Knowledge, Skills and Attitude of Pre-Service Mathematics Teachers Towards Higher-Order Thinking Skills

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Abstract: This research was aimed to determine the level of knowledge, skills and attitude of pre-service Mathematics teachers in Universiti Pendidikan Sultan Idris (UPSI) towards higher-order thinking skills (HOTS) and whether the elements of HOTS were translated into the teaching courses. The research was also designed to analyze the relationship between the pre-service Mathematics teachers' exposure to HOTS through the teaching courses and their level of knowledge, skills and attitude towards HOTS. The study utilized a quantitative approach by administration of a survey to a simple random sample of 110 pre-service Mathematics teachers from UPSI. A questionnaire with five different parts was used as the research instrument with a reliability value of .979. The collected data were then analyzed using descriptive and inferential statistics. The descriptive statistics were used to determine the mean scores of the level of knowledge, skills and attitude among the pre-service Mathematics teachers, whereas inferential statistics using Pearson-r correlation was implemented to describe the relationship between the studied variables. The findings demonstrated that the knowledge and skills of pre-service Mathematics teachers towards HOTS were at a moderate level as opposed to their attitude and exposure to HOTS which were found to be at a high level. The data analysis using Pearson correlation illustrated a significant positive relationship with $r = .727$, $r = .757$ and $r = .667$ between the exposure to HOTS through the teaching courses and the level of knowledge, skills and attitude regarding HOTS of pre-service Mathematics teachers at UPSI, respectively. In conclusion, the research here indicates that pre-service Mathematics teachers in general, are positive towards the implementation of HOTS but they are lacking in terms of knowledge and skills. This research is useful in the field of Mathematics education as it can serve as a guidance to further enhance the knowledge, skills and attitudes especially for future Mathematics teachers in implementing HOTS effectively and improving the quality of the teaching program offered by the university indirectly.

Keywords: *Exposure, higher-order thinking skills, teaching.*

Introduction

The education transformation in Malaysia has demanded students to think beyond the usual capacity. The thinking skill is highlighted as one of the six aspirations in Malaysia Education Blueprint 2013-2025 which needs to be acquired by each student today. The thinking skill being emphasized by the Ministry of Education Malaysia is the higher order thinking skills (HOTS). It is important for students to master the higher order thinking skills as this contributes to students being more creative and innovative (Ministry of Education Malaysia, 2014a). By general definition, HOTS is the ability to apply knowledge, skills and values to make reasoning and reflection in solving problems, making decisions, being innovative and being able to create new ideas that could be used as solutions for any new situation faced (Ministry of Education Malaysia, 2014b).

The role of the teachers is very significant in helping students to possess higher order thinking skills. Mat Nor et al. (2017) pointed out that the role of the teachers now is completely different from the last decade. Nowadays, teachers need to ensure that their students are able to apply what they have learned to solve the real-life problems instead of

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only understanding what they have learned. Therefore, the development of today's education encourages teachers to be more advanced and to demonstrate skills in teaching. It is vital for teachers to be knowledgeable about HOTS in order for its effective implementation to take place in pedagogy (Ministry of Education Malaysia, 2014b). This reinforces the need for teachers and future teachers to prepare themselves in facing the new and challenging education system.

The crucial aspect to integrate HOTS in teaching and learning mathematics is knowledge (Nooriza & Effandi, 2015). Additionally, teachers' inadequate skills in inculcating HOTS in their teaching and learning settings have resulted in the failure to produce students with HOTS (Ball & Garton, 2005). Furthermore, Halim (2013) found that teachers' attitude was also a hurdle to implement thinking skills in teaching and learning. Teachers' readiness to apply HOTS depends on whether they had extensive knowledge of HOTS implementation, had skills in conducting HOTS based learning and had positive attitude towards HOTS (Toresingam et al., 2019). However, most of them were still more comfortable using conventional method to teach, which were more towards the teacher-centered approach, where they had full control of the class and this resulted in students being passive (Nooriza & Effandi, 2015). The findings from past studies revealed that most teachers were still incompetent in various aspects of applying HOTS in teaching and learning mathematics (Nooriza & Effandi, 2015). These aspects included teachers' low knowledge about HOTS, and teachers' difficulties in delivering apperception and HOTS based learning materials to students, in designing and applying the assessment based on HOTS, in making learning media based on HOTS, and in preparing learning tools based on HOTS (Afifah & Retnawati, 2019).

Report in Cheda and Utha (2021) stated that time constraints, language barriers, and terminology used in class textbooks were among the difficulties teachers face when implementing HOTS. Moreover, teachers were more focused in attaining A achievers in the subjects they taught, which caused them to be ignorant in emphasizing HOTS. This statement was supported by Nursafra et al. (2021) which indicated that teachers only taught to meet the requirements of the exams. The low level of implementing HOTS among teachers has been a concern and has made it difficult to cultivate HOTS among students in Malaysia (Anida et al., 2018). Norfariza and Nur Fadhillah (2018) also stated that the lack of training and exposure to HOTS was the reason for teachers' inability to implement HOTS.

These findings have raised questions as to whether teachers have had enough training while undergoing their training at teaching institutions or universities. According to Berry et al. (2010), an effective teacher would be produced from a higher quality of teacher training program. In line with the current needs in education, the teacher education program should prepare pre-service teachers with HOTS since this will later enable the students to thrive on the global stage. An excellent teacher education program could be an influential medium to initiate a long-term revolution in the field but pre-service teachers should first comply with the changes in the learning culture (Häkkinena et al., 2016). Result in Mohd Aderi et al. (2017) found that many teachers were not ready to implement HOTS due to the lack of exposure about HOTS while they were taking education courses in the teaching institutes or universities. However, according Mohamad Hisyam et al. (2017), all pre-service Mathematics teachers claimed that they had acquired a lot of knowledge in the field of teaching including thinking skills after attending an education course in teaching institutions.

