Original Research Article

INVESTIGATING PRESERVICE MATHEMATICS TEACHERS' PERCEPTION ON COGNITIVE NEEDS

ABSTRACT

This article reports on part of a two- year study. The paper examined the perception of preservice mathematics teachers' cognitive needs via the lens of Maslow theory of needs. The research design employed was the mixed methods approach specifically sequential explanation mixed methods design. The population for this study was preservice mathematics teachers at the University of Education, Winneba of Ghana. The purposive sampling technique was employed to select Level 300 preservice mathematics teachers. Level 300 students were 183. The simple random sampling technique was used in selecting 125 respondents for the study. Questionnaire and interview protocol were used as instruments to collect data. Data collected through the questionnaire were analysed quantitatively and the interview data collected were analysed qualitatively. Results showed that the cognitive needs of the preservice mathematics teachers have been met to a very large extent. Recommendations were thereof made accordingly.

Keywords: Maslow theory of hierarchy of needs, Cognitive needs, Content Courses, Pedagogy Courses, ICT Courses

1. INTRODUCTION

Year in, year out, the performance in mathematics (especially core mathematics) at the Senior High School (SHS) level in Ghana has been the least among the other core subjects (English Language, Integrated Science and Social Studies). For instance, it was observed in 2014 that the performance of SHS candidates in Core Mathematics had been poorer than in Integrated Science, Social Studies and English Language (Mensah, 2014). Also, Ministry of Education (MoE) (2018, p. xvii) stated that "in terms of learning outcomes, results from the West African Senior Secondary Certificate Examination (WASSCE) have been poor for both core and elective science and mathematics subjects, particularly in 2015". Similar complaints about WASSCE mathematics (especially core mathematics) results have been trumpeted by stakeholders (e.g. Parents, Civil Society Organisations (CSOs), Ministry of Education (MoE), West African Examination Council (WAEC), etc.) in education (Akaboha & Kwofie, 2016; CitiNewsRoom, 2018; Daily Graphic, 2011a; Daily Graphic, 2011b; Doozie, 2015; Ghanaian Times, 2016; Kumsah, 2017; McCarthy, Gyan, Baah-Korang, & McCarthy, 2015; Nyavor, 2014; Pulse, 2018; Yeboah, 2018). Poor performance in mathematics and science has brought down overall performance, and this trend has remained unchanged for several years (MoE, 2018). Among various reasons attributed to the poor performance in core mathematics is a poor teaching skill as claimed by the Executive Director of the National Council for Curriculum and Assessment of the Ghana Education Service (GES) (Ansah, 2016). Also, Doozie (2015) asked that are the teachers found in our various schools up to the standards to teach mathematics? Doozie (2015) similarly asked whether the institutions (e.g., the University of Education, Winneba (UEW) that train these mathematics teachers are producing the right calibre of mathematics teachers that are capable of handling especially core mathematics?

The question that comes to mind is how are the preservice mathematics teachers in Ghana prepared to teach mathematics at the SHS level? Are the preservice mathematics teachers' needs met to some extent before they go out for teaching practice or before graduation? Needs are somethings that are required because they are essential or very important (Need, 2019). There are fundamental needs (e.g., content, pedagogy and technology needs) of preservice mathematics teachers that are acquired through the various courses that are taught to them. Lutz (2014) said preservice mathematics teachers have basic needs to be met in order to grasp concepts that are taught at the pre-tertiary levels. Demir (2019) also said that the more needs are met, the more preservice mathematics teachers would learn so that they can teach mathematical concepts when they find themselves on the teaching field.

According to Cooney (2019), preservice mathematics teachers are trained in diverse ways, depending to a great extent on the context in which the education occurs and the kind of courses that are offered to them. Most often, preservice mathematics teachers do not tell stakeholders (e.g., departments training preservice mathematics teachers) whether the courses they have taken have addressed their needs or not. For instance, a large number of preservice mathematics teachers in Ghana entered training via SHS and they have been taught core mathematics and some even were taught both core and elective mathematics. They should be able to tell their views about the courses offered them, whether the courses have met their needs or not. Demir (2019) was of the view that preservice mathematics teachers should be able to choose what they want to learn.

Preservice mathematics teachers could build their confidence for classroom instruction when their needs are met to some extent (Li & Kulm, 2008) and that could be ascertain when their perceived views are sought about the courses they have been taught. As put by some researchers (Bramald, Hardman, & Leat, 1995; Calderhead & Robson, 1991; Carter & Doyle, 1995; Thompson, 1992), preservice mathematics teachers entering training have pre-conceptions about teaching and about mathematics and the likes and are capable of telling whether what is been taught meet their needs. The academic achievement of preservice mathematics teachers is normally measured by grade point averages, while preservice teachers' adaptation to their new social environment is measured through such things as retention rates and graduation rates and how courses address the needs of preservice mathematics teachers are normally overlooked.

