



KNOWLEDGE, SKILLS AND ATTITUDE OF PRE-SERVICE MATHEMATICS TEACHERS IN COLLEGES OF EDUCATION, NORTH CENTRAL NIGERIA TOWARDS HIGHER -ORDER THINKING SKILLS (HOTS)

ABSTRACT

This study aimed to determine the level of knowledge, skills and attitude of pre-service Mathematics teachers in Colleges of Education, North Central Nigeria towards higher-order thinking skills (HOTS) and teachers' exposure to HOTS through the teaching mathematics courses through their level of knowledge, skills and attitude towards HOTS. The study was conducted at Colleges of Education, North Central Nigeria which comprises Niger State, Benue State, Kogi State, Nasarawa State, Plateau State, Kwara State and FCT Abuja. There are 31 Colleges of Education

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INTRODUCTION

Mathematics is a compulsory subject for students at elementary and secondary school levels. Teaching and learning activities in mathematics classroom always involve the mathematics teachers and students. Therefore, the mathematics teacher serves as the creator of students learning conditions that are designed in a planned, systematic, and continuous way. The process of learning and teaching mathematics can be planned and implemented with the best possible skills. Therefore, Mathematics learning has an important role in improving the quality of human resources. In order to achieve this, mathematics learning should facilitate individuals to develop Higher-order Thinking Skills (Apino &Retnawati, 2016).

Mathematical thinking is an important skill to develop students to implement their knowledge in mathematics in their real life independently, mathematical thinking allows for understanding of the necessity of using knowledge and skills and in addition, mathematical thinking allows for learning how to learn by oneself and the attainment of the abilities required for required independent learning.

Mathematics learning in schools today is still far from high-level thinking skills. The essentials in high-level skills (HOTS) are the learners' skills in problem solving, questioning skills, reasoning skills, communication skills and skillualization skills. These skills will be realized if the learner is able to design mathematics learning well and more on the interwoven way of learning mathematics, and using mathematical knowledge that is considered important in learning mathematics (Mad, 2017).



in these North Central States both Federal, State and Private were used in this study. A sample of 620 pre-service mathematics teachers were used in the study through simple random sampling techniques. Questionnaires were used as instrument in the research and were distributed to preservice Mathematics teachers to obtain data regarding their levels of knowledge, skills and attitude towards HOTS and the exposure to HOTS through teaching mathematics courses in Colleges of Education, North Central Nigeria. The descriptive statistics were used to determine the mean scores of the level of knowledge, skills and attitude among the pre-service Mathematics teachers. The findings shown that the knowledge and skills of pre-service Mathematics teachers in Colleges of Education, North Central Nigeria 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. In conclusion, the indicates that pre-service Mathematics teachers in Colleges of Education have positive attitude towards the implementation of HOTS and they have knowledge and skills. This study can be 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 Colleges of Education in Nigeria.

Keywords: Knowledge, Skill, attitude, Higher-order thinking skill, pre -service mathematics teachers, & Exposure

Mathematics teachers are only trained to ask HOTS questions, but most of them have little knowledge on the pedagogical knowledge of HOTS. Therefore, the best way to enable mathematics students to use HOTS in their everyday life is when the mathematics teachers in our schools have good pedagogical knowledge on HOTS and then transfuse this knowledge in their everyday mathematics lesson so that it will be easier to see our mathematics students thinking skill. Pre -Service Mathematics teachers should be aware of the importance of teaching higher order thinking skills (HOTS) in mathematics in order to prepare pre-services teachers for the 21st Century challenges. However, in reality, many mathematics teachers find difficulties in teaching HOTS (Afifah, & Retnawati, 2018). However, when students are solving mathematics problems, they are unable to arrived at a good solution especially with good thinking skills, this is simple because they are unable to think creatively and critically. This is a problem in which the students are unable to apply critical thinking outside familiar academic contexts Therefore, every student should master a range of important cognitive skills such as critical thinking, reasoning, creative thinking, and innovation

One of the effective ways in which mathematics teachers can teach higher order thinking skills in our Colleges of Education is when they infusion on critical and creative thinking in their prepared activities. The researcher believes that there are activities that are prepared to teach the students on how to think critically as well as analytically. Also, there should be serious efforts to ensure the implementation of higher order thinking skills in mathematics classrooms so that it would result in



students who can use higher order thinking skill fully to solve problems (Rhashvinder, Charanjit, Tunku, Nor, & Tarsem, 2018).

