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Factors Influencing Pre-Service Teachers' Performance in Mathematics in Colleges of Education: Re-counting Experiences in Ghana

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Abstract

This study explored the factors affecting pre-service teachers' performance in mathematics in the colleges of education in Ghana. A descriptive cross-sectional survey design was employed. Data was collected with the use of a questionnaire from a sample of 400 first-year pre-service teachers selected using stratified random sampling technique from the three regions across the Ghana. Data were analyzed using exploratory factor analysis and regression analysis. The results suggested that pre-service teachers perceived the following as factors affecting their performance in mathematics: teaching-learning conditions, motivation, parents' educational background, valuing of mathematics, and health and safety issues. It was also revealed that pre-service teachers' motivation was the best predictor of their performance in mathematics, followed by health and safety issues and then teaching-learning conditions. Implications of the findings are discussed in the study.

Keywords: perceived factors; pre-service teachers; pre-service teachers' performance in mathematics

Introduction

Mathematics is seen in most less developed countries as being difficult and abstract (Kiwanuka, Damme, Noortgate, Anumendem, & Namusisi, 2015) for students to learn. Its significance in scientific and technological development cannot be ignored as the survival of every nation or society depends largely on the application and usage (Tella, 2008) of this all-important subject of mathematics. In Ghana, for instance, one of the mandatory subjects in the basic, secondary and colleges of education is Mathematics. It means that the country's economic growth and development depend on mathematical literacy. Students perform poorly in mathematics regardless of its usefulness and importance (Kiwanuka, et al., 2015) to society. Again, mathematics has multiple applications and some of which are in Engineering, Medicine (e.g. Mathematical Medicine at the University of Nottingham), Industrial Mathematics, Actuarial Science, Chemical Engineering (Tella, 2008), and in the use of 3-D effects in Architecture. It is, therefore, impossible for any person to live anywhere in this world (Wilmot, 2008) without making use of mathematics of some kind, evidence that mathematics is very useful in all aspects of life.

In Ghana, students must leave senior high school having appropriate knowledge and skills in mathematics, but the Chief Examiner's report for West African Senior Secondary School Certificate Examinations (2008) on Core Mathematics shows that students' performance in mathematics was

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weak. Again, the Chief Examiner's report for the Institute of Education. U.C.C, UCC Colleges of Education Examinations (2008, 2009, and 2019) on Numbers and Basic Algebra, Geometry and Trigonometry, Statistics and Probability also showed that first-year pre-service teachers' performance in mathematics has been decreasing over the years when the colleges were awarding Diploma in Basic Education. For Numbers and Basic Algebra, in particular, the report pointed out that 32.9% of the candidates who sat for this paper had grades D or D+ and 20.9% failed in the subject. Additionally, the first-year pre-service teachers offering Bachelor of Education Degree in 2019 wrote their first and second-semester examinations, and the course coordinators' report (2019) on Algebra I which is considered as core mathematics in the colleges of education, revealed that out of 9,804 candidates who wrote the examinations, 5,481 of the candidates representing 55.91% performed below the 50% mark. The report, therefore, concluded that performance on Algebra I was generally below average. This further suggests that pre-service teachers' performance in mathematics has not seen significant improvement in recent times. Thus, though the programme at the colleges has been changed from Diploma to Bachelor Degree in Basic Education, the performance of pre-service teachers in Mathematics has not improved. A majority of them still fall within the weak brackets. Literature (Addae & Agyei, 2018; Benning & Agyei, 2016; Fumador & Agyei, 2018) report of different factors that account for students' poor performance in mathematics in the context.

It is, therefore, necessary to find out why a subject like mathematics with so much importance to our daily life could have such weak performance from students. Given this, it calls for another study to be conducted at the tertiary level especially at the colleges of education to understand the nature of the situation from both pre-tertiary and tertiary levels. This would allow both mathematics tutors and the pre-service teachers to be aware of what affects the performance of pre-service teachers and find the appropriate strategies to reduce the negative impact of such factors. In this study, exploration of the factors that affect pre-service teachers' performance in mathematics in the colleges of education were conceptualized at different levels and measured as; students' factors (entry behaviour, attitude and motivation of pre-service teachers), socioeconomic factors (education of parents and occupation of parents), school-based factors (provision and usage of teaching/learning materials, teacher quality and performance), and environmental factors (school environment and home environment). These factors are further discussed in the following section.

