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Research Article

FACTORS THAT INFLUENCE THE PERFORMANCE OF PRE-SERVICE TEACHERS IN MATHEMATICS

[1]Philip Ntaah, [1,] *Joseph IssahAwinyam, [2]Dennis Offei Kwakye

[1]Department of Mathematics and ICT, Enchi College of Education, Enchi, Ghana.
[2]Department of Mathematics and ICT Education, C.K. Tedam University of Technology and Applied Sciences, Navrongo, Ghana.

***Corresponding Author Email Id:** Issahjoseph2@gmail.com

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ABSTRACT

Mathematics education is key to the development of the world. As a result, the performance of students especially pre-service teachers should be of concern to everyone. This study sought to examine the factors that affect pre-service teachers' performance in mathematics. Descriptive survey design was used for the study. From the study, the factors that influence the performance of pre-service teachers were pedagogical, demographic, attitudinal and students perceptual in nature. There was also a significant difference in the factors that influence the performance of pre-service teachers across all four strands of factors except the perception related factors.

Keywords: Pre-service teachers, performance, pedagogical, attitudinal, demographic, perception.

INTRODUCTION

There is the view that the inability of the student to perform creditably in mathematics makes it impossible for him or her to climb the academic ladder. According to the National Education Assessment Unit (2013), "a strong foundation in mathematics is important for success both in school and in the job market. A child's level of mathematics in the early grades is a strong predictor of later academic achievement and employability" (p.32). Thus, problem-solving skills that children develop through mathematics are transferable to other areas of life and work. In most countries, including Ghana, mathematics has been made a compulsory subject at both the primary and secondary levels of education. According to Seldon (2003), one needs a solid understanding of the mathematics at, and beyond, the level at which students being observed are working so as to be able to teach effectively.

Post, Harel, Behr, and Lesh (1988) also argue that, a firm grasp of the underlying concepts is an important and necessary framework for the elementary school teacher to possess when teaching related concepts to children and many teachers simply do not know enough mathematics. Simmons (1993) also contends that, in order to teach well the teacher needs to know about the subject matter in both width and depth to a degree unlikely to be found amongst those beginning a teacher training course. If the content knowledge of mathematics teachers is very crucial in effective teaching and learning, it stands to reason that, poor performance of pre-service teachers in mathematics would be a worrisome situation to all and sundry.

Regrettably, the performance of pre-service teachers in Ghana in content courses, especially, during the first year, has not been impressive. Meanwhile, all pre-service teachers met the minimum entry requirements as defined by the National Accreditation Board. As to what causes the poor performance of teacher trainees in mathematics seems to be unknown and needs to be investigated.

Statement of the Problem

Mathematics plays an important role in the scientific andtechnological development of every nation and as a result forms an integral part of the Colleges of Education curriculum in Ghana. For its content to be understood it must be taught effectively and one key player in effective teaching and learning of mathematics is the teacher. Despite the important role that the knowledge of the teacher plays in effective teaching and learning of mathematics (Mapolelo and Akinsola, 2015), pre-service teachers have recently performed poorly in mathematics especially in the first year. Evidence from the Institute of Education, University of Cape Coast, a body mandated to assess teacher-trainees suggests that,between 2012 and 2016 a total of 53,650 candidates wrote *number and algebra*. Out of this, 8,354 (15.6%) failed, 8,443 (15.7%) had grade 'D+' and 8,443 (15.7%) also had grade 'D'. In effect, a cumulative total of 25,240 (47.0%) of the teacher-trainees who wrote this course within the same period either failed or attained weak grades.Similarly, out of the 51,702 candidates who wrote Geometry and Trigonometry between 2012 and 2016, 8,397 (16.2%) failed, 8,494 (16.4%) had grade 'D+' and 8,751 (16.9%) also had grade 'D'. This means that a cumulative total of 25,642 (49.6%) of the teacher-trainees who wrote this course within the same period either failed or attained weak grades. This trend could eventually affect the teaching and learning of mathematics in basic schools in the country. Meanwhile, there is little or no empirical evidence about the factors that contribute to pre-service teachers performance in mathematics courses. This article explores the factors that influence the performance of pre-service teachers in mathematics.