It is self-evident that preservice mathematics teachers are often not allowed to give feedback on whether the courses they have taken have met their cognitive needs or not. Notwithstanding, some studies (Boyd, Grossman, Lankford, Loeb, Wyckoff, 2009; Miller & Davidson, 2006; Masters, 2009; Norton, 2010; Whitworth, 1996) found that when preservice mathematics teachers' views are sought concerning the courses they have taken at a particular level, it helps in the restructuring of courses and also, it would help policy makers to do some tweaking to courses that need to be reviewed. In the case of the Department of Mathematics Education of the UEW, it is only the instructors that make suggestions to the review of courses. If learners are not asked whether courses, they have taken have addressed their needs, how can those involved in course reviewing know what to add, what to subtract and how to arrange courses?

It was very intriguing when an intern on teaching practice in one of the SHSs in Ghana was explaining the properties of indices to SHS learners and one of the learners asked for clarification of $(x+2)^3$ when the intern explained that $(ab)^n = a^n b^n$. The intern said $(x+2)^3 = x^3 + 2^3 = x^3 + 8$ which is incorrect. Similarly, another SHS learner asked the intern the simplification of $2\left(\frac{2}{3}\right)^n$ and the explanation from the intern was that $2\left(\frac{2}{3}\right)^n =$

$2\left(\frac{2^n}{3^n}\right) = \frac{2^n}{2.3^n} = \frac{2^n}{6^n}$ which is not correct. Even when the learners were not convinced due to previous explanation of properties of indices, the intern tried to convince them. The lesson had to be stopped by the supervisor for further directions.

Preservice mathematics teachers who do not themselves know the content well, are not likely to have the knowledge they need to help SHS students learn the content (Ball, Thames, & Phelps, 2008). It is very logical to find out preservice mathematics teachers perceived views on the courses they have taken before going for an internship programme or before they graduate.

When investigating the literature on teacher training and mathematics teacher training for that matter, it could be seen that works are generally about school performance, experiments and the likes but very little of them are about their ideas and opinions of trainees on university training programmes (Baştürk, 2011; Dursun & Kuzu, 2008; Eraslan, 2008; Eraslan, 2009; Inal & Büyükyavuz, 2013; Memduhoğlu & Topsakal, 2008; Mete, 2013; Sarıtaş, 2007; Sezgin Nartgün, 2008; Tüfekçi Aslım, 2013; Yıldırım, 2013). So, this study looked into the views of preservice mathematics teachers on the courses they have taken. Whether the courses have met their needs or not. Besides, this research empirically addressed the limited literature and information on preservice mathematics views on whether their cognitive needs have been met by the courses offered to them

2. THEORETICAL FRAMEWORK

Need is something that is required because it is essential or very important rather than just desirable (Need, 2020). Abraham Maslow developed the Hierarchy of Needs model in 1940-50s, and the Hierarchy of Needs theory remains valid today for understanding human training, and personal development (Businessballs, 2019). Maslow (1943, 1954) stated that people are motivated perfectly when certain needs are met. Maslow initially have a five-model hierarchy of needs (Physiological needs, Safety needs, Love and belongingness needs, Esteem needs and Self-actualization needs) and continued to refine his theory based on the concept of a hierarchy of needs over several decades (Maslow, 1943, 1962, 1987). Regarding the structure of his hierarchy, Maslow (1987) proposed that the order in the hierarchy “is not nearly as rigid” (p. 68) as he may have implied in his earlier description.

It is important to note that Maslow's (1943, 1954) five-stage model has been expanded to include cognitive and aesthetic needs (Maslow, 1970a) and later transcendence needs (Maslow, 1970b). The needs have also been segmented into deficiency needs (D-needs) and growth or being needs (B-needs) (see Figure 1). Deficiency needs arise due to deprivation and are said to encourage people when they are unmet. Growth needs continue to be felt and may even become stronger once they have been engaged.