According to Chinese proverb “Give a man a fish and you feed him for a day; but teach a man to fish and he’ll have a skill to use all his life” In the line of above, the content-based instruction is like giving students a fish, by providing them the knowledge that can help them in only a specific situation. However, building students’ higher-order thinking skills, is like teaching students how to fish. If this is done well, then the students will be able to develop the ability to evaluate information, make decisions, solve problems and build arguments. Therefore, the higher-order thinking skills help students to become productive employees, informed citizens, and as well as good parents.

The recent trends have re-targeted mathematics as a subject that need to overhaul emphasis in the curriculum, the degree of which it should be assessed, and the focus on developing higher order thinking skills. Mathematics teachers focus only on learning targets, not on depth of knowledge tasks (Donahue, 2021). This challenge can differ from College to College depending on whether Higher -Order Thinking Skills (HOTS) is consider when choosing standards. Higher Order Thinking Skill (HOTS) of students are develop through teaching and learning of Mathematics.

Teachers’ knowledge about HOTS and its teaching and learning tactics are the key success of Education (Retnawati, Djidu, Ezi Apino, Anazifa, 2018). HOTS is an important aspect of teaching and learning process, because it is appropriate with the teaching goal, which is to make sure that students think and solve the problems critically (Chidozie et al., 2014). According to the Nigeria Certificate in Education Minimum Standard for Mathematics (2012; 2020) the philosophy of the NCE mathematics is inspired to help students to become intellectually informed in mathematical ideas notations and skills for logical reasoning, scientific enquiry and for the pursuit of techno-scientific education.

The roles of pre service Mathematics teachers are becoming more complex and more vital in the 21st century. Therefore, the pre service Mathematics teachers must realize that the characteristics of 21st-century learning of mathematics are marked by 4Cs, such as critical thinking and problem solving, creativity and innovation, communication, and collaboration. It is however hard to imagine a pre-service mathematics teacher who is not aware of the importance of teaching higher-order thinking skills to prepare young men and women to live in the 21st Century. The development of the 21st century requires everyone to equip themselves with skills in facing the era of globalization (Chai & Kong, 2017). Therefore, higher-order thinking skills are a necessity as a reliable workforce in the 21st century. HOTS is one of the essential skills in the 21st century, in which the developed nations have acknowledged as accelerative skills in this changing era (Ibrahim, Ayub & Yunus, 2020). Individuals not only need to have an education but also be able to think creatively and make the right decisions (Huang, 2011). Therefore, this means that education in the 21st century should highlight students’ skills for HOTS, transfer, and flexible reasoning over memorizing facts (Richland & Simms, 2015). Students with high level of HOTS tend to be more successful (Tanujaya, Mumu & Margono, 2017).

In view of the above, the Higher Order Thinking Skills (HOTS) are the need for life skills in the 21st century. There are seven C’s 21st Century Lifelong Skills such as (1) critical thinking, (2) creativity, (3) communication, (4) collaboration, (5) career and learning self-reliance, (6) cross cultural understanding, and (7) computing / ICT literacy (Bernie Trilling, 2005). Furthermore, Joke Voogt & Natalie Pareja Roblin (2010) suggested that the assessment HOTS, can enhance critical thinking



skills (critical thinking), creativity (creativity) and confidence (learning self-reliance). Higher order thinking skills over the decades have become a top priority. The aim is developing and enhancing students higher order thinking skills (HOTS) which has been a major educational goal in order to promote STEM (Zohar, & Schwartz, 2005).

Definition of higher -order thinking Skills (HOTS)

According to philosophy and psychology HOTS is define as a thinking skill, which involves problem solving and critical thinking (Lewis & Smith, n.d.). This means that the students are trained to solve a real life and complex problem. Anderson & Krathwohl from Bloom's Taxonomy revision propose this in 2001 Thinking Higher-order thinking involves using thinking skills that go beyond simple recall or understanding of information (Holt, Young, Keetch, Larsen, & Mollner, 2015). These skills generally make use of evaluation, analysis, and synthesis. In addition, ccreativity is also considered as a higher-order thinking skill