Students' factors

Students' factors are the factors or characteristics within the students as well as their direct discourse with others such as teachers and other students, (Bertolini, Stremmel, & Thorngren, 2012). In this study, student factors were categorized into three sub-constructs (Pre-service teachers' entry behaviour, attitude and motivation of pre-service teachers), these have been discussed below.

Pre-service teachers' Entry behaviour (Characteristics)

Entry behaviour in this study refers to those requirements (qualifications and sound mind) that make an individual eligible to gain admission into any educational institution. These requirements vary from institution to institution depending on what that institution expects in addition to the basic rules laid down by that nation (Ogbonnaya, Okpuruka, Iheanacho, & Ndu, 2014). In this study, the pre-service teachers' entry behaviour was

observed as the results based on which they were offered admission into the colleges of education.

The motivation of Pre-service teachers

Mathematics education needs highly motivated (both intrinsic and extrinsic) students because it requires logical reasoning, problem-solving, and making interpretations (Saritas & Akdemir, 2009). For a person to put in his or her maximum best in his or her job, then it requires that person should be motivated enough to increase productivity. If the student is not motivated enough to study diligently then it can lead to the student performing poorly academically (Etsey, 2005). It is therefore necessary that the students are motivated enough to boost their performance. A review on motivational research conducted revealed that how students perceive their success in mathematics is associated with their motivational attitudes. The review further showed that the actions and attitudes of teachers in the mathematics classroom, the strategies employed in designing the teaching/learning instructions and the quality of the lesson delivered by the mathematics teacher contribute to motivating the student towards mathematics (Teoh, Koo, & Singh, 2010). For this study, motivation refers to the encouragement given by both parents and tutors in relation to pre-service teachers' mathematics learning.

Attitudes of Pre-service teachers

The attitude that students have towards mathematics is influenced by the efforts that these students place into the understanding and their ability to practice the mathematical ideas and skills learned in the classroom. Akey (2006) explained that the belief that students have about their ability to succeed and their expectations for the outcome of the results in school is directly connected to their levels of commitment and their mental states that urge or interfere with their physical and cognitive ability to be academically successful. Thus, Benson (1999) reiterated that attitudes predict the effort with which a student is most probably able to put into his or her learning of mathematics. Mathematics teachers therefore, need to do their maximum best to maintain positive attitudes toward mathematics for good performance among students. The attitude of pre-service teachers towards mathematics referred to the emotional disposition that they have towards mathematics learning. This variable was measured in terms of their interest in mathematics, anxiety toward mathematics, enjoyment of mathematics, confidence in doing mathematics, and the value of mathematics.

Socioeconomic factors

In most research, socioeconomic factors are considered as the educational background of parents, the work that parents do and the amount of money earned by the family (Sule & Bintu, 2016). Socioeconomic status (SES) is referred to as the overall level that a family or an individual finds him or herself in the social and economic environment (Sule & Bintu, 2016). Researchers such as Considene and Zappala (2002); Jeynes (2005) posited that socioeconomic status comprised of the educational background of the parents, the parents' occupational level and the amount of money earned by the parents. They further reported that the socioeconomic status of parents is one major factor that affects the performance of students and that the success of students greatly depends on the socioeconomic status of the parents. This urges such students to learn harder and pay attention to subjects such as mathematics which is core to the development of every nation in the world. For this study, parents' socio-economic status refers to the social and economic background of parents in society. In particular, parents' socio-economic background was measured by their educational levels and occupation.

School-based factors

School-based factors are the physical, human and financial resources that are needed in the day-to-day running and development of the school to improve academic performance (Nambuya, 2013). Literature has grouped the school-based factor into the provision and use of teaching/learning resources and, teacher quality and performance.

Availability and usage of teaching/learning resources

To improve the academic performance of students, teaching and learning resources should be made readily available and easy to be accessed by the teachers during their interactions with students in the mathematics classroom. A study conducted by Adedeji and Owoeye (2002) revealed that the academic performance of students was significantly related to the provision and use of approved textbooks for teaching and learning mathematics. Moreover, a shortage of instructional resources such as textbooks, poor conditions of resource centres, libraries, poor internet connectivity in ICT laboratories, poor ventilation of classrooms, large class sizes and teachers' meagre salaries were observed to contribute to students' low academic performance in mathematics (Howie, 2006; Muller & Roberts, 2000). This was also affirmed by Enu, Agyemang, and Nkum (2015) who posited that the availability of human and material resources has greater prowess in improving the academic performance of students. In this study, the availability and usage of teaching/learning resources refers to the number of resources that are readily available and easily accessible to the pre-service teachers to help them improve their mathematics performance.

