mathematics teachers about HOTS as a whole is in the good and very good categories. This condition can be further analyzed based on differences in gender and academic abilities. Based on the results of the analysis prerequisite test in Table 4, the data comes from populations that are not normally distributed, thus testing the differences between gender differences and differences in academic ability using non-parametric statistics. The results of the difference test are presented in Table 6. Based on Table 6 it is known that significance 2-tailed for a gender difference of 0.413 > 0.05, thus it can be concluded that H_0 is accepted, which means that there is no significant average difference in the knowledge of preservice mathematics teacherabout HOTS based on gender differences. Next, the sig. (2-tailed) for differences in academic ability of 0.003 < 0.05, it can be concluded that H_0 is rejected, which means that there is a significant average difference in knowledge of preservice mathematics teacherabout HOTS based on differences in academic ability.

Table 6. The average difference test results

Testing	Statistics test	Significance value	Statistical decisions
Different genders	Mann-Whitney U = 5916500	0.413	H_0 is accepted
Different academic	Kruskal-Wallis H = 16.093	0.03	H_0 is rejected

3.2. The statistical relationship between students background and student knowledge

The results of testing the relationship and influence between students' backgrounds and their knowledge are presented in Table 7. Based on Table 7, the correlation coefficient value is 0.07, meaning that the strength of the relationship (correlation) between gender and the knowledge of preservice mathematics teachers about HOTS is 0.07 or there is almost no correlation, while the correlation coefficient value is 0.235, meaning the strength of the relationship (correlation) between academic abilities and the knowledge of preservice mathematics teachers about HOTS is 0.235 or very weak. The R square value or the coefficient of determination (KD) which shows how good the regression model is formed by the interaction of the independent variables and the dependent variable. The coefficient of determination (KD) value obtained is 0% which can be interpreted that the gender variable does not affect knowledge about HOTS but is influenced by other factors besides gender. Furthermore, the value of R square or the KD is 5, 5% which can be interpreted that the independent variable of academic ability has a contribution effect of 5.5% on the HOTS knowledge variable and the other 94.5% is influenced by other factors outside of the academic ability variable and KD value of 0.55. The significance value is 0.917 > 0.05, which means that gender does not significantly affect the knowledge of preservice mathematics teachers about HOTS. The significance value is 0.00 < 0.05, which means that academic ability has a significant effect on the knowledge of preservice mathematics teachers about HOTS. In testing the independent variables simultaneously, the correlation coefficient value is 0.330, meaning that the strength of the relationship (correlation) between gender and academic ability on the knowledge of preservice mathematics teachers about HOTS is 0.330 or a weak correlation. Furthermore, the R square value or the coefficient of determination (KD) is 11.5% which can be interpreted that the independent variables of gender and academic ability have a contribution effect of 11.5% on the HOTS knowledge variable and 88.5% are influenced by other factors outside gender variable and academic ability. The significance value is 0.00 < 0.05, which means that gender and academic knowledge together have a significant effect on the knowledge of preservice mathematics teachers about HOTS.

Table 7. Correlation test results

Testing	Correlation coefficient	Determination coefficient	Regression significance value	Statistical decisions
Gender and knowledge	0.07	0.00	0.917	H_0 is rejected
Academic level and knowledge	0.235	0.055	0.00	H_0 is accepted
Gender and academic level and knowledge	0.330	0.115	0.000	H_0 is accepted

Furthermore, to test the effect of gender and academic ability on each aspect of HOTS knowledge, a multivariate analysis was carried out, the results of which are presented in Table 8. The data in Table 8 shows the test results for each student background item for all aspects of HOTS knowledge and its effect on HOTS knowledge using four different types of tests. The results show that the academic ability significance value is < 0.05, which means that there is an influence of preservice teacher student academic abilities on HOTS while the gender aspect does not have a significant effect on preservice teacher knowledge in HOTS. This is consistent with the previous correlation and linear regression tests.

Table 8. Multivariate analysis

Multivariate tests								
Effects		Value	F	Hypothesis df	df errors	Sig.	Noncent parameter	Observed power d
Intercepts	Pillai's trace	0.996	10526.379b	5.000	234.000	0.000	52631894	1.000
	Wilks' lambda	0.004	10526.379b	5.000	234.000	0.000	52631894	1.000
	Hotelling's trace	224.923	10526.379b	5.000	234.000	0.000	52631894	1.000
	Roy's largest root	224.923	10526.379b	5.000	234.000	0.000	52631894	1.000
Gender	Pillai's trace	0.069	3.481b	5.000	234.000	005	17.403	0.910
	Wilks' lambda	0.931	3.481b	5.000	234.000	005	17.403	0.910
	Hotelling's trace	0.074	3.481b	5.000	234.000	005	17.403	0.910
	Roy's largest root	0.074	3.481b	5.000	234.000	005	17.403	0.910
Academic abilities	Pillai's trace	0.229	2.872	20.000	948.000	0.000	57.449	1.000
	Wilks' lambda	0.785	2.940	20.000	777.040	0.000	48.448	0.998
	Hotelling's trace	0.257	2.983	20.000	930.000	0.000	59.664	1.000
	Roy's largest root	0.167	7.911c	5.000	237.000	0.000	39.555	1.000
Computed using alpha = 05								