The main purpose of this research was to study the knowledge, skills and attitude of pre-service Mathematics teachers in Universiti Pendidikan Sultan Idris (UPSI) regarding HOTS. In particular, this research also looked into whether the Mathematics education program in UPSI exposes HOTS to the pre-service Mathematics teachers. In this research, the meaning of the word 'exposure' is to expose the elements of HOTS to future teachers, which can be attained either through HOTS courses or HOTS programs or HOTS training. The relationship between the exposure to HOTS through the teaching courses of pre-service Mathematics teachers at UPSI and their level of knowledge, skills and attitude regarding HOTS is also studied in this research. The research questions formulated are given as follows:

1. What are the levels of knowledge, skills and attitude of pre-service Mathematics teachers at UPSI towards HOTS?

2. Are the pre-service Mathematics teachers in UPSI exposed to HOTS through the teaching courses?

3. Is there a relationship between the exposure to HOTS through the teaching courses among pre-service Mathematics teachers at UPSI and their level of knowledge, skills and attitude towards HOTS?

Methodology

Research Design

This non-experimental research utilized the quantitative approach with the implementation of a survey method. A survey method was chosen due to the large population size utilised in this research. The respondents selected were pre-service Mathematics teachers in UPSI taking either Bachelor of Education (Mathematics) with honors (AT14) program or Bachelor of Science (Mathematics) with Education (AT48) program from semester three until semester eight. The pre-service Mathematics teachers in semester one and semester two from these two programs were excluded since they had only been exposed to several courses; eight courses in semester one and seven courses in semester two. Overall, the population of this research was 733 pre-service Mathematics teachers from both programs.

Sample and Data Collection

The determination of the sample size in this research was conducted using the rule of thumb that incorporated the number of subjects per variable. Therefore, this research involved a sample of 110 pre-service Mathematics teachers, obtained by a simple random sampling. The instrument used was a set of questionnaires and it was distributed to pre-service Mathematics teachers to obtain data regarding their levels of knowledge, skills and attitude towards HOTS and the exposure to HOTS through teaching courses in the university. The items used in the questionnaire were adapted and modified from Rajendran (2004), Wan Ismail et al. (2016), Nor Hasmaliza and Zamri (2016), and Hasnah and Jamaludin (2017), which were in line with the objectives of this research. This questionnaire was divided into five different parts and each part contained 10 items. A four-point Likert scale was used to measure each item. The questionnaire was validated by three experts to ensure there were no overlapping criteria. The average content validity test result was 85.7% demonstrating that the instrument used in this research had a satisfactory level of validity. All the comments and criticisms received from these experts were taken into account to further reinforce those items in the questionnaire. A pilot study involving 30 pre-service Mathematics teachers in semester three until semester eight was conducted to obtain the reliability of the instrument, which was based on statistics Cronbach's alpha (α). The reliability of the instrument was tested using Statistical Packages for Social Science (SPSS) software version 20.0 and a value of $\alpha = .979$ was obtained which indicated that the instrument had a very high internal consistency. The details for each construct in the instrument are given in Table 1.

Table 1. Cronbach's Alpha for Each Construct

Construct	Cronbach's Alpha	Cronbach's Alpha based on Standardized items	*N* of Items	Strength of data	Internal Consistency
Level of Knowledge	.943	.943	10	Very strong	Excellent
Level of Skills	.965	.967	10	Very strong	Excellent
Level of Attitude	.898	.907	10	High	Good
Exposure to HOTS	.960	.962	10	Very strong	Excellent

Analyzing of Data

Descriptive and inferential statistics were used to analyze data in this research. A simple descriptive analysis by searching the means scores of the total items for each variable was conducted in order to assess the levels of knowledge, skills and attitude of pre-service Mathematics teachers at UPSI towards HOTS and to determine whether the pre-service Mathematics teachers at UPSI are exposed to HOTS through their teaching courses. For this purpose, this research had applied a similar set of score distribution, according to Chew (2017), in which the level or position of perception can be interpreted (see Table 2). Inferential statistics using Pearson-r correlation was then applied to study the relationship between the exposure to HOTS through teaching courses taken by pre-service Mathematics teachers at UPSI and their levels of knowledge, skills and attitude towards HOTS. Normality assumption was based on two numerical measures of shapes – skewness and kurtosis. If the skewness is between -2 and $+2$ (Tabachnick & Fidell, 2007) and kurtosis is between -7 and $+7$ (Byrne, 2010) then the data is considered to be normal and met the criteria related to normality. Table 3 demonstrates normally distributed items since the values of skewness were seen ranging from -1.702 to 0.050 and the values of kurtosis are seen ranging from -1.019 to 3.475.

Table 2. The Score Distribution

Level	Score
Low	1.00 – 2.00
Medium	2.01 – 3.00
High	3.01 – 4.00

Table 3. Numerical Measures - Skewness and Kurtosis Test

	N	Min	Max	Mean	Standard deviation	Skewness		Kurtosis	
						Statistic	Standard Error	Statistic	Standard Error
K01	40	1	4	3.50	0.731	-1.702	0.427	3.475	0.833
K02	40	1	4	2.93	0.691	-0.583	0.427	1.160	0.833
K03	40	1	4	2.97	0.718	-0.548	0.427	0.830	0.833
K04	40	1	4	2.93	0.828	-0.262	0.427	-0.590	0.833
K05	40	1	4	3.23	0.774	-0.920	0.427	0.922	0.833
K06	40	1	4	3.07	0.828	-0.520	0.427	-0.300	0.833
K07	40	1	4	2.90	0.759	-0.335	0.427	0.041	0.833
K08	40	1	4	2.97	0.890	-0.561	0.427	-0.265	0.833