Teacher quality and performance

Several researchers and policymakers have posited that to enhance the academic achievement of students, teachers should be well qualified, mastery in the subject matter, knowledgeable and skillful in teaching and should be professionally developed in their areas of study (Darling-Hammond, 2002; Zhang, 2008). This implies that teachers with the aforementioned characteristics would do their possible best to help raise the academic achievement of students. Teachers' level of education and their experiences are considered as two characteristics of teacher quality that have become popular in many studies. A study conducted by Son, Han, and Kang (2016), revealed that teacher quality is an essential contributor to the achievement in students learning. This is because, if teachers teach well, employ motivational strategies in arousing students' interest and they are effective in their lesson delivery, then irrespective of the students' academic achievement level, there would surely be an enhancement in their mathematics performance (Bandura, 1997; Henson, 2002). In this study, teacher quality and performance were measured by the level of teacher's education, teacher qualification, teaching approaches used, teacher experience and exposure.

Environmental factors

Environmental factors were not considered as factors that contribute to mathematics performance until recently that researchers started considering the influence of environmental factors on academic performance. Studies conducted so far have shown that there is an association between environmental factors and the academic performance of students. This, therefore, shows that the environment (Chukwuemeka, 2013) has a lot to offer so far as improvement in mathematics performance is concerned. In this study, environmental factors were categorized into two sub-constructs namely; school environment and home environment.

School environment

After examining the environmental health conditions in Nigerian schools, reported basic unfriendly practices that occur in some schools. These practices included sitting in schools, inadequate facilities, and poor ventilation in classrooms (Chukwuemeka, 2013). In most cases, the school structures were identified to have no electricity, poor ventilation where school buildings are available. Another observation made was with respect to insufficient facilities and other teaching resources such as ICT laboratories, spacious libraries and sickbays where first aid is administered to the students in case of health emergencies. By this, it, therefore, means that the health and safety conditions of students and teachers may adversely affect performance in mathematics as no meaningful teaching-learning can take place when students or teachers are not in good health. It is argued that a careful examination of the factors that affect mathematics performance environmentally among students can help improve the conditions that exist to have impeded the schools' attempt to improve students' performance in mathematics. In the sense of this study, school environment refers to the school culture, school climate, and the physical environment.

Home environment

The home environment can be defined as all the objects, forces and situations in the home that physically, intellectually and emotionally affect the wellbeing of the child (Muola, 2010). The first point of contact for any child is the home, meaning that it is the home that the child is taught how to add, subtract, multiply and divide. Hence, the development (Jayanthi & Srinivasan, 2015) of the child into a well-respected and important person is determined by the home.

To develop any individual to fit well in the society and become a productive member requires the efforts and abilities of the family through various contributions made towards that individual (Adekeyi, 2002). The parents must provide all the family support and skills required by the student to survive as a member of the society. Therefore, the home helps the child to learn to sort and order right from their infancy, this is due to how things in the home are arranged, talk of how kitchen gadgets and utensils are packed, how the furniture in the sitting room is arranged, and how clothes are also arranged in the closet, to mention but few. All these go a long way to mold the child into being successful or not. It is expected that the community where the child lives will have a significant impact on the pre-service teacher. The home environment in this study was operationalized to mean how parents assist their wards, provide them with what they need in order to perform well in mathematics, and the motivation that pre-service teachers get from their parents.

Research Questions

The study aimed at finding out the factors affecting first-year pre-service teachers' performance in mathematics in the colleges of education in the Ahafo, Bono and Bono East regions of Ghana. The research questions that guided this study and thus helped in achieving the purpose of the study were:

- What factors could possibly affect first-year pre-service teachers' performance in mathematics in the colleges of education?
- Which factors are highly and lowly ranked by the first-year pre-service teachers to affect their performance in mathematics in the colleges of education?
- To what extent do these factors predict pre-service teachers' performance in mathematics at the colleges of education?

Materials and methods

Four out of 5 colleges of education in the Ahafo, Bono and Bono East Regions of Ghana were conveniently sampled for this study. A proportional stratified random sampling

technique was employed in selecting 400 first-year pre-service teachers (194 males, 206 females) from the four colleges. The mean age of the first-year pre-service teachers is approximately 22.75 years implying that most of them were mature enough to take decisions on their own relating to their mathematics learning.

