



Investigating Pre-service Mathematics Teachers' Perception on Cognitive Needs

Nana Akosua Owusu-Ansah^a and Jones Apawu^{a*}

^a Department of Mathematics Education, University of Education, Winneba, Ghana.

Authors' contributions

This work was carried out in collaboration between both authors. Author JA brought the idea, reviewed the literature with author NAOA. Author JA design the questionnaire and author NAOA design the interview guide. Author NAOA conducted the interviews after author JA administered the questionnaire. Author JA entered the questionnaire responses into the IBMSPSS software and clean the data. Author JA analyse the questionnaire data and author NAOA analyse the interview data. Author JA put all the components together and author NAOA worked on the references list. Author NAOA and author JA read and approved the final manuscript.

Article Information

DOI: 10.9734/ARJOM/2023/v19i9705

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/102234>

Original Research Article

Received: 01/05/2023
Accepted: 01/07/2023
Published: 17/07/2023

Abstract

This article reports on part of a two- year study. The paper examined the perception of pre-service 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 pre-service mathematics teachers at the University of Education, Winneba of Ghana. The purposive sampling technique was employed to select Level 300 pre-service 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 pre-service mathematics teachers have been met to a very large extent. Recommendations were thereof made accordingly.

*Corresponding author: Email: jonesapawu2010@gmail.com;

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 ([51]). Also, [55], 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 [1]; [15]; [20]; [21]; [24]; [30]; [37]; [48]; [60]; [64]; [78]). Poor performance in mathematics and science has brought down overall performance, and this trend has remained unchanged for several years ([55]). 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) ([3]). Also, [24] asked that are the teachers found in our various schools up to the standards to teach mathematics? [24] 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 pre-service mathematics teachers in Ghana prepared to teach mathematics at the SHS level? Are the pre-service 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 ([57]). There are fundamental needs (e.g., content, pedagogy and technology needs) of pre-service mathematics teachers that are acquired through the various courses that are taught to them [40] said pre-service mathematics teachers have basic needs to be met in order to grasp concepts that are taught at the pre-tertiary levels. [23] also said that the more needs are met, the more pre-service mathematics teachers would learn so that they can teach mathematical concepts when they find themselves on the teaching field.

According to [16], pre-service 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, pre-service mathematics teachers do not tell stakeholders (e.g., departments training pre-service mathematics teachers) whether the courses they have taken have addressed their needs or not. For instance, a large number of pre-service 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. [23] was of the view that pre-service mathematics teachers should be able to choose what they want to learn.

Pre-service mathematics teachers could build their confidence for classroom instruction when their needs are met to some extent ([39]) and that could be ascertain when their perceived views are sought about the courses they have been taught. As put by some researchers ([9]; [12]; [13]; [75]), pre-service 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 pre-service mathematics teachers is normally measured by grade point averages, while pre-service 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 pre-service mathematics teachers are normally overlooked.

It is self-evident that pre-service 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 ([8]; [54]; [48]; [59]; [77]) found that when pre-service 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.

Pre-service 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 ([6]). It is very logical to find out pre-service 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 ([7]; [25]; [27]; [28]; [33]; [50]; [52]; [67]; [68]; [76]; [79]). So, this study looked into the views of pre-service 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 pre-service 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 ([58]). 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 ([11]). [42], [43] 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 [42], [44], [47]. Regarding the structure of his hierarchy, [47] 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 [42]; [43] five-stage model has been expanded to include cognitive and aesthetic needs [45] and later transcendence needs [46]. The needs have also been segmented into deficiency needs (D-needs) and growth or being needs (B-needs) (see Fig. 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.