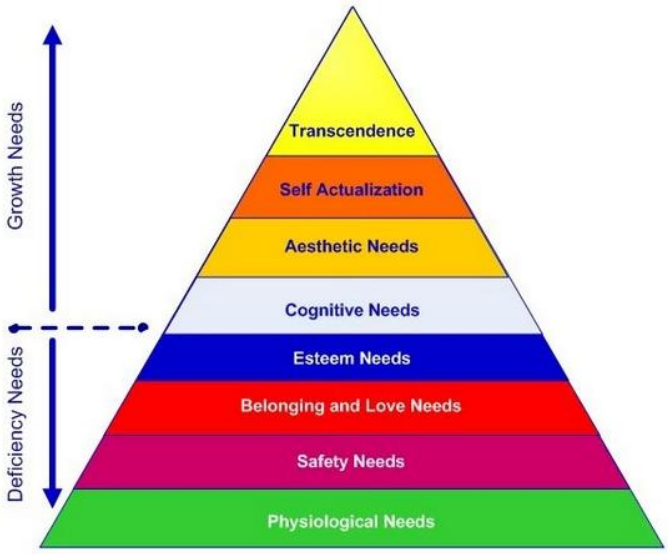

Figure 1. Maslow's Hierarchy of Needs.
Source: https://www.simplypsychology.org/maslow.html

Though Maslow's work fell out of favour with many academics, his theories are enjoying renaissance due to the rising interest in positive psychology (Cherry, 2019). Maslow's hierarchy of needs have been applied in psychology, biology, management, marketing, education, etc. but limited in mathematics education. Yong (2016) was able to explain Maslow's hierarchy of needs in relation to mathematics.

To be able to investigate whether the courses taken by preservice mathematics have met their needs, this study was situated in the cognitive needs level of the Maslow's theory of hierarchy of needs. The cognitive needs level of Maslow's hierarchy of needs was operationalised as preservice mathematics teachers' cognitive needs (PSMTCN). The details of PSMTCN are explained in the ensuing subheading.

PSMTCN Conceptual Framework

To be able to investigate the perceived cognitive needs of preservice mathematics teachers based on the courses they have been taught, this study conceptualized PSMTCN framework base on Maslow's cognitive needs. The PSMTCN is a tripartite which encompasses content needs (CN), pedagogy needs (PN) and technology needs (TN) (see Figure 2).

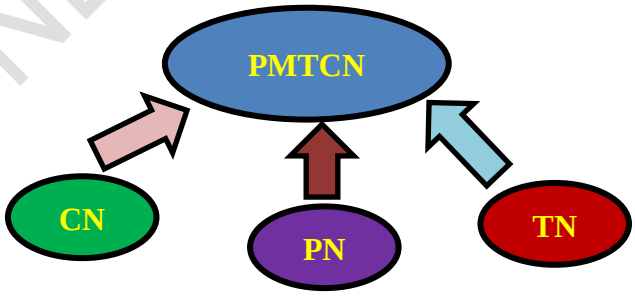

Figure 2. PSMTCN framework.

The CN was viewed in this study as preservice mathematics teachers perceived views on whether the content courses, they have taken have met their needs or not. The PN was

viewed as preservice mathematics teachers perceived views on whether the pedagogy cum pedagogical content courses, they have taken have met their needs or not. The TN was viewed as preservice mathematics teachers perceived views on whether technology/ICT courses, they have taken have met their needs or not. It depends on where preservice mathematics teachers are trained and the kind of courses that will be related to CN, PN, and TN.

The CN draws on the works of Masters (2009), Miller and Davidson (2006), Norton (2010), Shulman (1987), Keith (2004), Fennema and Franke (1992), Leikin (2006) and Hill, Ball, and Schilling (2008) that content knowledge is needed in training preservice mathematics teachers. PN is necessary in training preservice mathematics teachers so that they can transmit mathematics concepts to their learners when found on the teaching field (Emerick, Hirsch, & Berry, 2003; Keith, 2004; Ma, 1999; Miller & Davidson, 2006; Shulman, 1987, 1999; Silvernam & Thomson, 2008). TN is needed for preservice mathematics teachers to be able to incorporate technologies/ICTs into the teaching of mathematics (Pacific Policy Research Center, 2010, Powers & Blubaugh, 2016)

3. METHODOLOGY

A fixed mixed methods design (Choosing a mixed methods design, n.d.) with emphasis on the explanatory sequential or sequential explanatory design was used in this study. Fixed mixed methods designs are mixed methods researches where the use of quantitative and qualitative methods is predetermined and planned at the start of the research process, and the procedures are implemented as planned (Choosing a mixed methods design, n.d.). An explanatory sequential mixed methods design (also called a two-phase model; Creswell & Plano Clark, 2011) consists of first collecting quantitative data and then collecting qualitative data to help explain or elaborate on the quantitative results (Creswell, 2012). The sequential explanatory enabled the researchers to use both quantitative and qualitative approaches to generate enough data for the study, validate and interpret using systematic principles (Johnson & Christensen, 2008).