The results of testing the effect of each preservice teacher's background on each aspect of knowledge about HOTS are presented in Table 9. Table 9 shows that gender characteristics do not significantly affect knowledge about HOTS levels in Bloom's taxonomy, curriculum, and pedagogy because they have a significance value of > 0.05. Academic knowledge has a significant effect on preservice teacher knowledge in almost all aspects of HOTS knowledge except for pedagogical aspects.

Table 9. Multivariate analysis

Tests of between-subjects effects								
Source	Dependent variables	Type III sum of squares	df	Mean square	F	Sig.	Noncent. parameter	Observed power f
Gender	Definition	77.133	1	77.133	5043	0.026	5043	0.609
	HOTS levels	33.097	1	33.097	2.134	0.145	2.134	0.307
	Curriculum	200.707	1	200.707	1634	0.202	1634	0.247
	Pedagogy	0.590	1	0.590	022	0.883	022	0.052
	Assessment	395.670	1	395.670	13.865	0.000	13.865	0.960
Academic abilities	Definition	380.969	4	95.242	6.227	0.000	24.908	0.988
	HOTS levels	326.796	4	81.699	5.267	0.000	21.069	0.969
	Curriculum	3110662	4	777.666	6.330	0.000	25.322	0.989
	Pedagogy	153.812	4	38.453	1.420	0.228	5.680	0.439
	Assessment	771.579	4	192.895	6.760	0.000	27.038	0.993
Computed using alpha = 05								

The purpose of this study is to describe preservice mathematics teachera knowledge of HOTS in terms of definition, Bloom’s taxonomy level, 2013 curriculum, learning, and evaluation. This knowledge description includes knowledge about HOTS, its relation to gender aspects and academic abilities. These two factors are important factors in various studies that differentiate general mathematical knowledge of both students and teachers [29]–[32]. The research findings reveal that the knowledge level of the HOTS preservice math teacher is greater than 231 or is at a good level based on one sample hypothesis testing. Has a different opinion [33] which revealed that preservice teacher knowledge regarding HOTS was at a moderate level according to the field being taught because of different evaluation dimensions. On the one hand, the knowledge of preservice mathematics teachers is at a good level, but other findings show that preservice mathematics teachers are not able to design non-routine problems. They tend to design familiar application problems that require students to memorize facts, concepts, or procedures that have been done before and apply them to context [27]. These two different things explain the existence of two different measurement domains. Knowledge about HOTS is related to more theoretical knowledge, namely in the aspects of definition, curriculum, pedagogy, assessment, and HOTS conception in Bloom's taxonomy [34]. Due to the nature of conceptual knowledge, it is more likely to have a good level of knowledge.

Preservice math teachers already have the correct concept of HOTS definition, HOTS level in Bloom's taxonomy, HOTS in the 2013 curriculum, pedagogy, assessment and are able to identify the types of questions that are at the HOTS level. Incomplete knowledge is in the aspect of the definition of HOTS where there is still a tendency to mention HOTS as difficult questions, with long calculation procedures, as well as elementary and advanced question levels [26], [35]. The level of knowledge of teachers in the good category is influenced by the learning process that has been experienced by preservice mathematics teacher students, whereas if it enters the realm of content measurement and thinking skills in problem solving, especially at the cognitive level of creation, the knowledge of preservice mathematics teachers still needs to be improved [36]. This shows that the skill of using knowledge in solving non-routine problems requires the involvement of the ability to connect various concepts, experience involved in problem solving activities and complete prerequisite knowledge which is also influenced by the amount of time available for learning, the characteristics of the instructor and the content being studied [37]. Besides that, Narh-Kert and Ampadu [38] revealed that the factors that influence the ability of preservice teachers of mathematics are the way of conveying knowledge of mathematics, perceptions of mathematics as a subject, perceptions of teaching and learning mathematics and attitudes towards mathematics. Of these various factors, attitudes to mathematics tend to underlie the mathematical performance of preservice mathematics teachers [39]. Mathematical attitudes include motivation, self-regulation, self-confidence, and perceptions of mathematics. This good knowledge of HOTS provides opportunities for teachers to be able to develop learning activities that are oriented towards thinking skills according to the characteristics of mathematics. In general, the knowledge of HOTS preservice mathematics teachers is good, but if examined from gender differences there is no difference in the knowledge of preservice mathematics teachers about HOTS between boys and girls. Boys outperform girls on tests of visual-spatial ability and mathematical reasoning, whereas girls do better on memory and language use [40]. This description explains that women and men differ in cognitive structure including their performance in mathematics but do not significantly differentiate theoretical knowledge about HOTS. This is because, the same learning experience contributes relatively the same knowledge.