Level of Knowledge, Skills and Attitude Towards HOTS

Student required knowledge, skills and attitude which they will be able to think critically. Although thinking is a conscious process and it is undeniably the core of learning, being able to use higher order thinking skills for instance analyzing, applying, synthesizing and evaluating needs to be emphasized in teaching and learning mathematics The ability to think effectively is very important in today's world especially when it becomes more complex and sophisticated problems solving. Therefore, Higher-order thinking skills is one of the skills that students are more exposed to solving various problems and having to take numerous decisions day by day

Literature Review

Atmojo, Sajidan, Sunarno, & Ashadi (2017) examined the competence profile of high-order thinking skills (HOTS) ability of 120 pre-service teachers in science materials at Universitas Sebelas Maret. They employed descriptively quantitatively in the study. The finding shows that the competence of pre-service teachers in HOTS has a mean of 33.2% (40 ESPT). This indicates that the high thinking skills of prospective elementary teachers are medium category, but there is still need for improvement on certain materials

Tanudjaya & Doorman (2020) examine HOT in Indonesian lower secondary mathematics classrooms by assessing students' ability to demonstrate HOT skills through an open-ended mathematics problem, and by exploring teachers' views of HOT skills through semi-structured interviews. The study involved 372 ninth-grade students and six mathematics teachers from six lower secondary schools in Jakarta and Palembang. The findings show that most students could construct the mathematical model but experienced difficulty in transferring knowledge into new contexts, in applying creative thinking, and with information literacy skills. Besides, some of the teachers were familiar with the concept of HOT, but some viewed HOT as skills for talented students, or HOT problems having a high level of difficulty and long storylines. The knowledge of existing teaching strategies, familiarity with HOT problems, and colleague-support are needed to improve the development of HOT skills in the mathematics classroom.

Fadhullah, & Ahmad (2017) encourage students to become critical thinkers and to provide lecturers with the best approach to develop students' critical thinking skills at tertiary level. They



adapted The Cornell Critical Thinking Test Level X (CCTTX). 61 students taking Diploma in Office Management and Technology were chosen as samples of the study. The data were collected through observation and classroom-based activities namely debates, discussions, article analysis, problem-solving situations and case studies. The result shows that their critical thinking ability ranged from low to moderate level. Thus, strategies of teaching and learning which stresses on student-centered learning must be adopted to stimulate student's thinking by encouraging critical and creative thinking and the construction of new knowledge

Affiah & Retnawati (2018) investigated teachers' difficulties in teaching HOTS in the classroom using 10 high school mathematics teachers in Yogyakarta, Indonesia. The study employed descriptive explorative research design by using qualitative approach. Questionnaire was used for data collected in the research. The result of the study shows that the teachers still find difficulties in teaching HOTS in the classroom, those are (1) teachers' knowledge about HOTS is still low, (2) teachers' difficulty in delivering apperception to students, (3) teachers' difficulty in designing and applying the assessment based on HOTS, (4) teacher's difficulty in delivering HOTS based learning materials, (5) teacher's difficulty in making learning media based on HOTS, and (6) teachers' difficulty in preparing learning tools based on HOTS.

Tajudin, Puteh & Adnan (2017) conducted a study with the intention to develop guiding principles for fostering Higher order thinking skills in teaching mathematics in secondary schools. They used snowballing method to identify the items and themes for GP-HOTS. Their results showed that there are seven main themes of how teachers can foster HOTS in teaching and learning of mathematics namely determining the learning outcomes, planning questioning strategies, practicing active learning, developing habits of mind, practicing reflective thinking, implementing optimally assessment for learning and integrating information, communication and technology. These themes improved the teachers' mathematical knowledge for teaching, hence creating futuristic minded students.

In a most recent study, Suwarnoa, Nusantaraa, Susiswoa, & Irawatia (2022) explore the decision making of a prospective mathematics teacher in the process of improving a Lower Order Thinking Skills (LOTS) problem to be a Higher Order Thinking Skills (HOTS) problem. The study involves 51 prospective mathematics teachers that took part in improving HOTS problems. Two students were chosen based on their uniqueness and quality of HOTS problems produced and their fluency in communication. Semi-structured interviews were conducted to both participants and the data were analyzed qualitatively. The results showed that S1 was able to produce three-question related to one another, take two questions assess the reasonableness; finally decide one problem consisting of two items. S2 was able to generate three separate ideas, clarify the three ideas, and assess the three ideas and finally decide on one HOTS problem. S1 and S2 are still lack in involving Pedagogical Content Knowledge in assessing ideas especially. These results have an impact on the importance of developing a teaching model that improves the Decision-making Strategy.