Pragmatism which is related to mixed methods research offers an alternative worldview to those of positivism and constructivism/interpretivism, and focuses on the problem to be researched and the consequences of the research (Creswell & Plano Clark, 2011; Miller, 2006; Tashakkori & Teddlie, 2003; Teddlie & Tashakkori, 2009). Pragmatism holds that there are singular and multiple realities that are open to empirical inquiry and orients itself toward solving practical problems in the “real world” (Creswell & Plano Clark, 2011; Rorty,1999). Hence, pragmatism allows the researchers to be free of the mental and practical constraints imposed by the “forced choice dichotomy between positivism and constructivism” (Creswell & Plano Clark, 2011, p. 27).

The population for this study was preservice mathematics teachers at the UEW, Ghana. All the preservice mathematics teachers of UEW on the four-year programme constituted the targeted population for the study. The four-year programme is a teacher training programme that allows preservice mathematics teachers to teach mainly at SHS when they graduate. In all, there are four different year groups which are level 100 students, level 200 students, level 300 students and level 400 students.

The researchers employed the purposive sampling technique specifically homogeneous sampling technique (Alvi, 2016; Necessary knowledge to conduct a business research, 2018; Palys, 2008) to select level 300 mathematics teachers from the department of mathematics education of the UEW. Sample size software tool was used to determine a sample size of 125 for the study with 5% margin of error, 95% confidence level and 50%

response distribution (Raosoft, 2004 cited in Apawu, 2014). After the determination of the sample size, simple random sampling technique was used in selecting the respondents for the study by the help of International Business Machine Statistical Package for the Social Sciences (IBMSPSS) version 26.0 The remaining 58 students who were not in the sample took part in the think aloud process and pretesting. In the first phase of the study, the entire 125 respondents making the sample size took part in the quantitative data collection whilst in the second phase, 6 selected respondents who agreed to be interviewed took part in the qualitative data collection. In a nutshell, a sample relationship criterion with emphasis on nested sequential sample relation (Johnson & Christensen, 2008) was employed in this study. According to Johnson and Christensen (2008), a nested sequential sample relation means that the respondents that were selected for one phase of a study represent a subset of those respondents who were selected for the other phase of the same study. In this study, the 6 respondents who agreed to take part in the qualitative data collection were also part of the 125 respondents who took part in the quantitative data collection.

With the lens of Maslow's theory of hierarchy of needs, PSMTCN framework, and from the research literature, and expert judgment, questionnaire and interview protocol were chosen to gather data for this study. The questionnaire items were in the Likert-type scale. The interview protocol was a semi- structured interview protocol structured around the study constructs. The semi-structured interview protocol allowed clear differences and similarities that emerged between respondents but was also flexible enough to allow further probing, through the use of appropriate prompts, of interesting points or areas where information was difficult to elicit (Prescott, 2011). There were seven questions on the semi-structured interview protocol. Validity and reliability of the instruments were ascertained before they were used in collecting data. For items on perceived content needs provided by mathematics content courses (questions 3 – 20), Cronbach's Alpha was 0.892. For items addressing perceived pedagogy needs provided by mathematics pedagogy courses (questions 21 – 27), Cronbach's Alpha was 0.917. For items addressing perceived technology needs provided by ICT courses (questions 28 – 34), Cronbach's Alpha was 0.834. The Cronbach's alphas were computed with the help of the IBMSPSS version 26.0. Reverse scoring was done in the IBMSPSS 26.0 before the alphas of the constructs were computed. The questionnaire data and the interview data were analysed sequentially. Permission was obtained from the students of the department of mathematics education of UEW before the commencement of the study and anonymity of the respondents was protected.

4. RESULTS AND DISCUSSION

This section is on the results and discussion.

In order to find the cognitive needs of preservice mathematics teachers, they were asked to indicate their level of agreement on courses that have addressed their needs as preservice mathematics teachers. Table 1 shows preservice mathematics teachers' ratings on how the content courses have addressed their needs.

Table 1
Appraisal of mathematics content courses by preservice mathematics teachers