A questionnaire was used to collect data for this study. The first part of the questionnaire was made up of the biographic data of the first-year pre-service teachers such as their age, gender, college of education attending, index numbers and programme of study while items for the second part were developed based on instruments generated by Kiwanuka et al. (2015) to measure factors influencing pre-service teachers' performance in mathematics. Forty-two of the items were slightly modified and used to explore factors affecting pre-service teachers' performance in mathematics in this study. The items were measured on a four-point Likert scale (4 = strongly agree, 3 = agree, 2 = disagree, 1 = strongly disagree) . The scores are interpreted as follows: 1 is the lowest possible score, which represents a very strong negative attitude, while the 4 is the highest possible score which represents a very strong positive attitude.

The study also used performance scores (end-of-second semester examination grades in Geometry and Trigonometry of the first-year pre-service teachers College results) as the dependent variable. The questionnaire had a space for official use on the cover page. This was used later by the researcher to capture the grades of each respondent and these were converted into performance scores based on the University of Cape Coast (UCC) grading system. The distribution of the scores are presented in Table 1. The table indicates that out of the 400 first-year pre-service teachers sampled for this study, 4.5 percent of them obtained a score of 80 – 100, which is considered a grade A, 3.0 percent had a score of 75 – 79 and likewise obtained a grade of B+. Furthermore, 6.25 percent of pre-service teachers obtained a score of 74 – 70 which is considered a B, while 12.5 percent and 24.75 percent scored 65 – 69 and 60 – 64 which are regarded as C+ and C respectively. Again, 20.25 percent of the pre-service teachers had a score of 55 – 59 indicating a D+ and 22.75 percent had a score of 50 – 54 also indicating a grade D. Finally, 6.0 percent had below 50 and that is graded an E which means fail. Based on the statistics, 26.25 percent of the first-year pre-service teachers obtained grades A to C+, 67.75 percent had grades C to D while the remaining 6 percent had grade E. The results seem to indicate that majority of the first-year pre-service teachers did not perform well in the mathematics content (Geometry and Trigonometry) and this study among others seeks to explore factors contributing to this.

Table 1 Pre-service Teachers' performance score in mathematics (Geometry and Trigonometry)

Scores	Number of pre-service teachers (%)	Grade
80 – 100	18 (4.5)	A
75 – 79	12 (3.00)	B+
74 – 70	25 (6.25)	B
65 – 69	50 (12.50)	C+
60 – 64	99 (24.75)	C
55 – 59	81 (20.25)	D+
50 – 54	91 (22.75)	D
Below 50	24 (6.00)	E
Total	400	

Data Collection Procedure

The questionnaire was administered by the first author to the first-year pre-service teachers after the normal school hours so as not to disrupt classes. This strategy was chosen

because the designed questionnaire could be collected within a short period and any doubt that the respondents might have on any question could be clarified on the spot (Sekaran, 2003). First-year pre-service teachers in each participating college were given 30 minutes to complete the instruments. Performance scores from first-year pre-service teachers' end-of-second semester examinations in Geometry and Trigonometry were also collected from the colleges that participated in the study. This was made possible because of ethical clearance received from the Institutional Review Board of the University of Cape Coast.

Data Analysis Procedure

The quantitative data collected from the first-year pre-service teachers' questionnaire were checked for obvious errors. The collected data were then subjected to an exploratory factor analysis to figure out the dominant factors or variables that are responsible for first-year pre-service teachers' performance in mathematics. The authors further employed multiple regression analysis to help predict the extent of the effect that the independent variables (factors) on the dependent variable (test scores) in the colleges of education.

Results

Research question one sought to find out the factors that could possibly affect first-year pre-service teachers' performance in mathematics in the colleges of education and to achieve this, the quantitative data collected from the first-year pre-service teachers were subjected to exploratory factor analysis to identify the perceived factors that could possibly exist at the colleges that affect their performance in mathematics.

The KMO measure of the data had a high value of 0.849 for all the colleges sampled indicating that the adequacy of the sample size for the factor analysis was achieved. Again, Bartlett's test of Sphericity was also significant (0.000) for the data suggesting a non-identity matrix for the sample. From the data collected, items with significant factor loadings at components they were not meant to measure, items with poor factor loadings (< 0.4) and items that loaded alone onto their respective components were all deleted. These processes continued until 25 items were retained under 5 components having eigenvalues greater than one accounting for 58.68% of the variance. The scree plot in Figure 1 illustrates the factors that were obtained at the identified, but only those with eigenvalues greater than one were maintained for the data analysis.