Donahue (2021) explored the frequency of higher-order thinking opportunities available for mathematics students in middle and secondary schools that made the move to a proficiency-based system. The research used an explanatory sequential mixed-methods design. Two rounds of 50 observations were conducted within five different schools (2 middle schools and 3 high schools) using the Instructional Practices Inventory (IPI) tool. In a sixth school, one round of 50 observations took place. In the end there were 550 total data points. The researcher also included 11 total focus



groups with mathematics teachers. The results suggest that high school math students in a proficiency-based structure tend to receive more opportunities for higher-order thinking within their classrooms. The research also pointed to individual pace learning structures impacting student ability to access higher-order thinking opportunities and suggested that the advanced students receive the bulk of the opportunities in PBE classrooms.

Problem Statement

The effective ways of teaching higher order thinking skills are when there's infusion on critical and creative thinking in the activities prepared by the pre-service mathematics teachers. The activities prepared are to teach the students how to think critically as well as analytically. There is need for more efforts to ensure that the implementation of higher order thinking skills by the mathematics teachers in the classrooms is done, so that students can use higher order thinking skilfully to solve problems in mathematics and others related subjects. Despite the fact that there are multiples of programs to help teachers to infuse higher order thinking skills into teaching, yet pre-service mathematics teachers were not prepared to teach higher order thinking skills through infusion in their own Mathematics classrooms (Rajendran,1999). Also, most of the pre-service mathematics teachers lacked the skills to construct higher order thinking skills related content knowledge, and are unable to use higher order thinking skills which is vital because without conscious attempt one can't build up what one have learned before. Since higher order thinking skills requires one to form connections between what one had learned with what one is going to learn, it is important to develop skills to assist this level of thinking.

Others issues encounter by Pre service mathematics teachers in Colleges of Education in North Central Nigeria is lacking of producer of prospective teachers with Higher Order thinking skills, and the prospective teacher students and even pre-service mathematics teachers are having difficulty to applying higher-order thinking skills (Collins, 2014; Abosalem, 2016; Arafah, et al., 2021) Higher-Order Thinking Skills (HOTS) is an ongoing topic of interest among scholars, however, there is no wide exploration of such notion and its relation to knowledge, skills and attitude of Pre-Service Mathematics Teachers towards Higher-Order Thinking Skills in Colleges of Education in North Central Nigeria. The relevant literature reveals that the knowledge, skills and attitudes of pre-service mathematics teachers in Colleges of Education, North Centre towards Higher -Order Thinking Skills have not been investigated thoroughly. Therefore, this study sought to examine knowledge, skills and attitude of pre-service mathematics teachers towards HOTS in Colleges of Education in North Central Nigeria

Purpose of the Study

The main purpose of this research was to examined the knowledge, skills and attitude of pre-service Mathematics teachers in Colleges of Education, North Centre Nigeria regarding HOTS. Therefore, the following are specific objectives of the study;

1. Determine the levels of knowledge, skills and attitude of pre-service Mathematics teachers at Colleges of Education North Centre Nigeria towards Higher -Order Thinking Skills
2. find out whether the pre-service Mathematics teachers in Colleges of Education in North Centre Nigeria are exposed to HOTS through the teaching mathematics courses.



Research Questions

To achieve the purpose of this study, the following research questions were formulated thus;

1. What are the levels of knowledge, skills and attitude of pre-service Mathematics teachers at Colleges of Education in North Centre Nigeria towards higher order thinking Skills?
2. Are the pre-service Mathematics teachers in Colleges of Education in North Centre Nigeria exposed to HOTS through the teaching Mathematics courses?

Methodology

Research Design

This study employed a non-experimental research design which utilized the quantitative approach with the implementation of a survey method. This design was chosen because of the large population size used in this study. The respondents were pre-service Mathematics teachers in North Central Colleges of Education taking Nigeria Certificate in Education Mathematics and Bachelor of Education (Mathematics)