Item	D	N	A
MATD 111: Algebra I has addressed my needs as a pre-service mathematics educator to a very large extent	4(3.2%)**	4(3.2%)	117(93.6%)*
MATD 112: Geometry I has addressed my needs as a preservice mathematics educator to a very large extent	9(7.2%)**	25 (20%)	91(72.8%)*
MATD 113: Probability and Statistics I has addressed my needs as a preservice mathematics educator to a very large extent	7(5.6%)**	16(12.8%)	102(81.6%)*
MATD 121: Algebra II has addressed my needs as a pre-service mathematics educator to a very large extent	4(3.2%)**	4(3.2%)	117(93.6%)*
MATD 122: Calculus I has addressed my needs as a preservice mathematics educator to a very large extent	9(7.2%)**	25(20%)	85(68%)*
MATD 123: Probability and Statistics II has addressed my needs as a preservice mathematics educator to a very large extent	11(8.8%)**	19(15.2%)	119(95.2%)*
MATD 124: Geometry II has addressed my needs as a preservice mathematics educator to a very large extent	15(12%)**	24(19.2%)	86(68.8%)*
MATD 231: Trigonometry has addressed my needs as a preservice mathematics educator to a very large extent	2(1.6%)**	10 (8.0%)	113(90.4%)*
MATD 232: Calculus II has addressed my needs as a preservice mathematics educator to a very large extent	11(8.8%)**	16(12.8%)	117(93.6%)*
MATD 241: Linear Algebra has addressed my needs as a preservice mathematics educator to a very large extent	1(0.8)**	10(8.0%)	114(91.2%)*
MATD 242: Vectors has addressed my needs as a pre- service mathematics educator to a very large extent	2(1.6%)**	13(10.4%)	110(88.0%)*
MATD 351MA: Ordinary Differential Equations has addressed my needs as a preservice mathematics educator to a very large extent	7 (5.6%)**	19(15.2%)	99 (79.2%)*
MATD 352: Introductory Analysis has addressed my needs as a preservice	14(11.2%)**	32(25.6%)	79(63.2%)*

mathematics educator to a very large extent			
MATD 361: Abstract Algebra has addressed my needs as a preservice mathematics educator to a very large extent	6(4.8%)**	33(26.4%)	86(68.8%)*
MATD 362: Further Statistics has addressed my needs as a preservice mathematics educator to a very large extent	28(22.4%)**	32(25.6)	65 (52.0%)*
MATD 362Ma: Mechanics has addressed my needs as a preservice mathematics educator to a very large extent	14(11.2%)**	24(19.2%)	87(69.6%)*
MATD 363: Numerical Analysis has addressed my needs as a pre- service mathematics educator to a very large extent	0(0.0%)**	15(12.0%)	110(88%)*
In general, the content courses have addressed my needs as a preservice mathematics educator	1(0.8%)**	13(10.4%)	111(88.8%)*

**Sum and percentage include Strongly Disagree and Disagree and reported as Disagree
* Sum and percentage include Strongly Agree and Agree and reported as Agree

For the 17 content courses, Table 1 shows that to a very large extent, the preservice mathematics teachers of UEW agreed that the top two (2) courses that have addressed their content needs as preservice mathematics teachers are: Algebra II (119, 95.2%) and Algebra I (117, 93.6%) out of 125 respondents. Also, Introductory Analysis (79, 63.2%) and Further Statistics (65, 52.0%) were rated respectively as the two (2) bottom courses that have addressed their needs to a very large extent.

From the interview data, Algebra I and Algebra II were among the top content courses that have addressed the content needs of preservice mathematics teachers and Introductory Analysis and Further Statistics were among the least agreed courses that have addressed the content needs of the preservice mathematics teachers. These findings suggested that preservice mathematics teachers perceived mainly Algebra I and Algebra II courses among other content courses as courses that have addressed their needs to teach mathematics (especially core mathematics) which invariably relates to their content needs. The choice of Algebra I and Algebra II as the two top courses by the preservice mathematics teachers might be due to the fact that the SHS mathematics (core and elective) syllabi may have contents similar to Algebra I and Algebra II course contents unlike Introductory Analysis and Further Statistics courses.

In general, 88.8%(n=111) (see Table 1) of the preservice mathematics teachers agreed that the mathematics content courses they have taken have addressed their content needs to a very large extent and the interview data corroborated the questionnaire data to some extent. It presupposes that the content needs (CN) of the preservice mathematics teachers have been met to a very large extent. When the interviewees were asked in what way(s) have the content courses addressed their needs they stated various reasons (see Table 2).

Table 2
Summary reasons the mathematics content courses met preservice mathematics teachers' content needs

Interviewee	Some Reason(s)
Student A	Hmmmm, sir, what I can say is that the content courses have helped me to understand some things I didn't understood when I was at SHS. For example, I can say that I can teach logarithm which I didn't understand very well when I was at SHS.
Student B	For me, I now know the geometrical interpretation of differentiation and other things that the content courses have offered me and I say that they help me paaaa.
Student C	The content courses helped in the sense that, I can say I can explain most core mathematics stuffs when I am made to teach core mathematics or even elective mathematics.
Student D	Hmmmm, the Algebra I and Algebra II courses met my needs so that I can teach topics from the core mathematics and elective maths syllabi. E.g., some proofs at the SHS level can be done easily.
Student E	When it comes to detail steps of solving mathematics problems at the SHS, I would be able to take students through so I can say that the content courses have met my needs.
Student F	I got to know that zero is an even number when I entered the university so now things that I had misconception on are now made clear to me and I hope I can deliver after leaving school.