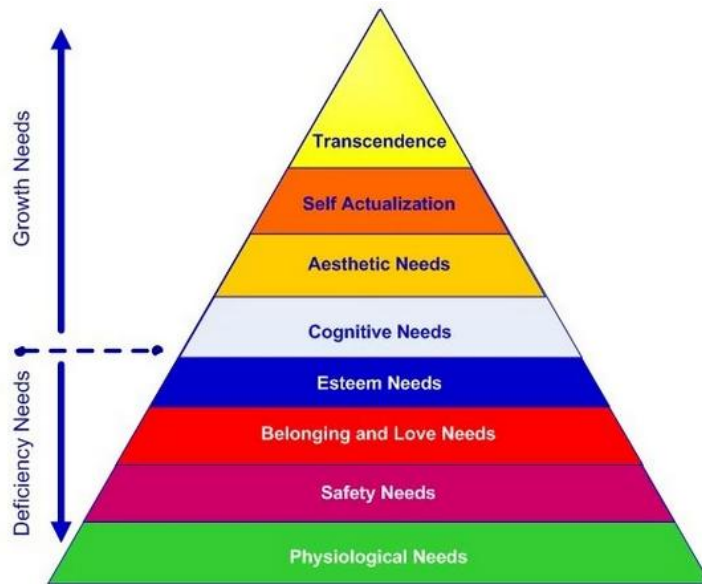


Fig. 1. Maslow's hierarchy of needs

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 [39]. Maslow's hierarchy of needs have been applied in psychology, biology, management, marketing, education, etc. but limited in mathematics education [27] was able to explain Maslow's hierarchy of needs in relation to mathematics.

To be able to investigate whether the courses taken by pre-service 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 pre-service mathematics teachers' cognitive needs (PSMTCN). The details of PSMTCN are explained in the ensuing subheading.

2.1 PSMTCN Conceptual Framework

To be able to investigate the perceived cognitive needs of pre-service 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 Fig. 2).

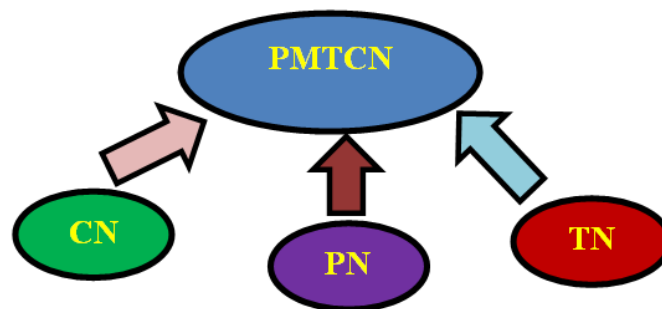


Fig. 2. PSMTCN framework

The CN was viewed in this study as pre-service mathematics teachers perceived views on whether the content courses, they have taken have met their needs or not. The PN was viewed as pre-service 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 pre-service mathematics teachers perceived views on whether technology/ICT courses, they have taken have met their needs or not. It depends on where pre-service 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 [48], [54], [59], [69], [35], [29], [38] and [32]) that content knowledge is needed in training pre-service mathematics teachers. PN is necessary in training pre-service mathematics teachers so that they can transmit mathematics concepts to their learners when found on the teaching field ([26]; [35]; [41]; [54]; [69], [70]; [71]). TN is needed for pre-service mathematics teachers to be able to incorporate technologies/ICTs into the teaching of mathematics ([61], [62])

3 Methodology

A fixed mixed methods design ([14]) 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 ([14]). An explanatory sequential mixed methods design (also called a two-phase model; [19]) consists of first collecting quantitative data and then collecting qualitative data to help explain or elaborate on the quantitative results ([18]). 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 ([34]).

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 ([19]; [53]; [72]; [74]). 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” ([19]; [66]). Hence, pragmatism allows the researchers to be free of the mental and practical constraints imposed by the “forced choice dichotomy between positivism and constructivism” ([19], p. 27).

The population for this study was pre-service mathematics teachers at the UEW, Ghana. All the pre-service 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 pre-service 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 ([2]; [56]; 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 ([4]). 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 (IBMSPPSS) 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 ([34]) was employed in this study. According to [34], 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 ([63]). 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 pre-service mathematics teachers, they were asked to indicate their level of agreement on courses that have addressed their needs as pre-service mathematics teachers. Table 1 shows pre-service mathematics teachers' ratings on how the content courses have addressed their needs.