The five components obtained were themed as follows; Component one was named '*teaching-learning conditions* (conditions that facilitate teaching-learning of mathematics); component two labeled as *pre-service teachers' motivation* (encouragement given to pre-service teachers by both parents and tutors); component three *parents educational background* (parents academic achievement); component four *pre-service teachers' valuing* (what pre-service teachers consider important in their mathematics learning) and component five as *health and safety issues at the college* (conditions that ensure pre-service teachers wellbeing on campus).

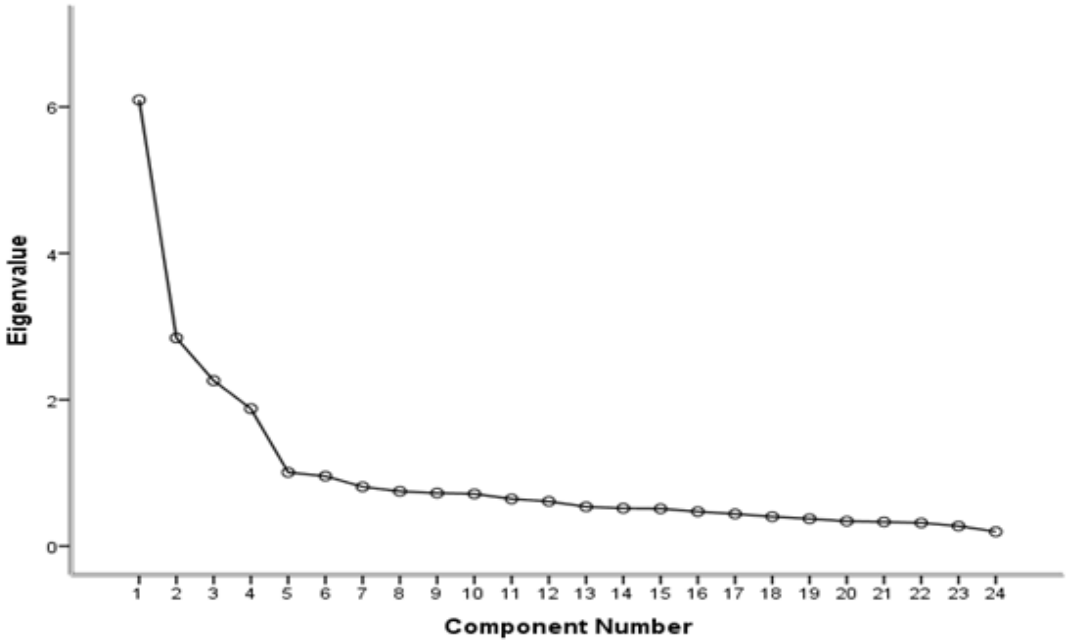

Figure 1 **A scree plot showing factors identified in the colleges of education**

final stage of the exploratory factor analysis. This scree plot shows that many factors were

The naming of the above-identified factors was based on a careful examination and upon considerations with other experts in mathematics education on the inherent relationship among the items found under each of the components in the selected colleges of education. For instance, Component 4 was named Pre-service teachers' Valuing because the items in that component expressed the importance of the subject mathematics to the pre-service teachers. Valuing in mathematics education is defined by different researchers (Anderson & Österling, 2019; Davies, Carr, & Ampadu, 2019; Seah, 2013; Zhang, 2019) as "what I find important" (in Mathematics learning).

Besides, Peng and Nyroos, (2012) posited that one factor that can influence students' performance in mathematics is many teachers not being aware of students' values in mathematics education. Thus, considering component 4 as pre-service teachers' valuing was not out of place as the the argument was supported by the literature. Similar arguments supported the naming of the other components. Thus, from the first-year pre-service teachers' perspectives, 5 factors (teaching-learning conditions, pre-service teachers' motivation, parents' educational background, pre-service teachers' valuing, and health and safety issues) were reported to have some kind of influence on mathematics performance in the colleges of education.

The factors extracted from the exploratory factor analysis with their internal consistency reliabilities and factor loadings as perceived by the pre-service teachers are summarized in Table 2.