Research Questions

- Which factors influence the performance of pre-service teachers in mathematics?
- Do factors that affect the performance of pre-service teachers in mathematics differ across colleges?

Factors that Influence the Performance of Students in Mathematics

There is agreement in literature that the factors that influence the performance of students especially in mathematics is multifaceted ranging from the student to the teacher. Saritas and

Akdemir (2009) explains that self-directed learning plays an important role in school mathematics because self-directed students are able to take initiative in their learning by making diagnosis of their needs, formulate goals, and identify resources for learning and evaluate their learning outcomes. Their findings point to the fact that students who are not able to cultivate and use self-directed learning approaches in the learning of mathematics always perform poorly because they lack the capacity for diagnosing their needs, formulating goals, identifying learning resources and evaluating their learning outcomes. According to Ojimba (2012), students' negative attitude towards mathematics is a major contributing factor that accounts for the poor performance of students in the subject. This is explained further to mean that one's positive attitude towards an activity goes a long way to affect the individual's performance.Umameh (2011) share the view that the interest a student has in mathematics enables him or her to perform better or otherwise. Umameh maintains that a student who has a positive attitude towards what he or she learns becomes highly motivated to engage in activities that automatically promote his or her learning. They again indicated that the most important approach for improving students' performance in mathematics is the promotion of the participation or involvement of students in the learning process. It is evidently clear that if students' attitude towards the subject is negative, hardly they will devote much time, energy and efforts to learn or to perform.

Concerting to the above, Nur (2010), explains that students' attitudes have been found to be highly positive in the early years of education but as they progress through higher levels, their attitudes decline and that result in poor performance by students.Mutai (2010) posits that students who repeatedly had lower academic achievements in mathematics at a lower level tend to have negative attitude towards the subject at a higher level of learning the subject. This phenomenon consequently influences the students' attitude in view of the hatred therein developed towards the subject and finally performing poorly.The teacher's competence in a mathematics class contributes greatly towards the success or failure of his or her students.According to Sa'ad *et al.,* (2014), inadequate number of qualified mathematics teachers is a cause of students' poor performance in the subject.

A qualified teacher naturally has a good command of his or her subject matter and pedagogy and that enables him or her to teach the lesson with ease. Adaramola (2012) and Anene and Okpala (2012) share a similar view that where we have a good number of unqualified mathematics teachers handling the subject in schools, performances of students become poor because the knowledge and skill base of the teachers fall short of the expected level. They explained that if the teacher of mathematics is not well-trained, students' output automatically dwindles. In a study conducted by Enu, Agyeman and Nkum (2015) on students' performance in mathematics, they explained that the complexities of teaching mathematics together with the qualification of teachers lead to good performance of students in the subject. Consenting to the above, Alexander and Fuller (2005) posit that students who are taught by teachers with higher degrees in mathematics generally perform better than those who are taught by teachers who have lower qualifications. They go on to explain that teachers of mathematics who have majored in the subject at degree level and beyond usually teach better than teachers who possess minor certificates or qualifications and that automatically translate into the performance of their students.

Anaduaka and Okafor (2013) concluded in a study that experiences of the mathematics teachers count a lot in the performance of the students they teach. They intimated that if the mathematics teacher has a mastery of the subject matter and the pedagogy, he or she produces good mathematics students. Conversely, if mathematics teachers lack mastery of the subject matter and pedagogy, they will eventually produce poor performing students. They explained that computer literacy is a key factor in this direction and if mathematics teachers are computer-literate that will enable them to access innovative teaching methods and best approaches or practices for teaching which are always posted on the net. Osokoya (1999), Fettler (1999) and Rivkin, Hannushek and Kain (2000) as cited in Umameh (2011) share the view that the stock of experiences of mathematics teachers has significant effect on the achievement of their students. They explained that there exists a relationship between the experience of the mathematics teachers and their students and as such, incompetent and inexperienced teachers are less effective than their experienced colleagues. This can further be explained to mean that the professional development of mathematics teachers in content knowledge, pedagogical knowledge and pedagogical content knowledge has a very strong significant relationship with students' performance. Thus, the ineffectiveness of the mathematics teachers consequently produces poor performance of the students.