Procedure and Data Collection

This research was conducted in North Central States Colleges of Education, Nigeria which comprises Niger State, Benue State, Kogi State, Nasarawa State, Plateau State, Kwara State and FCT Abuja. There are 31 Colleges of Education in these North Central States in Nigeria both Federal, State and Private which used in this research. A sample of 620 pre-service mathematics teachers were used in the study through purposive sampling techniques. Questionnaires were used as instrument in the research and were distributed to preservice Mathematics teachers to obtain data regarding their levels of knowledge, skills and attitude towards HOTS and the exposure to HOTS through teaching mathematics courses in Colleges of Education, North Central Nigeria. Questionnaire items were adapted from the studies of Rajendran (2004), Wan Ismail et al. (2016), Nor Hasmaliza & Zamri (2016), and Hasnah & Jamaludin (2017) and were modified to suit the objectives of the study. The questionnaire was divided into five different parts and each part contained 10 items. Three experts validated the content of the instrument and it was 84.7%. A pilot was conducted using three Colleges of Education in North West Nigeria using 30 pre-service Mathematics teachers to obtained reliability of the instrument. Statistical Packages for Social Science (SPSS) software version 20.0 was used for the reliability of the instrument with a value $\alpha = .965$.

Data Analysis

This research uses descriptive statistics was used to analysed the data. However, a simple descriptive analysis by looking for 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 Colleges of Education in North Central, Nigeria towards HOTS and to examined whether the pre-service Mathematics teachers at North Central Colleges of Education in Nigeria are exposed to HOTS through teaching Mathematics courses.



Results

This section presents the results and analysis connected to levels of knowledge, skills and attitude of pre-service Mathematics teachers towards HOTS of pre service Mathematics teachers' which consisted of 620 Pre-Service Mathematics teachers from 31 Colleges of Education in North Central Nigeria and also to examined their level of exposure towards HOTS through their teaching mathematics courses

Research Question one: What are the levels of knowledge, skills and attitude of pre-service Mathematics teachers at Colleges of Education in North Centre Nigeria towards higher order thinking Skills?

The mean scores obtained for the level of knowledge among pre-service Mathematics teachers in Colleges of Education in North Central, Nigeria, indicates that Item 3 (know how to applying HOTS in teaching Mathematics) has the highest mean score of 3.63 which followed by item 1 (Know the concepts of implementing HOTS in the classroom) with a mean score of 3.55. while the lowest mean score of items₁₀ (Know the theories or models related to HOTS) with mean score of 1.82 followed by item 9 (Know ways to increase students' HOTS with a mean score of 2.37. The knowledge concerning applying HOTS in mathematics classroom, implementing Hots in the classrooms could help to generate higher order thinking skills among students in Colleges of Education, North Central Nigeria. However, the overall knowledge towards Hots among pre-service mathematics teachers in colleges of Education North Central Nigeria was considered to be moderate with an average mean score of 3.05.

Table 1: Levels of Knowledge among pre-service Mathematics teachers in Colleges of Education, North Central Nigeria Towards HOTS based on 10 items

No.	Items	Mean
1	Know the concepts of implementing HOTS in the classroom	3.55
2	Know how to develop HOTS in students	3.32
3	know how to applying HOTS in teaching Mathematics	3.63
4	Know various strategies and techniques to implement HOTS	3.36
5	Know the importance of implementing HOTS	3.16
6	Know how to prepare HOTS questions in Mathematics	3.14
7	Know how to evaluate HOTS elements in my students' answers in mathematics	3.34
8	Know how use a variety strategies and techniques for teaching HOTS	2.84
9	Know ways to increase students' HOTS	2.37
10	Know the theories or models related to HOTS	1.82
	Average	3.05

Table 2 depicts the level of skills among pre-service Mathematics teachers in Colleges of Education, North Central Nigeria based on 10 items. The highest mean score was shown by Item 5 (Skilled in providing illustrative examples in mathematics) with a mean score of 3.52 followed by Item 6 (Skilled in identify new solutions in mathematics) with a mean score of 3.44. Item 8 (Skilled in developing students metacognitive thinking ways) showed the lowest mean score of 2.24. Item 1 (Skilled in giving solution to HOTS questions) and Item 9 (Skilled in using various strategies to



integrate HOTS in teaching and learning Mathematics) also demonstrated low values of mean scores of 2.87 and 2.86 respectively. The level of skills towards HOTS among pre-service Mathematics teachers were found to be moderate with an average mean score of 2.98.