Table 2: Internal Consistency Reliability of the Factors reported by the Pre-Service Teachers

Factors	Cronbach's alpha	Items (N = 400)	Factor loadings
Teaching-learning conditions	0.83	The library in my college meets my mathematics learning needs.	.720
		Lecture room conditions are very favourable for teaching and learning mathematics.	.698
		The mathematics resource centre in my college is well resourced for the teaching-learning of mathematics.	.660
		My college has well-ventilated lecture rooms for teaching-learning of mathematics.	.658
		My college has enough computer laboratories which help in the integration of ICT into teaching-learning of mathematics.	.634
		My college has a well-furnished library which meets my learning needs.	.626
		My college has adequate lecture rooms to enhance the teaching and learning of mathematics.	.598
		Tutors in my college are able to cover all the mathematics topics on time.	.496
Pre-service Teachers' Motivation	0.85	Given the chance, I would like to pursue mathematics-related courses in the future.	.804
		I would have chosen to take mathematics even if it were not made a compulsory subject.	.787
		I am happier in a mathematics class than in any other class.	.771
		I usually enjoy studying mathematics in school.	.715
		I have a high level of self-confidence when it comes to the use of mathematical ideas.	.713
Parents' Educational background	0.86	My father/male guardian's highest qualification.	.864
		My father/male guardian's highest level of education.	.840
		My mother/female guardian's highest level of education.	.836
		My mother/female guardian's highest qualification.	.799
Pre-service Teachers' Valuing	0.73	Mathematics will help improve my thinking capacity.	.791
		I am aware that mathematics will help me earn a living.	.761
		The use of teaching and learning materials influence my understanding of mathematical concepts.	.656
		My parents are more concerned about my performance in mathematics.	.572
Health and Safety Issues	0.71	My college has a strong security system that ensures that everybody is safe.	.785
		The general sanitation level in my college is acceptable.	.772
		My parents provide quality help on my school work.	.537
		My college has provided a sickbay to provide first aid for students.	.521

Research question two also sought to determine how the perceived factors identified to exist in the colleges were ranked by the first-year pre-service teachers as affecting their performance in mathematics. The rankings of each perceived factor were determined by the use of mean values as were reported by the respondents. Table 3 provides an over of the results as were reported by the respondents. The higher the mean the more that factor was ranked by the pre-service teachers and vice versa. These ranked means were compared with the average scale value of 2.5 to determine whether the factor was ranked high or low. The identified factors mean rankings and spread in the perspective of the 400 first-year pre-service teachers in the selected colleges of education are presented in Table 3.

Table 3: Descriptive Statistics of Factors reported by Pre-service Teachers (N = 400)

Factors	Mean (M)	Standard Deviation (SD)
Pre-service Teachers' Valuing	3.34	0.69
Health and Safety Issues	3.23	0.79
Teaching-learning conditions	2.83	0.76
Pre-service Teachers' Motivation	2.49	0.93
Parents' Educational background	2.44	1.24

From Table 3 above, it can be observed that pre-service teachers' valuing (M = 3.34, SD = 0.69) was ranked as the most perceived factor affecting pre-service teachers' performance. This was followed by health and safety issues (M = 3.23, SD = 0.79), teaching-learning conditions (M = 2.83, SD = 0.76) and pre-service teachers' motivation (M = 2.49, SD = 0.93) while parents educational background (M = 2.44, SD = 1.24) was the least ranked perceived factor. The best data spread was recorded for the pre-service teachers' valuing whereas the worst spread was identified for the factor on parents' educational background. Generally, high mean rankings were recorded for the factors: pre-service teachers' valuing, health and safety issues and teaching-learning conditions while pre-service teachers' motivation and parents' educational background recorded lower mean rankings.

For research question three, the extent to which the perceived factors predict first-year pre-service teachers' performance in mathematics was determined. Thus, we used the test scores as the dependent variable and explored the extent to which perceived factors (independent variables) affected mathematics performance. Before presenting results on the regression analyses, we first conducted correlational analysis between the perceived factors (independent variables) and mathematics performance (dependent variable) in Table 4. The results showed that correlations were significant between "first-year pre-service teachers' performance scores and teaching-learning conditions" ($r = 0.095$, $p = 0.028$); "first-year pre-service teachers' performance scores and pre-service teachers' motivation" ($r = 0.092$, $p = 0.033$) and "first-year pre-service teachers' performance scores and health and safety issues" ($r = 0.135$, $p = 0.004$) at 0.05 levels of significance respectively. Insignificant relationships were however observed between "first-year pre-service teachers' performance scores and pre-service teachers' valuing" ($r = 0.015$, $p = 0.382$) as well as "first-year pre-service teachers' performance scores and parents' educational background" ($r = 0.067$, $p = 0.091$) at 0.05 levels of significance respectively.