Table 3. Continued

	N	Min	Max	Mean	Standard deviation	Skewness		Kurtosis	
						Statistic	Standard Error	Statistic	Standard Error
K09	40	1	4	2.83	0.791	-0.132	0.427	-0.444	0.833
K10	40	1	4	3.03	0.809	-0.482	0.427	-0.184	0.833
S01	40	1	4	2.97	0.928	-0.486	0.427	-0.623	0.833
S02	40	1	4	3.17	0.874	-1.007	0.427	0.687	0.833
S03	40	1	4	3.10	0.803	-0.616	0.427	0.063	0.833
S04	40	1	4	3.00	0.830	-0.387	0.427	-0.483	0.833
S05	40	2	4	3.13	0.730	-0.214	0.427	-1.019	0.833
S06	40	1	4	3.17	0.747	-0.819	0.427	1.089	0.833
S07	40	1	4	3.27	0.691	-1.080	0.427	2.644	0.833
S08	40	1	4	3.07	0.907	-0.731	0.427	-0.124	0.833
S09	40	1	4	2.93	0.828	-0.653	0.427	0.350	0.833
S10	40	1	4	3.10	0.712	-0.762	0.427	1.465	0.833
A01	40	2	4	3.53	0.571	-0.732	0.427	-0.429	0.833
A02	40	2	4	3.43	0.568	-0.326	0.427	-0.819	0.833
A03	40	2	4	3.37	0.615	-0.404	0.427	-0.567	0.833
A04	40	2	4	3.33	0.547	0.050	0.427	-0.699	0.833
A05	40	2	4	3.60	0.563	-1.042	0.427	0.176	0.833
A06	40	2	4	3.53	0.571	-0.732	0.427	-0.429	0.833
A07	40	2	4	3.47	0.571	-0.456	0.427	-0.748	0.833
A08	40	2	4	3.27	0.691	-0.409	0.427	-0.770	0.833
A09	40	1	4	3.40	0.770	-1.339	0.427	1.874	0.833
A10	40	1	4	3.37	0.809	-1.630	0.427	3.148	0.833
E01	40	1	4	3.10	0.995	-0.662	0.427	-0.811	0.833
E02	40	1	4	3.27	0.828	-0.942	0.427	0.350	0.833
E03	40	1	4	3.20	0.887	-0.738	0.427	-0.481	0.833
E04	40	1	4	3.23	0.817	-0.876	0.427	0.340	0.833
E05	40	1	4	3.13	0.937	-0.820	0.427	-0.201	0.833
E06	40	1	4	3.00	0.871	-0.671	0.427	0.053	0.833
E07	40	1	4	3.03	0.890	-0.383	0.427	-0.915	0.833
E08	40	1	4	3.03	0.928	-0.624	0.427	-0.439	0.833
E09	40	1	4	2.83	0.986	-0.339	0.427	-0.890	0.833
E10	40	1	4	3.17	0.834	-0.715	0.427	-0.083	0.833

Results

This section describes the data analysis related to assessing the levels of knowledge, skills and attitude of pre-service Mathematics teachers towards HOTS in UPSI and assessing the relationship between their level of exposure towards HOTS through the teaching courses taken and their levels of knowledge, skills and attitude towards HOTS. The interpretation of the findings will also be discussed in this section.

Level of Knowledge, Skills and Attitude Towards HOTS

The findings related to the first research question are shown in Table 4. According to the mean scores obtained for the level of knowledge among pre-service Mathematics teachers in UPSI, Item 1 (Know the concepts of implementing HOTS in the classroom) showed the highest mean score of 3.25 followed by Item 5 (Know the importance of implementing HOTS) with a mean score of 3.17. The lowest mean score was Item 9 (Know ways to increase students' HOTS) with a mean score of 2.87 followed by Item 4 (Know various strategies and techniques to implement HOTS) with a mean score of 2.90. The knowledge regarding the concept of implementing HOTS, the importance of HOTS and the function of thinking tools showed high mean scores compared to the knowledge regarding how to increase students' HOTS, various strategies and techniques to implement HOTS and activities that could help to generate HOTS among students. Overall, the knowledge towards HOTS among pre-service Mathematics teachers was considered to be moderate with an average mean score of 3.00.

The second column in Table 4 depicts the level of skills among pre-service Mathematics teachers in UPSI based on 10 items. The highest mean score was shown by Item 7 (Skilled in encouraging students to think) with a mean score of 3.18 followed by Item 5 (Skilled in providing illustrative examples) with a mean score of 3.14. Item 9 (Skilled in using various strategies to integrate HOTS in teaching and learning Mathematics) showed the lowest mean score of 2.86. Item 1 (Skilled in giving solution to HOTS questions) and Item 3 (Skilled in integrating HOTS in mathematics question) also demonstrated low values of mean scores of 2.87 and 2.89 respectively. The skills regarding HOTS among pre-service

Mathematics teachers were found to be moderate with an average mean score of 2.99. The skills in using various strategies to integrate HOTS in teaching and learning Mathematics, giving solution to HOTS questions and integrating HOTS in mathematics question were relatively low compared to the skills in encouraging students to think and in providing illustrative examples.

The last column in Table 4 exhibits that Item 6 (Often relate problems in everyday life into mathematics questions) had the highest mean score of 3.50, followed by Item 5 (Encourage students to make conclusions about what they have learned) with a mean score of 3.48. Item 9 (Like to encourage students to solve non-routine mathematics questions) demonstrated a low mean score of 3.18. Similarly, Item 8 (Like to engage with students asking difficult questions in class) also had a low mean score of 3.15, which is the lowest mean score exhibited in the last column of Table 4. Overall, the attitude towards HOTS among pre-service Mathematics teachers was considered high with an average mean score of 3.37. The results indicated that pre-service Mathematics teachers like to relate problems in everyday life to mathematics questions to encourage their students to make conclusions about what they have learned and provide activities that encourage their students to explore new ideas.