For instance, Student A stated "*Hmmmm, sir, what I can say is that the content courses have helped me to understand some things I didn't underst[and] when I was at SHS. For example, I can say that I can teach logarithm which I didn't understand very well when I was at SHS*".

From the interview data, the following mathematics content courses were perceived by the preservice mathematics teachers as courses that could be restructured in terms of content and sequencing: Abstract Algebra, Probability and Statistics II, Ordinary Differential Equations, Introductory Analysis, Geometry I, Geometry II, Further Statistics, Calculus I, Trigonometry, and Calculus II. For instance, Student A said "*I think calculus one and trigonometry should be brought to [the first semester] and then the others will follow. Because, in Calculus I you will be differentiating Trigonometric Functions But you do Trigonometry in [Level]200 and so Calculus… ehm, Geometry II… You will take functions and then, you have not done integration and then Trigonometry yet So, it makes the learning difficult. I think if we had treated Trigonometry and Calculus one in level 100 [that would have been okay]*".

Table 3 shows preservice mathematics teachers' ratings on the pedagogy courses that have addressed their pedagogy needs. Some of the items in Table 3 were restated after respondents responded to negatively worded statements.

Table 3
Appraisal of pedagogy courses by preservice mathematics teachers

Item	D	N	A
PMTD 111: Psychology of Learning Mathematics has addressed my needs as a preservice mathematics educator to a very large extent	31(24.8%)**	14(11.2%)	80(64.0%)*

PMTD 121: Mathematics Curriculum of Learning Mathematics has addressed my needs as a preservice mathematics educator to a very large extent	32(25.6%)**	16(12.8%)	77(61.6%)*
PMTD 231: Methods of Teaching Junior High School Mathematics has addressed my needs as a preservice mathematics educator to a very large extent	34(27.2%)**	14(11.2%)	77(61.6%)*
PMTD 241: Methods of Teaching Senior High School Mathematics I has addressed my needs as a preservice mathematics educator to a very large extent	32(25.6%)**	12(9.6%)	81(64.8%)*
PMTD 351: Methods of Teaching Senior High School Mathematics II has addressed my needs as a preservice mathematics educator to a very large extent	35(28.0%)**	11(8.8%)	79(63.2%)*
EDPD 361: Pre-Internship Seminar has addressed my needs as a pre- service mathematics educator to a very large extent	35(28.0%)**	9(7.2%)	81(64.8%)*
In general, the pedagogy courses have addressed my needs as a pre-service mathematics educator to a very large extent	30(24.0%)**	14(11.2%)	81(64.8%)*

** Sum and percentage include Strongly Disagree and Disagree and reported as Disagree

* Sum and percentage include Strongly Agree and Agree and reported as Agree

From Table 3, 64.8% (n=81) respondents agreed that Methods of Teaching Senior High School Mathematics I and Pre-Internship Seminar have addressed their pedagogy needs as preservice mathematics teachers to a very large extent. The interview data on the pedagogy courses has confirmed the questionnaire data to some extent.

In general, 64.8%(n=81) (see Table 3) the preservice mathematics teachers agreed that the pedagogy courses they have taken have addressed their pedagogy needs to a very large extent and the interview data corroborated the questionnaire data to some extent. It presupposes that the pedagogy needs (PN) of the preservice mathematics teachers have been met to a very large extent. During the interview sessions, the interviewees were asked how the pedagogy courses have addressed their pedagogy needs and they gave various views (see Table 4).

Table 4
Summary reasons the pedagogy courses met preservice mathematics teachers' pedagogy need

Interviewee	Some Reason(s)
Student A	With the method courses taken, I can write detail lesson plan and explain topics that are in the mathematics syllabi to learners. I can also use TLMs effectively.

Student B	The training I had so far can help me use different approaches to teach a topic which I thought it is known as multiple embodiment principle hahaha. I can also motivate students by telling them that mathematics is not a difficult subject.
Student C	Implementing a lesson plan on a topic is something that I have learnt and I hope to implement that during my internship and after graduation. When I am on the field, I would do likewise. Understanding students also was explained to us and I will not shout on my students when I found myself in the classroom.
Student D	The pedagogy courses I have taken have met my needs that I can write SMART objectives and teach systematically.
Student E	I can assess students through various means. I can make my classroom conducive for my students.
Student F	Through the pedagogy courses I have taken; I can manage my class effectively. I can also write constructive feedback in students' exercise books. The pre-internship has helped me to be effective in the classroom.