Table 4: A correlation Analysis between Performance scores and Perceived Factors (N = 400)

		Teaching-learning conditions	Pre-service teachers' motivation	Pre-service teachers' valuing	Health and safety issues	Parents' educational background
Performance scores	Pearson Correlation	0.095*	0.092*	0.015	0.135*	0.067
	Sig. (2-tailed)	0.028	0.033	0.382	0.004	0.091

Though three of the independent variables showed significant relationships with the dependent variable, the relationship was observed to be weak at 0.05 level of significance only but not at the 0.01 significance level. Two of the independent variables; pre-service teachers' valuing and parents' educational background did not correlate significantly with performance scores at any level. Thus, in exploring the impact and the best predictor of pre-service teachers' performance scores, we placed emphasis on pre-service teachers' motivation, health and safety issues, and teaching-learning

The regression analysis verified that the ($F(5, 394) = 3.907$, $p < 0.05$) was significant indicating that the independent variables predict the dependent variable (see Table 5). The coefficient of determination, R^2, was

The standardized coefficients of the various predictors were 0.098, 0.156 and 0.151 for teaching-learning conditions (TLC), pre-service teachers' motivation (PTM), and health and safety issues (HSI) respectively. Thus, the standardized coefficients yielded the regression model given as: *Performance scores = 0.098TLC + 0.156PTM + 0.151HSI*. As shown in the model, pre-service teachers' motivation appeared to be the strongest predictor of mathematics performance followed by health and safety issues and teaching-learning conditions respectively.

Discussion

The discussion of the research question that sought to find the factors that could possibly affect pre-service teachers performance in mathematics showed that five (5) identified

Table 5 Summary of Multiple Regression Analysis of the Perceived Factors on College Results

Dependent variable	Perceived factors	Coefficients			F-test	
		Unstandardized	Standardized	Sig	F	Sig
Performance scores	Constant	63.753		0.000	3.907	0.002
	TLC	1.174	0.098	0.009		
	PTM	1.537	0.156	0.005		
	HSI	1.745	0.151	0.014		

Significant at $P < 0.05$, Multiple $R = 0.467$, $R^2 = 0.218$, Adjusted $R^2 = 0.195$
TLC = Teaching-learning conditions
PTM = Pre-service teachers' motivation
HSI = Health and safety issues

0.218 for the independent variables. This is an indication that the model could explain 21.8 % of the variance associated with mathematics performance in the performance scores.

factors (teaching-learning conditions, pre-service teachers' motivation, parents' educational background, pre-service teachers' valuing, and health and safety issues) were

perceived by the first-year pre-service teachers to affect their performance in mathematics. Literature (Hijazi and Naqvi 2006; Suan, 2014; Demir, Kılıç, & Depren, 2009) seem to support the finding that the identified perceived factors essentyially affect students' performance in mathematics, an indication that when it comes to mathematics performance, these factors are key.

In particular, pre-service teachers' valuing (Saritas and Akdemir, 2009; Peng and Nyroos, 2012) identified in this study is one of the important components of teaching and learning of mathematics which has not been given the needed attention and that limited studies have proposed it as a factor that affects performance. The importance of this factor cannot be overlooked as it was highly and best-ranked by the pre-service teachers. Similarly, health and safety issues were identified as one of the important factors that have a relationship with students' performance. This is a new factor that has been proposed in this current study and seems not to be already existing in literature. This factor was ranked highly and the second-best among all the five perceived factors. Based on the findings from this study, first-year pre-service teachers seems to be concerned about their health and safety issues at the colleges of education. For this reason, it follows that when pre-service teachers are in good health and feel safe it has a positive effect on their performance. From the above discussions, it is clear that this current study sits with some major studies in the area of factors affecting performance in mathematics education.