Table 4. Level of Knowledge, Skills and Attitude Towards HOTS (n=110)

Level of Knowledge		Level of Skills		Level of Attitude	
Item	**Mean**	**Item**	**Mean**	**Item**	**Mean**
Item 1	3.25	Item 1	2.87	Item 1	3.35
Item 2	2.95	Item 2	3.01	Item 2	3.45
Item 3	2.92	Item 3	2.89	Item 3	3.44
Item 4	2.90	Item 4	2.92	Item 4	3.41
Item 5	3.17	Item 5	3.14	Item 5	3.48
Item 6	3.08	Item 6	3.08	Item 6	3.50
Item 7	2.95	Item 7	3.18	Item 7	3.45
Item 8	3.03	Item 8	2.98	Item 8	3.15
Item 9	2.87	Item 9	2.86	Item 9	3.18
Item 10	2.91	Item 10	2.99	Item 10	3.32
Average	**3.00**	**Average**	**2.99**	**Average**	**3.37**

Level of Exposure to HOTS

The research findings related to the second research question on the level of exposure to HOTS through the teaching courses taken in the university are shown in Table 5. According to the mean score shown in Table 5, Item 2 (Exposed to various thinking tools) had the highest mean score of 3.15 followed by Item 4 (Exposed to the importance of HOTS) with a mean score of 3.13. The lowest mean score was given by Item 9 (Exposed to teach HOTS through minor courses) with a mean score of 2.85 followed by Item 6 (Exposed to construct HOTS questions) with a mean score of 2.86. The exposure to teach HOTS through the three teaching courses (university, core and minor) had lower mean score compared to the exposure to various thinking tools, the importance of HOTS and the function of various thinking tools. Overall, the exposure to HOTS through the teaching courses among pre-service Mathematics teachers was considered to be slightly high with an average mean score of 3.01.

Table 5. Level of Exposure to HOTS (n=110)

No.	Item	Mean
1	I was exposed to various models (such as Bloom's Taxonomic Model etc.) to implement HOTS in teaching and learning math.	3.07
2	I was exposed to various thinking tools (such as graphics management, mind map, i-Think mapping etc).	3.15
3	I was exposed to the functions of each thinking tool.	3.12
4	I was exposed to the importance of HOTS teaching and learning math.	3.13
5	I was exposed to various activities that could generate HOTS.	3.00
6	I was exposed to ways to develop mathematics questions involving HOTS.	2.86
7	I got exposure to teach using HOTS through university courses.	2.94
8	I got exposure to teach using HOTS through core courses.	2.97
9	I got exposure to teach using HOTS teaching through minor courses.	2.85
10	I was exposed to various strategies for implementing HOTS in teaching and learning mathematics.	3.08
	Average	**3.01**

Relationship Between the Level of Exposure to HOTS Through the Teaching Courses and the Level of Knowledge, Skills and Attitude Towards HOTS.

There was a significant positive relationship, $r = .727$ between the average mean score on the level of exposure to HOTS through the teaching courses and the average mean score of the level of knowledge towards HOTS among pre-service Mathematics teachers in UPSI. The finding showed the value of $p = .000$ which is less than .05. Thus, the null hypothesis (There is no relationship between the exposure to HOTS through the teaching courses among pre-service Mathematics teachers at UPSI and their level of knowledge regarding HOTS) can be rejected.

The relationship between the average mean score of the level of exposure to HOTS through the teaching courses and the average mean score of the level of skills towards HOTS among pre-service Mathematics teachers in UPSI was also positively significant with $r = .757$ and $p = .000$. Thus, the null hypothesis (There is no relationship between the exposure to HOTS through the teaching courses among pre-service Mathematics teachers at UPSI and their level of skills towards HOTS) was rejected. Finally, the value of Pearson correlation, $r = .667$ showed the average mean score of the level of exposure to HOTS through the teaching courses and the average mean score of the level of attitude towards HOTS among pre-service Mathematics teachers in UPSI had a significant positive relationship. The third null hypothesis (There is no relationship between the exposure to HOTS through the teaching courses among pre-service Mathematics teachers at UPSI and their level of attitude towards HOTS) was rejected since the value of $p < .05$.

Discussion

In line with the aspiration of the Malaysian Education Blueprint 2013-2025, thinking skills are vital aspects to be inculcated among students and competent teachers are the key factor in achieving these aspirations. Consequently, teachers and future teachers need to equip themselves with knowledge regarding HOTS to make positive changes in the education system. In this research, the mean scores on the items involving knowledge in pedagogical and assessment based on HOTS were low. The finding here contradicts the research findings by Chew (2017) in which the teachers' knowledge in the aspect of pedagogy and assessment was high. Note that, Chew in his review of previous studies however, had found that teachers lack the knowledge and application of HOTS in the areas of curriculum, pedagogy and assessment, which the results of this research were inclined towards to. This research also indicates that pre-service Mathematics teachers were most knowledgeable upon the concept of implementing HOTS in the classroom. In-depth knowledge regarding HOTS concept among teachers is crucial to ensure effective teaching. However, other recent studies, such as Nooriza and Effandi (2015) had exposed that teachers still had minimal knowledge of the concept of HOTS and they were not yet ready to implement HOTS in their teaching. Nooriza and Effandi also found that pre-service mathematics teachers were less knowledgeable to use different strategies to implement HOTS and less knowledgeable to construct activities that could generate HOTS. They also had less knowledge to implement and integrate HOTS during teaching and to construct HOTS questions. The examination board through the Malaysia Examination Institute in 2014 stated that the study of HOTS elements in assessment found that teachers still lacked knowledge regarding the meaning and terminology of HOTS (Afinde, 2016). According to Anida et al. (2018) teachers also face problems in implementing HOTS assessment in the classroom because they do not understand the meaning of HOTS items. Overall, the finding of this research about the level of knowledge towards HOTS is in line with Atmojo et al. (2017), in which the readiness in the aspect of knowledge was still inadequate among pre-service teachers. The findings of this research however, contradict the findings from Mohamad Hisyam et al. (2017), Syazana and Zamri (2018), Norshuhada and Kamisah (2019), and Nursafra et al. (2021), in which the level of knowledge among teacher was at a high level.