In this study, learning experiences were traced as additional data which showed that most preservice teachers had studied HOTS from various sources, namely learning activities, seminars, and self-study. The HOTS concept that is measured is theoretical in nature so that it tends not to significantly differentiate women and men when compared to skills in solving HOTS problems. Another finding in this study is that the higher the academic ability, the better the knowledge of HOTS math teacher candidates. Academic ability is a combination of learning experience and skills to use knowledge consistently in life that provides long-term retention of information. The ability of a preservice teacher is influenced by perceptions about mathematics, the curriculum, the learning process, the relevance of theory and practice, gender, and attitudes towards mathematics [38], [41]. These factors, in addition to affecting general math skills, also affect the HOTS of preservice teachers because mathematics is actually about thinking processes and not just calculating skills. In addition, the nature of mathematics which is deductive reasoning confirms the opinion that good mathematical ability is directly proportional to HOTS and vice versa. A mathematics teacher candidate who has good knowledge of mathematics tends to be more adaptive to HOTS because basic content knowledge, ability to relate concepts, and analysis are used in solving non-routine problems.

4. CONCLUSION

Knowledge of HOTS is an important thing that must be owned by preservice mathematics teacher before becoming a teacher in the future. This knowledge is the first step which is then combined with skills in compiling questions and solving HOTS questions. The results showed that the knowledge of preservice mathematics teachers about HOTS was at a good level and further investigations could be carried out to describe skills in composing and solving HOTS questions. The knowledge of preservice mathematics teachers about HOTS did not differ between boys and girls but significant differences could be seen in the different levels of academic ability. This means that an increase in academic ability in general can lead to a linear increase in knowledge about HOTS.

ACKNOWLEDGEMENTS

We thank the Faculty of Teaching and Education, Nusa Cendana University for providing research funding support in 2021 as well as all respondents as research samples namely students Department of Mathematics Education; Faculty of Teaching and Education, Nusa Cendana University; the Department of Mathematics Education, Timor University; and Department of Mathematics Education, Faculty of Teaching and Education, Wira Wacana Sumba University.

APPENDIX

Table 1. HOTS knowledge questionnaire grid

Knowledge	Indicator	Description
The level of knowledge of preservice mathematics teachers on the definition of HOTS	Knowledge of HOTS defines	Understanding of the definition of HOTS and its characteristics
	The difference between HOTS and LOTS	An understanding of the difference between HOTS and LOTS
The knowledge level of preservice mathematics teachers on HOTS aspects in Bloom's taxonomy	Six cognitive levels in Bloom's taxonomy	Understanding of cognitive levels in Bloom's taxonomy, sequence, and definition of each level
	HOTS and LOTS in Bloom's taxonomy	Understanding of HOTS and LOTS levels in Bloom's taxonomy
The level of knowledge of preservice mathematics teachers on curriculum aspects	The HOTS conception in the 2013 curriculum has a scientific approach	Understanding of curriculum goals that support HOTS
		Understanding of the scientific approach, stages of the scientific approach, and scientific arguments to support HOTS
	Indicators of achievement of basic competence and competence according to the 2013 curriculum	Understanding of indicators of achievement of basic competencies and basic competencies, the relationship between the two, and the position of indicators that support HOTS
	Bloom's taxonomy	Understanding levels of Bloom's taxonomy and description of HOTS levels
	Learning model	Understanding of learning models in the 2013 curriculum and how learning models support HOTS
The level of knowledge of preservice mathematics teachers on pedagogical aspects	Contextual learning	An understanding of contextual learning as an approach that supports HOTS
	Ask scientifically	An understanding of how to create cognitively appropriate questions increases HOTS
	Utilization of non-routine and novelty problems	Understanding of how to convey non-routine problems in various forms and levels of thinking and teacher creativity in presenting problems
	Utilization of scaffolding strategies and metacognition	an understanding of how to provide appropriate assistance when students work in teams to discover concepts and solve problems.
	Student strategy	An understanding of how to build students' HOTS by encouraging their argumentative and investigative attitudes
	Technology integration	Understanding of technology that supports HOTS
The level of knowledge of preservice mathematics teachers on the assessment aspect	Bloom's taxonomy cognitive levels	Understanding of the characteristics of questions that are in accordance with HOTS
	Assessment category	Understanding of assessment categories and examples to support HOTS
	Item questions and indicators of achievement of competence	Understanding of the accuracy of the items and indicators of achievement of competence
	About HOTS	Understanding of examples of HOTS questions and differences in HOTS questions at each cognitive level
	The difference between HOTS and LOTS	An understanding of the differences between HOTS and LOTS questions

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