Table 1. Appraisal of mathematics content courses by pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service mathematics educator to a very large extent | 15(12%)** | 24(19.2%) | 86(68.8%)* |
| MATD 231: Trigonometry has addressed my needs as a pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service mathematics educator to a very large extent | 14(11.2%)** | 32(25.6%) | 79(63.2%)* |

| Item | D | N | A |
|---|-------------|-----------|-------------|
| MATD 361: Abstract Algebra has addressed my needs as a pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service mathematics teachers of UEW agreed that the top two (2) courses that have addressed their content needs as pre-service 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 pre-service mathematics teachers and Introductory Analysis and Further Statistics were among the least agreed courses that have addressed the content needs of the pre-service mathematics teachers. These findings suggested that pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service 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 understand 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 “Hmmm, 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 pre-service 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 pre-service 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 pre-service mathematics teachers

| Item | D | N | A |
|---|-------------|-----------|------------|
| PMTD 111: Psychology of Learning Mathematics has addressed my needs as a pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service mathematics teachers is shown in Table 5.

Table 5. Appraisal of ICT courses by pre-service mathematics teachers

| Item | D | N | A |
|--|-------------|-----------|-------------|
| ICTD 111: Introduction to ICT Systems and Tools for Mathematics Teachers has addressed my needs as a pre-service 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 pre-service mathematics educator to a very large extent | 18(14.4%)** | 29(23.2%) | 78(62.4%)* |
| ICT 231: Courseware Design and Development Using Multimedia Tools has addressed my needs as a pre- service mathematics educator to a very large extent | 7(5.6%)** | 7(5.6%) | 111(88.8%)* |
| ICTD 241: Computer Applications for Teaching and Learning Mathematics has addressed my needs as a pre-service mathematics educator to a very large extent | 9(7.2%)** | 6(4.8%) | 110(88.0%)* |

| Item | D | N | A |
|---|-------------|-----------|-------------|
| ICTD 351: Introduction to Computer Programming for Mathematics Teachers has addressed my needs as a pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service 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 pre-service 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 hahahahaha. |
| 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*”.

Pre-service 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 ([3]). According to [36], p. 63, “Knowledge of content is of critical importance for teachers” especially pre-service mathematics teachers and in this study, the pre-service 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 [10] and [17] that it can be overwhelming to pre-service 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 pre-service 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., [5]; [8]; [22]; [32]; [62]; [71]; [73]) found that if pre-service 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 pre-service mathematics teachers which confirmed studies ([17]; [31]; [35]; [36], [41]; [48]; [54]; [59]; [61]; [65]; [69], [70]; [71]) on what fundamental needs are expected of a pre-service 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 pre-service mathematics teachers on what could be done to the content courses, pedagogy courses and the ICT courses resonate with the claim by [23] that pre-service mathematics teachers need to be taught what they want to learn.

5 Implications for Practice

This study found that the pre-service 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 pre-service mathematics teachers’ needs (especially content, pedagogy, and ICT needs) are addressed to a very large extent, they would have very high confidence in teaching ([8]; [22]; [17]; [71]). There is the need to beef up the pedagogical skills of pre-service 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 pre-service mathematics teachers should be restructured in terms of content and sequencing intermittently.

Consent

As per international standard or university standard, Participants’ written consent has been collected and preserved by the author(s).

Ethical Approval

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

Areas for Further Research

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

Acknowledgements

We will like to acknowledge the preservice mathematics teachers who agreed to respond to the questionnaire items.

Competing Interests

Authors have declared that no competing interests exist.