Table 2: Levels of skills among pre-service Mathematics teachers in Colleges of Education, North Central Nigeria Towards HOTS based on 10 items

No	Item	Mean
1	Skilled in giving solution to HOTS questions	2.87
2	Skilled in consistently considering different students alterative thinking	2.35
3	Skilled in integrating HOTS in mathematics question	2.89
4	Skilled in transferring data between different HOTS Questions	3.23
5	Skilled in providing illustrative examples in mathematics	3.52
6	Skilled in identify new solutions in mathematics	3.44
7	Skilled in encouraging students to think	3.18
8	Skilled in developing students metacognitive thinking ways	2.24
9	Skilled in using various strategies to integrate HOTS in teaching and learning Mathematics	2.86
10	Skilled in organising HOTS information in mathematics	3.23
	Average score	2.98.

Table 3 shown that Item 7 (I prepare an activity that can motivate students explore new ideas through solving Mathematics problems) had the highest mean score of 3.86, followed by item 2 (I explain skills guide to students in making rationalization related to something solution-based topics problem) with men score of 3.82. Item 8 (Like to engage with students asking difficult questions in class) demonstrated to have the lowest mean score of 2.15 followed by item 9 (Like to encourage students to solve non-routine mathematics questions) with mean score of 2.32. But, Item 4 (I prepare an activity that can motivate students explore new ideas through solving Mathematics problems) and item 1 (Encourage students' reason to encourage mind development of skills) has moderate mean scores of 3.76 and 3.64 respectively. The overall level of attitude of pre-service Mathematics teachers towards HOTS among pre-service Mathematics teachers in Colleges of Education, North Central Nigeria was considered high with an average mean score of 3.20. The results therefore, indicated that pre-service Mathematics teachers in Colleges of Education, North Central Nigeria do prepare an activity that can motivate students explore new ideas through solving Mathematics problems, and do explain skills guide to students in making rationalization related to something solution-based topics problem.

Table 3: Levels of Attitude among pre-service Mathematics teachers in Colleges of Education, North Central Nigeria Towards HOTS based on 10 items

No.	Item	Mean
1	Encourage students' reason to encourage mind development of skills	3.64
2	I explain skills guide to students in making rationalization related to something solution-based topics problem	3.82



3	I explain skills using the important of ICT to stimulate students' interest in solving mathematics problems	2.47
4	I prepare an activity that can motivate students explore new ideas through solving Mathematics problems	3.76
5	Encourage students to make conclusions about what they have learned	3.43.
6	Often relate problems in everyday life into mathematics questions	3.40
7	I prepare an activity that can motivate students explore new ideas through solving Mathematics problems	3.86
8	Like to engage with students asking difficult questions in class	2.15
9	Like to encourage students to solve non-routine mathematics questions	2.32
10	I show skills provide auxiliary materials learning that enables students make explanation	3.12
	Average	3.20

Research Question two: Are the pre-service Mathematics teachers in Colleges of Education in North Centre Nigeria exposed to HOTS through the teaching Mathematics courses?

Table 4 shown that Item 2 (Exposed to various thinking tools such as graphics management, mind map, i-Think mapping etc) had the highest mean score of 3.25 followed by Item 3 (exposed to the functions of each thinking tool) with a mean score of 3.17. Therefore, item 6 (exposed to ways to develop mathematics questions involving HOTS) with the lowest mean score of 2.16, followed by item 7 (I got exposure to teach using HOTS through Colleges of Education mathematics courses) with mean score of 2.21. The overall, exposure to HOTS through the teaching mathematics courses among pre-service Mathematics teachers was considered to be low with a mean score of 2.85.

Table 4: Colleges of Education, North Central Nigeria Pre- Service Mathematics Techers levels of Exposure to HOTS

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	3.05
2	I was exposed to various thinking tools (such as graphics management, mind map, i-Think mapping etc)	3.25
3	I was exposed to the functions of each thinking tool.	3.17
4	I was exposed to the importance of HOTS teaching and learning mathematics.	3.04
5	I was exposed to various activities that could generate HOTS.	3.09
6	I was exposed to ways to develop mathematics questions involving HOTS.	2.16
7	I got exposure to teach using HOTS through Colleges of Education mathematics courses.	2.21
8	I got exposure to teach using HOTS through core courses.	2.67
9	I got exposure to teach using HOTS teaching through minor courses.	2.75
10	I was exposed to various strategies for implementing HOTS in teaching and learning mathematics	3.06



Average	2.85
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Discussion of the Findings