Teachers need to capture students' interest in giving responses during the teaching and learning sessions in order to stimulate students' thought processes. Based on these research findings, the pre-service Mathematics teachers were skilled in encouraging students to think and in providing illustrative examples. A study by Afifah and Nurbarirah (2017) suggested that teachers should adopt the teaching and learning approaches which emphasized the student-centered learning as it improved students' thinking skills by promoting critical and creative thinking and building new knowledge. A much earlier study by Abdul Halim et al. (2014) found that both in-service and pre-service Mathematics teachers still had low solving skills for non-routine mathematics problems. On the other hand, this research has shown that the pre-service Mathematics teachers were skilled in discussing the non-routine mathematics questions. The level of skills regarding HOTS among pre-service Mathematics teachers in this research was still at a moderate level. This research finding contradicts the study findings of Mohd Aderi et al. (2017) where a sample of 105 Islamic Education teachers within Bangi and Kajang area was found to have high level of skills on the implementation of HOTS. However, this research finding is similar to the findings from Nur Hawa Hanis and Ghazali (2018), where the level of skills in HOTS among 117 pre-service teachers in the Institut Pendidikan Guru Kampus Pendidikan Teknik was still at a moderate level. Mohamad Hisyam et al. (2017) and Nur Hawa Hanis and Ghazali (2018) also found that most of the teachers' level of skill regarding HOTS was still at a moderate level. The results of this study indirectly put great pressure on the university or teacher education institute (IPG) as these are the platforms that should prepare and equip future teachers with critical and creative thinking skills.

Teachers' ability to incorporate real-life problems into mathematics question and provide various activities are seen as the teaching strategies to improve students' interest in learning mathematics (Cai et al., 2009). The result from this

research has shown that pre-service Mathematics teachers had a positive attitude towards relating problems in real-life into mathematics questions and provided various activities to attract students' attention. The result seems to be a good indicator that most of the pre-service Mathematics teachers can cultivate student's interest in learning mathematics. This is in line with the findings reported in Siregar (2022) where the pre-service teachers in Indonesia who participated in the study supported positive attitude towards HOTS principles in preparing better assessment. Furthermore, pre-service Mathematics teachers like to combine their lesson planning with HOTS. Collins (2014) stated that lesson planning should be organized and systematic when implementing HOTS to help teachers carry out activities that generate HOTS. However, pre-service Mathematics teachers were not keen when students asked difficult questions during class. This is supported by Retnawati et al. (2018), stating that most of the Mathematics teachers were uncertain in answering HOTS questions. Overall, the attitude of pre-service Mathematics teachers at UPSI was positive. This in line with the findings from the study by Nur Hawa Hanis and Ghazali (2018) involving 143 History trained teachers in Perak, where a positive attitude towards the implementation of HOTS was observed. Moreover, Saipolbahrin et al. (2019) also found that pre-service teachers were always positive towards the implementation of HOTS in school. All teachers should have a positive attitude if the implementation of HOTS is to be realized in school, since the negative attitude diminishes efforts and causes confusion in implementing HOTS (Munawaroh et al., 2018).

It is important to ensure that teachers are always ready to implement HOTS-based teaching as the 21st century of teaching and learning requires students to master HOTS. Despite the important role of teachers in implementing HOTS, Norakma et al. (2015) claimed that teachers in Malaysia were still lacking in terms of exposure in knowledge and skills towards HOTS. The finding in this research showed that exposure to various thinking tools and their function had highest mean score, illustrating that pre-service Mathematics teachers were widely exposed to the function of various thinking tools. During the process of teaching and learning, teachers need to use appropriate thinking tools so that students can improve their thinking skill (Farah Aziana & Fadzilah, 2018) and can assist students to understand their learning (Abdul Rasid et al., 2017). Pre-service Mathematics teachers are also widely exposed to the importance of HOTS and to various strategies and models for implementing HOTS. They also might be familiar with the Bloom's Taxonomy Model, which is a popular model used to articulate the stages or skills needed in the HOTS more clearly and to enlighten teachers in implementing HOTS to students. This finding contradicted with Norakma et al. (2015), and Farah Aziana and Fadzilah (2018), which stated that teachers' un-readiness to implement HOTS was due to a lack of strategy in implementing it. This study also found that pre-service Mathematics teachers were less exposed in constructing HOTS questions and in constructing activities that could generate HOTS. This result supported the findings from Baya'a and Daher (2015) where pre-service teachers' in Czechia encountered difficulties in implementing HOTS activities, and also their views regarding the application of GeoGebra in the activities during mathematics classes. The overall findings of this research showed that the exposure to HOTS through the teaching courses in this research among pre-service Mathematics was slightly high. This result supports the finding from Munawaroh et al. (2018) regarding the suitability in the curriculum aspect, where most pre-service teachers were found to be satisfied with the curriculum related to developing the thinking skills and acknowledged it to be beneficial for the trainee teachers and appropriately implemented.