References

- [1] Akaboha AA, Kwofie S. Students' performance in Ghana: A discriminant analysis. *International Journal of Business and Social Research*. 2016;6(9):8-20.
Available:<https://thejournalofbusiness.org/index.php/site/article/viewFile/966/632>
- [2] Alvi MH. *A Manual for Selecting Sampling Techniques in Research*; 2016.
Available:https://mpr.aub.uni-muenchen.de/70218/1/MPRA_paper_70218.pdf.
- [3] Ansah M. Poor teaching skills to blame for poor students' performance; 2016.
Available:<http://citifmonline.com/2016/08/16/poor-teaching-skills-to-blame-for-poor-students-performance/>
- [4] Apawu J. Teaching undergraduate course: Blended instruction versus traditional instruction. *Future Tech: An International Journal of Science and Technology (FIJST)*. 2014;1(1):9-15.
- [5] Artzt A, Sultan A, Curcio FR, Gurl T. A capstone mathematics course for prospective secondary mathematics teachers. *Journal of Mathematics Teacher Education*. 2011;15(3):251-262.
Available:<http://dx.doi.org/10.1007/s10857-011-9189-5>
- [6] Ball D, Thames M, Phelps G. Content knowledge for teaching: What makes it special? *Journal of Teacher Education*. 2008;59(5):389-407.
Available:<https://www.math.ksu.edu/~bennett/onlinehw/qcenter/ballmkt.pdf>
- [7] Baştürk S. Mathematics Teacher candidates' evaluations of teaching and learning process in faculty of education. *International Journal of Human Sciences*. 2011;8(1):58-94.
Available:<https://jhumansciences.com/ojs/index.php/IJHS/article/view/1237/647>
- [8] Boyd DJ, Grossman PL, Lankford H, Loeb S, Wyckoff J. Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis*. 2009;31(4):416-440.
Available:<http://journals.sagepub.com/doi/pdf/10.3102/0162373709353129>
- [9] Bramald R, Hardman E, Leat D. Initial teacher trainees and their views of teaching and learning. *Teaching and Teacher Education*. 1995;11(1):23-31.
Available:<https://www.sciencedirect.com/science/article/abs/pii/0742051X94E0009T>
- [10] Brush T, Saye J. Strategies for preparing preservice social studies teachers to effectively integrate technology: Models and practices. *Contemporary Issues in Technology and Teacher Education*. 2009;9(1):46-59.
Available:<https://www.learntechlib.org/primary/p/28300/>
- [11] Businessballs. *Maslow's Hierarchy of Needs*; 2019.
Available:<https://www.businessballs.com/self-awareness/maslows-hierarchy-of-needs/>
- [12] Calderhead J, Robson M. Images of teaching: Student teachers' early conceptions of classroom practice. *Teaching and Teacher Education*. 1991;7:1-8.
Available:[http://dx.doi.org/10.1016/0742-051X\(91\)90053-R](http://dx.doi.org/10.1016/0742-051X(91)90053-R)

- [13] Carter K, Doyle W. Preconceptions in learning to teach. *The Educational Forum*. 1995;59:186-195.
- [14] Choosing a mixed methods design (n.d.). Chapter 3: Choosing a mixed methods design. Available:http://www.sagepub.com/upm-data/35066_Chapter3.pdf
- [15] Citi News Room. WAEC Releases 2018 WASSCE Results; 26,434 Candidates Involved In Cheating; 2018. Available:<https://www.modernghana.com/news/868084/waec-releases-2018-wassce-results-26434-candidates-involve.html>
- [16] Cooney TJ. The evolution of mathematics teacher education, *The Evolution of Mathematics Education as a Field of Inquiry*; 2019. Available:<https://education.stateuniversity.com/pages/2199/Mathematics-Education-Teacher-Preparation.html>
- [17] Cox DC, Chelser J, Beisiegel M, Kenney R, Newton J, Stone J. The status of capstone courses for preservice secondary mathematics teachers. *Issues in the Undergraduate Mathematics Preparation of School Teachers*. 2013;4:1-10. Available:<http://www.k12prep.math.ttu.edu/journal/4.curriculum/beisiegel01/article.pdf>
- [18] Creswell JW. *Educational research: planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). 501 Boylston Street, Boston, MA 02116: Pearson Education, Inc; 2012.
- [19] Creswell JW, Plano Clark VL. *Designing and conducting mixed methods research* (2nd ed.). Thousand Oaks, CA: Sage; 2011.
- [20] Daily Graphic. WAEC unhappy with students performance in English, Mathematics; 2011. Available:<http://www.modernghana.com/news/8834/1/waec-unhappy-with-students-performance-in-english-.html>
- [21] Daily Graphic. Nearly a quarter of WASSCE candidates failed in Maths; 2011. Available:<http://edition.myjoyonline.com/pages/education/201110/74608.php>
- [22] da Ponte JP, Chapman O. Preservice mathematics teachers' knowledge and development; 2008. https://www.google.com.gh/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwitj-Gjg4zWAhUMnBoKHe0aAakQFggxMAE&url=http%3A%2F%2Fwww.ugr.es%2F~pflores%2F2008_9%2FMaster_Conocim%2Ftextos%2F2520JP%2F%255B3B%255D_Ponte_Chapman_2008.doc&usg=AFQjCNGpbcqzf7t63rnLbnM16EML0sEkZg
- [23] Demir N. Application of Maslow's hierarchy needs and theory to education; 2019. Available:https://www.academia.edu/7214223/application_of_maslow_s_hierarchy_needs_and_theory_to_education
- [24] Doozie P. WASSCE 2015, Who Is To Blame For The Poor Performance, Teachers Or Students???. 2015. Available:<https://www.modernghana.com/news/636146/1/wassce-2015-who-is-to-blame-for-the-poor-performan.html>
- [25] Dursun ÖÖ, Kuzu A. Opinions of Teacher Candidates and Supervisors Regarding Problems Experienced in Teaching Practice. *Selçuk University Journal of Ahmet Keleşoğlu Faculty of Education*. 2008;25:159 - 178.
- [26] Emerick S, Hirsch E, Berry B. Unfulfilled promise: Ensuring high quality teachers for our nation's students; 2003. Available:<http://www.teachingquality.org/content/unfulfilled-promise-ensuringhigh-quality-our-nations-students-extensive-findings>