This study revealed that correlations were positive and significant, but very weak for three (pre-service teachers' motivation, teaching-learning condition, and health and safety issues) of the perceived factors and performance scores. Besides, these relationships between the pre-service teachers' perceived factors and performance are affirmed by Peteros *et al*. (2020) and Wekesa (2013). Again, two (pre-service teachers' valuing, and parents' educational background) of the factors were not significant with performance scores. However, parents' educational background according to Visser, Juan, and Feza (2015) had a relationship with students' performance in mathematics which opposes the findings in this current study. Moreover, the study observed that the three perceived factors (pre-service teachers' motivation, health and safety issues, and teaching-learning conditions) impacted positively on pre-service teachers' performance but accounted for only 21.8% of the variations towards pre-service teachers' performance. This suggests that there are still unidentified factors that exist at the colleges of education that account for the remaining 78.2% of the variations in the change of the colleges' results that were not explained by the perceived factors in this study.

Conclusions, implications, research limitations and future work

This study was not without limitations. The fact that data collection was restricted to four selected colleges of education in the Ahafo, Bone and Bono East Regions respectively limits the findings of the study for broad generalization, Again, the fact that the perceived variables reported in this study explains only 21.8% of the variations in change towards mathematics performance of pre-service teachers limits the study. Future research is recommended into the investigation of the other variables (not identified in this study), that would influence colleges of education pre-service teachers' performance in mathematics.

The limitations of the study notwithstanding, the findings provide some insights into areas that need to be targeted for effective mathematics teacher preparation in Ghana. The study identified some factors (i.e. teaching-learning conditions, pre-service

teachers' motivation, pre-service teachers' valuing, health and safety issues and parents' educational background) that exist in the colleges that could promote high performance in mathematics. This study further reiterated that these factors identified and reported are an indication that they were important ones exiting in the colleges which possibly could affect pre-service teachers' performance in mathematics. The existence of such factors has implications on curriculum development, teacher preparation and in-service training programmes for colleges of education. There is therefore the need for teacher educators, curriculum developers and in-service training providers themselves to be well informed and updated on these factors.

This study, therefore, recommends that teacher education programmes need to include courses on pedagogical issues related to these factors by the Ministry of Education and Ghana Tertiary Education Commission as much as possible. Similar arguments hold for colleges and other providers in the design of professional development arrangements for practicing tutors. In this way, both practicing and prospective tutors' competencies will be enhanced and their experience to integrate some of the identified factors in their future classes will increase. For, example this could ensure that tutors are less anxious and sufficiently prepared for new teaching methods which are flexible and involve appropriate use of motivational strategies that could promote higher performance in mathematics. Curriculum developers when developing or revising the curriculum for mathematics teacher education must put priority on these factors; attempts should be made to provide opportunities in the curriculum that will allow prospective tutors to acquire skills on how to integrate the identified factors in the study-taking context (e.g. teaching and learning conditions and health and safety issues) into account.

The outcome of this study further showed that, pre-service teachers' motivation, health and safety issues and teaching-learning conditions were predictors of pre-service teachers' mathematics performance. The most critical factor which was reported to influence performance was pre-service teachers' motivation. It is encouraging to note that motivating pre-service teachers can be both extrinsic and intrinsic. This means that at both the personal and school levels, there is an urgent need to promote motivational initiatives (such as introduction of award schemes and pre-service teachers being enthused to excel in mathematics) that intend could promote high-level achievements in mathematics. Secondly, health and safety issues impacted positively on pre-service teachers' performance in mathematics, meaning that at the school level, there is an urgent need to resolve difficult health and safety constrained issues such as weak security systems, poor sanitation and inadequate sick bays that contribute to weak performance in mathematics among pre-service teachers in the colleges. The study also showed that teaching-learning condition was the third significant predictor of high performance in mathematics. Thus, this study suggests that if teaching and learning conditions in the colleges improve, mathematics teaching and learning will improve and consequently, enhance pre-service teachers' performance in the subject.

In concluding, it can be concluded that first-year pre-service teachers reported five (5) factors (teaching-learning conditions, pre-service teachers' motivation, pre-service teachers' valuing, health and safety issues, and parents' educational background) perceived to be existing in their colleges that could possibly affect their performance in mathematics. The pre-service teachers also recorded high mean rankings for the factors: pre-service teachers' valuing, health and safety issues and teaching-learning conditions

and recorded lower mean rankings on pre-service teachers' motivation and parents' educational background. Finally, it can be stressed that the study has contributed to a better understanding of the problem under investigation by revealing that enough motivation, better teaching-learning conditions and ensuring good health and safety protocols tend to affect pre-service teachers' performance.

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