For example, Student B stated that "*the training I had so far can help me use different approaches to teach a topic which I thought it is known as multiple embodiment principle hahaha. I can also motivate students by telling them that mathematics is not a difficult subject*".

During the interview sessions the following pedagogy courses: Methods of Teaching J.H.S. Mathematics, Methods of Teaching S.H.S. Mathematics I, Methods of Teaching S.H.S. Mathematics II and Psychology of Learning Mathematics were mentioned as courses that could be relooked at. For instance, Student B said that "*my concern is though they teach us how to prepare lesson notes and teach[ing] learning materials and the techniques or methods to tackle individual topics, [I think] maybe if you pick the core mathematics syllabus, you pick unit one, what are the activities you use to introduce this or maybe teach*".

Deducing from Student B's concern, it can be claimed that methods of teaching J. H. S. mathematics, methods of teaching S. H. S. mathematics I and II should be restructured in such a way that concepts/topics are taken from for example the core mathematics syllabus and learners are taken through how to introduce and teach them.

The summary of the questionnaire data on the ICT courses offered by the department of mathematics education of UEW that have addressed the technology needs of her preservice mathematics teachers is shown in Table 5.

Table 5
Appraisal of ICT courses by preservice mathematics teachers

Item	D	N	A
ICTD 111: Introduction to ICT Systems and Tools for Mathematics Teachers has addressed my needs as a preservice mathematics educator to a very large extent	7(5.6%)**	9(7.2%)	109(87.2%)*
ICTD 121: Fundamentals of Computer Programming has addressed my needs as a preservice mathematics educator to a very large extent	18(14.4%)**	29(23.2%)	78(62.4%)*
ICT 231: Courseware Design and	7(5.6%)**	7(5.6%)	111(88.8%)*

Development Using Multimedia Tools has addressed my needs as a pre-service mathematics educator to a very large extent			
ICTD 241: Computer Applications for Teaching and Learning Mathematics has addressed my needs as a preservice mathematics educator to a very large extent	9(7.2%)**	6(4.8%)	110(88.0%)*
ICTD 351: Introduction to Computer Programming for Mathematics Teachers has addressed my needs as a preservice mathematics educator to a very large extent	15(12.0%)**	20(16.0%)	90(72.0%)*
ICTD 361: Web Technologies for Mathematics Teachers has addressed my needs as a preservice mathematics educator to a very large extent	7(5.6%)**	10(8.0%)	108(86.4%)*
In general, the pedagogy courses have addressed my needs as a pre-service mathematics educator to a very large extent	6(4.8%)**	10(8.0%)	109(87.2%)*

** Sum and percentage include Strongly Disagree and Disagree and reported as Disagree

* Sum and percentage include Strongly Agree and Agree and reported as Agree

From Table 5, majority (88.8%, n=111) of the preservice mathematics teachers agreed that Courseware Design and Development Using Multimedia Tools course has addressed their technology needs to a very large extent followed by 110 (88.0%) out of 125 respondents agreeing that Computer Applications for Teaching and Learning Mathematics has addressed their technology needs as preservice mathematics teachers. The questionnaire data related to the ICT courses (see Table 5) were also supported by the interview data to some extent.

In general, 87.2%(n=109) (see Table 5), the preservice mathematics teachers of UEW agreed that the ICT courses they have taken have addressed their technology needs to a very large extent and the interview data corroborated the questionnaire data to some extent. It presupposes that the technology needs (TN) of the preservice mathematics teachers have been met to a very large extent.
The interviewees gave related views on how the ICT courses have addressed their needs (see Table 6).

Table 6
Summary reasons the ICT courses met preservice mathematics teachers' ICT need

Interviewee	Some Reason(s)
Student A	I can use MS Word to prepare detail lesson plan. Hmm, with the ICT courses I have taken, I can even teach ICT at the SHS hahahahahaha.
Student B	I can incorporate ICTs into my teaching. I can teach linear programming using Excel. I can use Geogebra to explain some coordinate geometry at the SHS and more.

Student C	The ICT courses have met my needs because I can use Word to prepare documents, type mathematics expressions, equations and other mathematics stuffs.
Student D	The multimedia course has helped me a lot and I can design a lesson using PowerPoint. I can also make videos on mathematics topics for SHS students. I can develop a website. I can do a lot of mathematics things using ICTs. I can't mention all.
Student E	Through the ICT courses, I have learned a lot of softwares which can help me explain some concepts to students. E.g., I can use Word to draw mathematical shapes.
Student F	I love most of the softwares that I was thought and I hope that's why I can say that the ICT courses have met my needs. I can use Excel to keep students' records. E.g., assessment records. I can use PowerPoint to prepare lesson and do presentation on topics effectively to students.