- [27] Eraslan A. Faculty–School Partnership Programme: Prospective Mathematics Teachers’ Reflections on School Practice Course. Hacettepe University Journal of Education. 2008;34:95-105.
- [28] Eraslan A. Prospective mathematics teachers’ opinions on “Teaching Practice”. Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education. 2009;3(1):207-221.
Available:https://www.researchgate.net/publication/26625716_Prospective_Mathematics_Teachers%27_Opinions_on_Teaching_Practice
- [29] Fennema E, Franke M. Teachers’ knowledge and its impact in D.A Grouws (Ed) Handbook of Research on Mathematics Teaching and Learning. New York: Macmillan Publishing; 1992.
- [30] Ghanaian Times. WAEC bemoans poor performance in Maths; 2016.
Available:<http://www.ghanaiantimes.com.gh/waec-bemoans-poor-performance-in-maths/>
- [31] Harris KL, Jenz F. The preparation of mathematics teachers in Australia: Meeting the demand for suitably qualified mathematics teachers in secondary schools. The University of Melbourne; 2006.
Available: http://cshe.unimelb.edu.au/research/disciplines/docs/Prep_Math_Teach_Aust.pdf
- [32] Hill H, Ball DL, Schilling S. Unpacking pedagogical content knowledge: conceptualizing and measuring teachers' topic-specific knowledge of students. Journal for Research in Mathematics Education. 2008;39(4):372–400.
Available:<https://pdfs.semanticscholar.org/9a72/f2765a4e0880a413f32e0a7ddc7e53046b60.pdf>
- [33] Inal S, Büyükyavuz O. English Trainees “Opinions on professional development and pre-service education. Hacettepe University Journal of Education. 2013;28(2):221-233.
- [34] Johnson RB, Christensen LB. Educational Research. Qualitative, quantitative and mixed approaches (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc; 2008.
- [35] Keith ML. The preservice training of teachers – does it meet its objectives and how can it be improved? “Paper commissioned for the EFA Global Monitoring Report 2005, The Quality Imperative”; 2004.
Available:<http://unesdoc.unesco.org/images/0014/001466/146658e.pdf>
- [36] Koehler MJ, Mishra P. What is technological pedagogical content knowledge? Contemporary Issues in Technology and Teacher Education. 2009;9(1):60-70.
- [37] Kumsah CE. WAEC releases 2017 WASSCE results, 42% passed Maths; 2017.
Available:<https://www.primenewsghana.com/general-news/42-of-students-passed-in-maths-as-waec-releases-2017-wassce-results.html>
- [38] Leikin R. Getting aware: Secondary school teachers learn about mathematics challenges in education. Educational Review. 2006;4(1):20-45.
- [39] Li Y, Kulm G. Knowledge and confidence of pre-service mathematics teachers:the case of fraction division. ZDM Mathematics Education. 2008;40:833–843.
DOI:10.1007/s11858-008-0148-2.
Available:https://www.academia.edu/14862499/Knowledge_and_confidence_of_pre-service_mathematics_teachers_the_case_of_fraction_division?auto=download
- [40] Lutz K. Maslow's Hierarchy of Needs in an Inclusion Classroom.
Available:<http://psed516diversityproject.wikispaces.com/Maslow's+Hierarchy+of+Needs+in+an+Inclusion+Classroom-+By+Kaitlin+Lutz>
- [41] Ma L. Knowing and teaching elementary mathematics: Teachers’ understanding of fundamental mathematics in China and the United States. Mahawah, NJ: Lawrence Erlbaum Associates, Inc; 1999.