There was a positive relationship between the level of exposure to HOTS through the teaching courses and the levels of knowledge, skills and attitude towards HOTS among the pre-service Mathematics teachers. Teachers' needs in terms of exposure to HOTS concepts, approaches and strategies to implement HOTS is often an issue for teachers' inability and un-readiness to implement HOTS in teaching and learning process (Norakma et al., 2015; Siti Sarah & Lilia, 2021). Thus, courses or special workshops focusing only on HOTS need to be introduced as supplementary to the teaching courses to provide future teachers with adequate knowledge and skills to implement HOTS. Various efforts have been made to enhance teachers' knowledge and skills to implement HOTS. Norfariza and Nur Fadhillah (2018) noted that emphasizing on HOTS was the main strategy used throughout the teacher training courses at the IPG. The pre-service teachers were familiarized with the HOTS-based teaching and learning process in order to emulate the same practice of teaching and learning in schools. Exposure to HOTS-based teaching method is vital for teachers in every subject to enable them to practice teaching and learning process effectively and easily.

Conclusion

The Malaysian government is gearing towards the transformation of Malaysia education curriculum through Malaysia Education Blueprint 2013-2025, by emphasizing on HOTS to produce a creative and critical generation to compete in the global market. Teachers play an important role in determining the success of the Malaysian government to produce students that are able to master HOTS. Unfortunately, Toresingam et al. (2019) stated that HOTS among Malaysian teachers was still inadequate due to a low level of readiness to implement HOTS. Hence, early initiatives must be taken to ensure that teachers are ready to implement HOTS as soon as they begin to embark on the educational field, preferably when they first enrolled into their teaching courses either in university or teaching institution.

The findings in this research have shown that pre-service Mathematics teachers in UPSI supported and realized the benefits of the implementing of HOTS, but more time and training were needed to improve their knowledge and skills for the implementation process to be effective and comprehensive. With regard to the exposure to HOTS, the pre-

service Mathematics teachers need to be further exposed to HOTS through teaching courses in UPSI to enhance their knowledge and skills towards HOTS, as the level of exposure to HOTS was still considered to be at par, albeit the result being classified as high level. The findings of this research are anticipated to indirectly propel UPSI towards producing Mathematics teachers who are capable of realizing the government's aspiration and continuously improving the country's education system.

Recommendations

Future studies using a larger sample size and involving other teaching institutions or universities need to be conducted in order for the findings to be generalize to all future Mathematics teachers. Additionally, future studies as such are beneficial in comparing the best training courses provided by institutions. This will indirectly help improving the teaching training courses and in producing competent and high-minded teachers.

Future studies could also be done in the area of analyzing the needs of the pre-service teachers in implementing HOTS. This may help to improve the pre-service Mathematics teachers' knowledge and skills in HOTS prior to performing their duties as teachers in schools. With regards to that, providing a special course framework to provide a meaningful exposure towards HOTS during the teaching training course may also be an interesting area to work on for future research.

Limitations

This was survey research, using questionnaire as the research instrument. This research was conducted once within a specified time frame and the information given by the respondents was assumed honest and sincere. The validity and reliability were depended on the respondents' honesty in answering the questionnaire. Respondents were assured of confidentiality for the information given for this study. This study had limited respondents of 110 pre-service Mathematics teachers from the Mathematics department. Thus, the result presented cannot be generalized to all pre-service teachers in other departments or institutions.

The information regarding the aspects of competency in HOTS acquired in this research was limited to three aspects; knowledge, skills and attitude. Furthermore, the variables used in this research to answer the research questions were limited to what had been informed in the research instrument only.

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Authorship Contribution Statement

Ahmat: Supervision, concept and design, editing, final approval. Azmee: Statistical analysis, editing. Mohamed: Editing, reviewing manuscript. Zamzamir: Editing, reviewing manuscript. Zahari: Data interpreting, drafting manuscript. Shafie: Editing, reviewing manuscript. Mohamed: Data acquisition. Raja Ma'amor Shah: Material support, reviewing manuscript.

References

Abdul Halim, A., Nor Hasniza, I., Johari, S., Marlina, A., & Mohd Hilmi, H. (2014, December 8-10). *Non-routine mathematical problems among in-service and pre-service mathematics teachers* [Paper presentation]. IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE). Wellington, New Zealand. https://doi.org/10.1109/TALE.2014.7062620

Abdul Rasid, J., Martini, M., & Azhar, M. S. (2017). Penggunaan peta pemikiran i-think dalam pemahaman KOMSAS Bahasa Melayu [Use of i-Think Thinking Maps in understanding KOMSAS Bahasa Melayu]. *Jurnal Pendidikan Malaysia, 42*(1), 43-51. http://journalarticle.ukm.my/11050/

Afifah, F., & Nurbarirah, A. (2017). Thinking outside of the box: Determining students' level of critical thinking skills in teaching and learning. *Asian Journal of University Education, 13*(2), 51-70. https://tinyurl.com/y577cnra

Afifah, I. R. N., & Retnawati, H. (2019). Is it difficult to teach higher order thinking skills? *Journal of Physics: Conference Series, 1320*, Article 012098. https://doi.org/10.1088/1742-6596/1320/1/012098

Afinde, O. (2016). *Pengetahuan, kemahiran dan amalan guru membina item kemahiran berfikir aras tinggi (KBAT) dalam instrumen pentaksiran pembelajaran* [Knowledge, skills and practices of teachers in constructing higher order thinking skills (HOTS) items for learning assessment instruments] [Master's Thesis, Universiti Tun Hussein Onn Malaysia]. eprint UTHM. https://tinyurl.com/hfraedc9

Anida, S., Husna Faredza, M. R., Adenan, A., & Zuraini, R. (2018). Higher-order thinking skills (HOTS) in Malay Language pedagogy based on cognitive research trust (CORT) assessment. *Journal of Global Business and Sosial Entrepreneurship, 4*(11), 134-150. https://tinyurl.com/38ccjdcr