Examining the methods of teaching, Nicolaidou and Philippou (2003) explained that the philosophies held by mathematics teachers determine their methods of teaching of the subject and that affect the performance of their students. There are two popular views that mathematics teachers share. They are the traditional absolutist view and the non-traditional constructivist view. The traditional absolutist teachers create the teacher-centered approach to teaching and rote learning whereby rules are memorized by the students. The constructivist teachers, on the other hand, create teacher-student mode of instruction whereby students are made to explain and do a lot of investigations. Research has shown that if students learn mathematics by traditional absolutism only, they perform poorly. Clark and Steir (1988) as cited in Oloyede (2010) blames teachers for poor performance by candidates in ordinary level mathematics due to teaching methods which they employ, which show lack of commitment in preparing and imparting knowledge to pupils. They argue that variation of teaching methods by teachers tend to improve performance. They also argue that the methods of teaching which enhance performance are those methods that are student-centred rather than teacher-centred ones. These learner-centred methods are guided discovery, group process, projects and programmed learning.

Teaching and learning resources play vital role in the teaching learning process, no matter the level of education. They may include textbooks, teaching aids, laboratories, resource centres, calculators and computers. Sufficient teaching and learning resources for mathematics and equal access to them by both the teacher and students go a long way to support the learning process. Adjei (2002) and Douglas and Kristin (2000) as cited in Enu *et al.,* (2015) indicate that the provision and use of teaching and learning materials in the lesson delivery enhance the quality of teaching and consequently improves academic performance of the student. The use of appropriate teaching and learning materials make the teaching of mathematics more real and makes greater impact on performance. They contended that when mathematics teachers fail to use appropriate teaching and learning materials in teaching the subject, their students have difficulty in learning and that affect their performance.Saritas and Akdemir (2009), explain that a good mathematics curriculum should create situations for students to critically analyze problems and produce effective solutions. This situation requires students to learn, make sense of complex mathematical concepts and think mathematically. They maintain that every good mathematics curriculum must promote relational or meaningful learning where students understand and apply facts to discover, make connections and test mathematical concepts.

Explaining further, they all share the view that the above situations go a long way to equip students to perform well in mathematics. They however state that if the curriculum implementation and development overemphasize memorization of facts or rote learning and underemphasize understanding and application of facts to discover and make connections; students tend to perform poorly in mathematics. They further contended that if the curriculum is overloaded and has a lot of complexities beyond the capacity of students that affect their performance. Several studies conducted on performance of students show that the status of their parents has effect on their performance. In a related study in Kenya, Mbugua *et al.,* (2012) intimate that the status of parents has effect on their performance and that include source of income and the educational background of their parents. Karue and Amukowa (2013) as cited in Sa'ad *et al.,* (2014), explain that students from homes with good financial base learn better and improve their performance.

Enu *et al.,* (2015) concluded that students from homes that are imbued with socio-economic status of parents perform better in mathematics. This is explained to mean that parents' socio-economic status is correlated with students' mathematics performance; hence, students who come from seemingly insolvent homes perform poorly in mathematics. Socio-economic status greatly influences the academic performance of the students. Many research studies have shown that the socio-economic status is a factor responsible for the academic achievement of the students. Morakinyo (2003) found that there exists a relationship between socio-economic status and academic achievement of the students. White (1986) in a meta-analysis of 620 correlation coefficient from 100 students describes that there exists a definite relationship between socio-economic status and academic achievement of the students. He found that the frequency obtained correlation ranged from 0.10 to 0.70, which is positive relationship. It means that if one factor is increased the other will also increase. It is concluded that those children whose socio-economic status are strong show excellent academic performance and those with poor socio-economic status show poor academic performance.