- [42] Maslow AH. A theory of human motivation. *Psychological Review*. 1943;50(4):370-396. DOI:10.1037/h0054346
- [43] Maslow AH. *Motivation and personality*. New York: Harper and Row; 1954.
- [44] Maslow AH. *Towards a Psychology of Being*. Princeton, New Jersey: D. Van Nostrand Company; 1962.
- [45] Maslow AH. *Motivation and personality*. New York: Harper & Row; 1970.
- [46] Maslow AH. *Religions, values, and peak experiences*. New York: Penguin. (Original work published 1966); 1970.
- [47] Maslow AH. *Motivation and personality* (3rd Ed.). Delhi, India: Pearson Education; 1987.
- [48] Masters GN. *A shared challenge: Improving literacy, numeracy and science learning in Queensland primary schools*. Camberwell, Victoria: Australian Council for Educational Research; 2009. Available:<http://education.qld.gov.au/mastersreview/pdfs/final-report-masters.pdf>
- [49] McCarthy P, Gyan E, Baah-Korang K, McCarthy P. Analysis of results of core academic subjects of Ghanaian secondary schools: Case study of a secondary school in Ghana. *Journal of Education and Practice*. 2015;6(8):9-17. Available:<https://files.eric.ed.gov/fulltext/EJ1082730.pdf>
- [50] Memduhoğlu HB, Topsakal C. Quality and problems of teacher education graduate programs according to the views of students and faculty members. *Ege Education Magazine*. 2008;1(9):95–129.
- [51] Mensah AA. *Mathematical Association of Ghana begins 39th confab*; 2014. Available:<http://graphic.com.gh/news/education/28947-mathematical-association-of-ghana-begins-39th-confab.html>
- [52] Mete YA. Metaphors of prospective teachers, teachers, and school principals for the practical training course. *Journal of Teacher Education and Educators*. 2013;2(2):249-274. Available:<http://www.jtee.org/document/issue4/MAK4.pdf>
- [53] Miller S. Mixed methods as methodological innovations: Problems and prospects. *Methodological Innovations Online*. 2006;1:29-33. Available:<http://journals.sagepub.com/doi/pdf/10.4256/mio.2006.0005>
- [54] Miller KW, Davidson DM. What makes a secondary school science and/or mathematics teacher “highly qualified”? *Science Educator*. 2006;15(1):56-59. Available:<http://files.eric.ed.gov/fulltext/EJ773254.pdf>
- [55] Ministry of Education. *Education Sector Analysis*; 2018. Available:<https://sapghana.com/data/documents/Ghana-Education-Sector-Analysis-2018.pdf>
- [56] *Necessary knowledge to conduct a business research. Purposive sampling*; 2018. Available:<https://research-methodology.net/sampling-in-primary-data-collection/purposive-sampling/>
- [57] Need. In *Lexico dictionary*; 2019. Available:<https://www.lexico.com/en/definition/need>
- [58] Need. In *Lexico Oxford Dictionary*; 2020. Available:<https://www.lexico.com/definition/need>
- [59] Norton S. How deeply and how well? How ready to teach mathematics after a one- year program? *Mathematics Education and Special Education*. 2010;12(1):L65-84. Available:<http://www.merga.net.au/ojs/index.php/mted/article/view/61/39>