Higher Order Thinking Skills are vital aspects to be inculcated among mathematics students and competent mathematics teachers which are the key factors in achieving these aspirations of Nigerian students. Subsequently, mathematics teachers and upcoming mathematics teachers need to equip themselves with knowledge about HOTS to make positive changes in the education system. In this study, the levels of knowledge have overall mean scores of 3.05 which is moderately. The finding is in line with the findings of Ahmat, Azmee, Mohamed, Zamzamir, Zahari, Shafie, Mohamed, Azura, Shah (2022), but contradicts the findings of Chew (2017); Nooriza and Effandi (2015) in which the teachers' knowledge in the aspect of pedagogy and assessment was high. However, Chew in his study found that teachers lack the knowledge and application of HOTS in the areas of curriculum, and pedagogy, and these results of the study were inclined towards to HOTS.

The findings of this study re not in line with findings of 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. Mathematics Teachers need to arrest students' interest in giving responses during the teaching and learning of mathematics in order to stimulate students' thought processes. In the overall, the finding indicates that 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 study directly put great pressure on the Colleges of Education in North Central Nigeria These are the platforms that should prepare and equip future teachers with critical and creative thinking skills. However, the results of this study is similar to the findings of 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) found that most of the teachers' level of skill regarding HOTS was still at a moderate level.

In this study, the overall, attitude of pre-service Mathematics teachers in Colleges of Education in North Central Nigeria was positive. The result is in line with the findings of Nur Hawa Hanis and Ghazali (2018) involving 143 History trained teachers in Perak, where a positive attitude towards HOTS. Therefore, pre-service mathematics teachers adapted HOTS based on teaching and learning process in order to rival the same practice of teaching and learning in mathematics classrooms in Nigeria However, the exposure of pre-service mathematics teachers to HOTS was based on some several teaching methods which are important for the teachers in every subject to enable them to practice teaching and learning process effectively and easily.

Summary of Findings

This section presents the summary findings of the two research questions in the study. The results of the research question were obtained. The results indicated that there are 2 highest and 2 lower levels of knowledge of HOTS among pre-service mathematics teachers in Colleges of Education, North Central Nigeria. In terms of skills, the findings shown that is also 2 level of higher and 2 level of lower skills of HOTS among pre-service mathematics teachers. The study revealed that there are



two higher and also two lower level of attitude of HOTS among pre-service mathematics teachers. Furthermore, the results shown two highest and two lower level of exposed of pre-service mathematics teachers towards HOTS.

Conclusion

The results of this study have shown that pre-service Mathematics teachers in Colleges of Education, North Central Nigeria has supported and realized the benefits of the of HOTS in mathematics classroom. However, time and training are needed in order to improve their knowledge and skills for effective and comprehensive. In line about the exposure to HOTS, the pre-service Mathematics teachers need to be further exposed to HOTS through teaching mathematics courses in Colleges of Education North Central Nigeria need their knowledge and skills towards HOTS, as the level of exposure to HOTS which was still considered to be part. Measures need to be taken to ensure that mathematics teachers are ready to implement HOTS in their mathematics classrooms as soon as they begin to embark on the educational field.

Implication of the Study

This study is indirectly to put pressure on the mathematics teachers in Colleges of Education, Nigeria to prepare and equip them with critical and creative thinking skills. The mathematics teachers in the Colleges of Education should have the ability to incorporate real-life problems into mathematics question and provide various activities that will be seen as the teaching strategies to improve students' interest in learning mathematics. The study will also promote students' problem-solving skills, and encourage students in shaping their thinking. By implication, this study will prevent misconceptions in students understanding, perception and confidence

Limitations

This study used survey research design, and questionnaire as the research instrument. The validity and reliability of the instrument of study depended on the respondents' honesty in answering the questionnaire. Therefore, confidentiality of the respondents was assured for the information given in this study. This study had limited respondents of 620 pre-service Mathematics teachers from 31 Colleges of Education, North Central Nigeria in their Mathematics departments both NCE and B.Eds. programs. Therefore, the results of this study cannot be generalised to all pre-service mathematics teachers in all Nigeria Colleges of Education. The information regarding HOTS in this study was limited to four aspects; knowledge, skills, attitude and exposure. Additionally, the variables used in this study to answer the research questions were restricted to the information that were in the research instrument only

Acknowledgments

This research was funding by Tetfund. I would like to thank Head of Mathematics Departments in the 31 Colleges of Education, North Central Nigeria and mathematics students for their support. Without their help this research would have never been possible.

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