Atmojo, I. R. W., Sajidan, Sunarno, W., & Ashadi, A. (2017, October 19-20). *Profile of elementary school pre-service teacher based on high order thinking skills (HOTS) on Natural Science subject* [Paper presentation]. ICTTE 2017: International Conference on Teacher Training and Education, Trakia University, Stara Zagora. Bulgaria. https://doi.org/10.2991/ictte-17.2017.57

Ball, A. L., & Garton, B. L. (2005). Modelling higher order thinking: The alignment between objective, classroom discourse and assessment. *Journal of Agricultural Education, 46*(2), 58-69. https://doi.org/cm42q5

Baya'a, N., & Daher, W. (2015). The development of college instructors' technological pedagogical and content knowledge. *Procedia - Social and Behavioral Sciences*, *174*, 1166–1175. https://doi.org/jj3x

Berry, B., Daughtrey, A., & Wieder, A. (2010, January). *Preparing to lead an effective classroom: The role of teacher training and professional development programs*. Center For Teaching Quality. https://tinyurl.com/yzewwhu9

Byrne, B. M. (2010). *Structural equation modeling with AMOS; Basic concepts, applications, and programming* (2nd ed.). Taylor & Francis. https://doi.org/10.4324/9780203805534

Cai, J., Kaiser, G., Perry, G., & Wong, N. Y. (2009). *Effective mathematics teaching from teachers' perspectives*. Sense Publishers. https://doi.org/10.1163/9789087908225

Cheda, K., & Utha, K. (2021). Science teachers' understanding of higher order thinking skills. *International Journal of English Literature and Social Sciences, 6*(5), 200-208. https://doi.org/10.22161/ijels.65.32

Chew, B. G. (2017). *Pengetahuan dan pengaplikasian kemahiran berfikir aras tinggi dalam kalangan guru teknik dan vokasional* [Knowledge and application of higher order thinking skills among technical and vocational teachers] [Unpublished master's thesis]. Universiti Tun Hussein Onn Malaysia.

Collins, R. (2014). Skill for the 21st century: Teaching higher-order thinking. *Curriculum & leadership Journal*, *12*(14). https://tinyurl.com/5dt3u2vy

Farah Aziana, A. A., & Fadzilah, A. R. (2018). Sorotan kajian kesediaan dan keperluan guru bahasa melayu dalam pelaksanaan kemahiran berfikir aras tinggi (KBAT) di bilik darjah [Literature Review: Readiness and needs of teachers in implementing higher order thinking skills (HOTS)]. *PENDETA Journal of Malay Language, Education and Literature, 9*, 80-101. https://doi.org/10.37134/pendeta.vol9.7.2017

Häkkinena, P., Järveläb, S., Mäkitalo-Sieglc, K., Ahonena, A., Näykkib, P., & Teemu Valtonend, T. (2016). Preparing teacher-students for twenty-first-century learning practices (PREP21): A framework for enhancing collaborative problem-solving and strategic learning skills. *Teachers and Teaching: theory and practice, 23*(1), 25–41. https://doi.org/10.1080/13540602.2016.1203772

Halim, A. (2013). *Kemahiran berfikir dalam pengajaran pemahaman bacaan* [Thinking skills in teaching reading and comprehension]. [Doctoral dissertation, University of Malaya]. Universiti Malaya Students' Repository. https://cutt.ly/JNDaFSk

Hasnah, I., & Jamaludin, B. (2017). Kompetensi guru bahasa melayu dalam menerapkan kemahiran berfikir aras tinggi dalam pengajaran dan pembelajaran [Malay language teacher competency to implementation higher order thinking skill in teaching and learning]. *Jurnal Pendidikan Bahasa Melayu, 7*(1), 56-65. https://tinyurl.com/2a523xk8

Mat Nor, M. N. A., Kamarudin, N., Abdul Manaf, U. K., & Mohd Puad, M. H. (2017). Penerapan kemahiran berfikir aras tinggi (KBAT) dalam kurikulum Reka Bentuk dan Teknologi (RBT) sekolah rendah [Implementation of higher order thinking skills (HOTS) in Design and Technology Curriculum for primary school]. *International Journal of Education and Training, 3*(2), 1 – 7. https://tinyurl.com/4ecenmxt

Ministry of Education Malaysia. (2014a). *Elemen KBAT dalam kurikulum* [*HOTS elements in curriculum*]. Curriculum Development Division. https://tinyurl.com/2m8yfkcf

Ministry of Education Malaysia. (2014b). *Elemen KBAT dalam pedagogi* [*HOTS elements in pedagogy*]. Curriculum Development Division. https://tinyurl.com/4jsctj5r

Mohamad Hisyam, I., Nabilah, A., Muhamad Furkan, M. S., & Marhamah, I. (2017). Higher order thinking skills (HOTS): Teacher training and skills in assessing science learning. *Advanced Science Letters, 23*(4), 3259-3262. https://doi.org/10.1166/asl.2017.7732

Mohd Aderi, C. N., Mohd Talhah, A., & Engku Zarihan, E. A. R. (2017). Teachers' practice of higher order thinking skills in the lesson of Islamic education. *Journal Tamu, 3*(2), 1-13. https://cutt.ly/qNDaXmx

Munawaroh, H., Sudiyanto, & Riyadi. (2018). Teachers' perceptions of innovative learning model toward critical thinking ability. *International Journal of Educational Methodology, 4*(3), 153-160. https://doi.org/10.12973/ijem.4.3.153

Nooriza, K., & Effandi, Z. (2015). Integrasi kemahiran berfikir aras tinggi dalam pengajaran dan pembelajaran matematik: Analisis keperluan guru [Integration of higher order thinking skills in the teaching and learning of mathematics: Teachers' needs analysis]. In S. Milfayetty & M. S. Abdullah (Eds.), *Proceeding of Education Graduate Regional Conference* (pp. 60 - 67). The State University of Medan.