- [60] Nyavor G. Worst WASSCE performance under NDC trumps NPP's best – Ablakwa; 2014.
Available:<http://www.myjoyonline.com/news/2014/august-27th/worst-wassce-performance-under-ndc-trumps-npps-best-ablakwa.php?print=1>
- [61] Pacific Policy Research Center. 21st Century Skills for Students and Teachers. Honolulu: Kamehameha Schools, Research & Evaluation Division; 2010.
- [62] Powers R, Blubaugh W. Technology in mathematics education: Preparing teachers for the future; 2016.
Available:<http://www.citejournal.org/volume-5/issue-3-05/mathematics/technology-in-mathematics-education-preparing-teachers-for-the-future/>
- [63] Prescott FJ. Validating a long qualitative interview schedule. *WoPaLP*. 2011;5:16-38.
Available:<http://langped.elte.hu/WoPaLP/Particles/W5Prescott.pdf>
- [64] Pulse. WAEC says pidgin language is affecting students' performance; 2018.
Available:<https://www.pulse.com.gh/communities/student/waec-says-pidgin-language-is-affecting-students-performance-id8623241.html>
- [65] Putnam RT, Borko H. What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*. 2000;29(1):4-15.
Available:<http://journals.sagepub.com/doi/pdf/10.3102/0013189X029001004>
- [66] Rorty R. *Philosophy and social hope*. London: Penguin Books; 1999.
- [67] Sarıtaş M. Evaluation of Opinions about the Benefits Provided to Prospective Teachers by School Experience. *Journal of Uludağ University Faculty of Education*. 2007;20 (1):121-143.
- [68] Sezgin Nartgün Ş. Candidate teachers' views on the criteria of appointment to ministry of national education institutions. *Journal of Abant İzzet Baysal University Faculty of Education*. 2008;8(2):47-58.
- [69] Shulman LS. Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*. 1987;57(1):1-22.
- [70] Shulman LS. Knowledge and teaching: Foundations of the new reform. In J. Leach & B. Moon (Eds.), *Learners and pedagogy*. London: SAGE. 1999; 61-77.
- [71] Silverniam J, Thompson P. Toward a framework for the development of teachers. In F. K. Lester (Ed.), *Second handbook of research on mathematics learning and teaching*. Charlotte, NC: NCTM. 2008; 157224.
- [72] Tashakkori A, Teddlie C. *Handbook of Mixed Methods in Social & Behavioural Research*. Thousand Oaks: Sage; 2003.
- [73] Teacher Education Ministerial Advisory Group (TEMAG). *Action now: Classroom ready teachers*; 2014.
Available:<http://www.studentsfirst.gov.au/teacher-education-ministerial-advisory-group>
- [74] Teddlie C, Tashakkori A. *Foundations of mixed methods research: Integrating Qualitative and quantitative approaches in the social and behavioral sciences*. Thousand Oaks, CA: Sage Publications; 2009.
- [75] Thompson AG. Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning*. New York: Macmillan Publishing. 1992;127-146.
Available:https://www.researchgate.net/publication/246355884_Handbook_of_Research_on_Mathematics_Teaching_and_Learning

- [76] Tüfekçi Aslim S. Evaluation of the attitudes of candidate elementary teachers to the profession of teaching. The Journal of Industrial Arts Education Faculty of Gazi University. 2013;32(1):65-81.
- [77] Whitworth JM. Student teachers: Outsiders in curriculum reform? National Association for Research in Science. 1996;20-25.
- [78] Yeboah I. WAEC releases WASSCE 2018 results; withholds results of 26,434 candidates; 2018. Available:<https://www.graphic.com.gh/news/education/waec-releases-wassce-2018-results-cancels-entire-results-of-26-434-candidates.html>
- [79] Yıldırım A. Teacher education research in Turkey: Trends, issues and priority areas. Education and Science. 2013;38(169):175-191.

© 2023 Owusu-Ansah and Apawu; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here (Please copy paste the total link in your browser address bar)

<https://www.sdiarticle5.com/review-history/102234>