The interview data revealed that the following ICT courses: Fundamentals of Computer Programming, Computer Programming for Mathematics Teachers, Computer Applications for Teaching and Learning Mathematics and Courseware Design and Development Using Multimedia Tools need to be restructured. For instance, Student C said "*not content restructuring but the arrangement of especially ICTD 121 [Fundamental of Computer Programming] and ICTD 351 [Computer Programming for Mathematics Teachers]. We take ICTD 121 in First Year Second semester and ICTD 351 in third year first semester. I think after ICTD 121; it should be followed by ICTD 351 so that we may not forget some small small concepts*".

Preservice mathematics teachers from UEW mostly find themselves at the SHS and it expected that their teaching skills will be apt for the transmission of the content but this study found that the pedagogy courses in general was rated the least addressing their needs among the mathematics content and the ICT courses in general and it seems to support the claim that poor teaching skills is attributed to the poor performance in core mathematics (Ansah, 2016). According to Koehler and Mishra (2009, p. 63), "Knowledge of content is of critical importance for teachers" especially preservice mathematics teachers and in this study, the preservice mathematics teachers perceived that the content courses in general (ranked 1st) have addressed their needs to a very large extent which invariably means that their content needs have been met to a very large extent. This finding in this study is consistent with findings by Brush and Saye (2009) and Cox et al. (2013) that it can be overwhelming to preservice mathematics teachers when they are taken through simultaneously the learning of mathematics content, pedagogy and technology/ICT and that is why perhaps more than 50% of the preservice mathematics teachers agreed that in general, the content, the pedagogy and the ICT courses have addressed their needs to a very large extent. The findings also concur with what earlier studies (e.g., Artzt et al., 2011; Boyd et al., 2009; da Ponte & Chapman, 2008; Hill et al., 2008; Powers & Blubaugh, 2016; Silvernam & Thomson, 2008; Teacher Education Ministerial Advisory Group [TEMAG], 2014) found that if preservice mathematics teachers' needs (especially content, pedagogy, and ICT needs) are addressed to a very large extent, they would have a very high confidence in teaching after they have graduated and this study reported that more than 50% of the respondents claimed that in general, the mathematics content courses, the pedagogy courses and the ICT courses have addressed their needs to a very large extent which sum up to their cognitive needs have been met to a very large extent. Various views were given as how the content, the pedagogy and the ICT courses have addressed the needs of the preservice mathematics teachers which confirmed studies (Cox et al., 2013; Harris & Jensz, 2006; Keith, 2004; Koehler and Mishra, 2009; Ma, 1999; Masters, 2009; Miller & Davidson, 2006; Norton, 2010; Pacific Policy Research Center, 2010; Putnam & Borko, 2000; Shulman, 1987, 1999; Silvernam & Thomson, 2008) on what fundamental

needs are expected of a preservice mathematics teacher before s/he leaves schools. Moreover, this study shed light on which courses could be restructured in terms of content and sequencing by the Department of Mathematics Education of the UEW. Various suggestions by the preservice mathematics teachers on what could be done to the content courses, pedagogy courses and the ICT courses resonate with the claim by Demir (2019) that preservice mathematics teachers need to be taught what they want to learn.

5. IMPLICATIONS FOR PRACTICE

This study found that the preservice mathematics teachers agreed to a very large extent that in general, the mathematics content courses have addressed their needs followed by the ICT courses and then the pedagogy courses. If preservice mathematics teachers' needs (especially content, pedagogy, and ICT needs) are addressed to a very large extent, they would have very high confidence in teaching (Boyd et al., 2009; da Ponte & Chapman, 2008; Cox et al., 2013; Silvernam & Thomson, 2008). There is the need to beef up the pedagogical skills of preservice mathematics teachers so that they will be able to go out there and teach mathematics (especially core mathematics) very well since they rated in general the pedagogy courses as the least courses that have addressed their needs.

6. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings made in this study, it can be concluded that PSMTs cognitive needs could be met via the courses offered to them. Furthermore, based on the findings in this study, it is recommended that courses offered to preservice mathematics teachers should be restructured in terms of content and sequencing intermittently.

7. AREAS FOR FURTHER RESEARCH

More research on cognitive needs could be conducted on preservice mathematics teachers in other jurisdiction because of varied ways of training preservice mathematics teachers.

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