Nor Hasmaliza, H., & Zamri, M. (2016). Persepsi guru bahasa melayu sekolah menengah terhadap kemahiran berfikir aras tinggi [The perception of malay language teachers at secondary school towards higher order thinking skills]. *Malay Language Education Journal, 6*(2), 78-90. http://journalarticle.ukm.my/10198/

Norakma, M. D., Abdul Razak, A., & Noria Munirah, Y. (2015). Pembelajaran berteraskan kemahiran berfikir aras tinggi (KBAT) di dalam pengajaran dan pembelajaran mata pelajaran Sejarah [Higher order thinking skills (HOTS) in the teaching and learning of history]. In Mahdum (Ed.). *Proceeding of 7th International Seminar on Regional Education* (pp. 352–360). Universitas Riau.

Norfariza, M. R., & Nur Fadhillah, M. (2018). Tahap kompetensi guru dalam pelaksanaan kemahiran berfikir aras tinggi di sekolah kebangsaan daerah Sepang, Selangor [The competency of teachers in the implementation of HOTS in national primary schools in Sepang, Selangor]. *JuKu: Jurnal Kurikulum & Pengajaran Asia Pasifik, 6*(4), 12-28. https://cutt.ly/BNDaNhE

Norshuhada, J., & Kamisah, O. (2019). Tahap kesediaan dan keperluan latihan guru dalam mengaplikasikan KBAT dalam PdPc sains [Level of preparation and teacher's training requirements in implementing the HOTS in science]. *International Journal of Modern Trends in Social Sciences, 2*(8), 42-54. https://tinyurl.com/33zyazav

Nur Hawa Hanis, A., & Ghazali, D. (2018). Kesediaan guru melaksanakan kemahiran berfikir aras tinggi dalam pengajaran [Readiness of teachers in the implementation of higher order thinking skills in teaching]. *JuKu: Jurnal Kurikulum & Pengajaran Asia Pasifik, 6*(3), 22-31. https://doi.org/10.32861/jssr.spi5.668.675

Nursafra, M. Z., Wan Ali Akbar, W. A., Norasmahani, N., Nor Anisa, M., & Mohd Syaubari, O. (2021). Issues and challenges of the implementation of HOTS in religious teaching in Malaysia. *International Journal of Academic Research in Progressive Education and Development*, *10*(2), 308–316. https://doi.org/10.6007/ijarped/v10-i2/9789

Rajendran, N. (2004). *Infusing higher order thinking skills into the teacher education program: A case study of Universiti Pendidikan Sultan Idris* [Unpublished doctoral dissertation]. Universiti Pendidikan Sultan Idris.

Retnawati, H., Djidu, H., Kartianom, Apino, E., & Anazifa, R. D. (2018). Teachers' knowledge about higher-order thinking skills and its learning strategy. *Problems of Education in the 21st Century, 76*(2), 215-230. https://doi.org/10.33225/pec/18.76.215

Saipolbahrin, R., Muhammad Taufiq, A. G., Nazri, A., & Taj Rijal, M. R. (2019). Integrasi elemen kemahiran berfikir aras tinggi (KBAT) berasaskan kit media dalam amalan pembelajaran dan pemudahcaraan guru pelatih Bahasa Arab [The integration of higher order thinking skills elements using a media kit in learning and facilitating practices of Arabic language teacher trainees]. *International Journal of Language Education and Applied Linguistics. 9*(1), 33-44. https://doi.org/10.15282/ijleal.v9.308

Siregar, R. A. (2022). Pre-service English teachers' attitude towards HOTS to prepare better assessment. *Journal of English Education and Linguistics Studies, 6*(1), 51–72. https://doi.org/10.30762/jeels.v6i1.1072

Siti Sarah, M. R., & Lilia, H. (2021). The effectiveness of critical thinking in improving skills in KBAT problem solving. *Malaysian Science and Mathematics Education Journal, 11*(1), 60-76. https://tinyurl.com/mvm32w79

Syazana, S., & Zamri, M. (2018). Persepsi guru bahasa melayu sekolah rendah daerah Sri Aman terhadap kemahiran berfikir aras tinggi dalam pengajaran dan pembelajaran [The perception of malay language teachers in Sri Aman district primary schools towards the implementation of higher order thinking skills in teaching and learning]. *International Journal of the Malay World and Civilisation, 6*(1), 63-78. https://tinyurl.com/2s4jnmvk

Tabachnick, B. G., & Fidell, L. S. (2007). *Experimental designs using ANOVA* (5th ed.). Allyn and Bacon.

Toresingam, T. T., Othman, N., & Rahman, R. S. A. R. A. (2019). Pengetahuan dan kemahiran guru terhadap kemahiran berfikir aras tinggi (KBAT) dalam pengajaran dan pembelajaran ilmu asas perniagaan [Knowledge and teacher skills on higher order thinking skills (HOTS) in teaching and learning business studies]. *International Journal of Education, Phycology, and Counseling, 4*(26), 46-56. https://tinyurl.com/tuvyss3u

Wan Ismail, W. A., Muhammad, W. I., Lubis, M. A., & Hamzah, M. I. (2016). Kesediaan guru pendidikan Islam sekolah rendah di Selangor terhadap penerapan KBAT dalam pengajaran dan pembelajaran [Readiness of Islamic education teacher in Selangor's primary school in the implementation of KBAT in teaching and learning]. *Journal of Advanced Research in Applied Sciences and Engineering Technology, 3*(1), 79-92. https://tinyurl.com/374th97w