METHODOLOGY

The design adopted to investigate the factors that contribute to the performance of first year pre-service teachers in mathematics courses is descriptive survey. This enabled us to obtain and assess opinions, attitudes and practices of pre-service teachers. Through purposive and stratified sampling techniques a sample size of 234 second year preservice teachers from two colleges of education was selected for the study. The students' questionnaire was adapted from Tapia and Marsh (2004) instrument for students (Attitude towards Mathematics Inventory) as cited in Mensah *et al.,* (2013). Expert judgment was used to validate the instruments. A reliability co coefficient alpha of 0.782 was gotten. Descriptive statistical tools such as frequency counts, percentages, means and standard deviations and inferential statistical tools such as factor analysis and MANOVAwere used to determine the factors that influence the performance of the students in mathematics.

RESULTS AND DISCUSSION

Factors that affect the performance Pre-service teachers in mathematics

In carrying out factor analysis, the 26 items were subjected to principal components analysis (PCA). Prior to performing PCA the suitability of data for factor analysis was assessed. The Kaiser-Meyer-Oklin and Barlett's Test of Sphericity were carried out to test the suitability of the data for factor analysis.

Table 1: KMO and Barlett's Test

Kaiser-Meyer-Oklin Measure of Sampling Adequacy		**0.775**
Barlett's Test of Sphericity:	Approxi. Chi square	1245.195
	Df	325
	Sig	.000

From Table 1, the Kaiser-Meyer-Oklin value was 0.8, exceeding the recommended value of 0.6 (Kaiser, 1974) and the Barlett's Test of Sphericity (Bartlett, 1954) reached statistical significance ($p<0.05$), supporting the factorability of the data.Since factor analysis is aimed at data reduction and confirming whether proposed components of other researchers remain true, there was the need to carry out parallel analysis to confirm the number of factors to retain for further analysis. Only those eigenvalues that exceed the corresponding values from the random data set are retained. This approach to identifying the correct number of components to retain has been shown to be the most accurate (Zwick & Velicer, 1986).

Tale 2: Parallel Analysis of Factor Extraction

Co	Actual eigenvalue from PCA	Criterion value from parallel analysis	Decision
1	4.853	1.6619	Accepted
2	1.988	1.5569	Accepted
3	1.629	1.4832	Accepted
4	1.457	1.4160	Accepted
5	1.350	1.3613	Rejected
6	1.184	1.3092	Rejected
7	1.138	1.2554	Rejected
8	1.102	1.2072	Rejected
9	1.047	1.1571	Rejected
10	.990	1.1084	Rejected
11	.932	1.0699	Rejected
12	.810	1.0264	Rejected
13	.769	0.9873	Rejected
14	.717	0.9485	Rejected
15	.668	0.9093	Rejected
16	.634	0.8679	Rejected
17	.623	0.8330	Rejected
18	.597	0.7962	Rejected
19	.561	0.7629	Rejected
20	.531	0.7232	Rejected
21	.504	0.6901	Rejected
22	.433	0.6525	Rejected
23	.400	0.6159	Rejected
24	.378	0.5792	Rejected
25	.369	0.5362	Rejected
26	.337	0.4850	Rejected

Results from Table 2 show that, only four eigenvalues exceed the corresponding values from the random data set. This suggests that only four components must be retained for further analysis. In order to determine the variables or items to be retained, the rotated component matrix was generated. Table 3 presents the rotated component matrix of the four components. It excludes variables that load below 0.40.

Table 3: Rotated Component Matrix

	Item	Components			
		1	2	3	4
1	First-year core mathematics course tutors do not give students adequate attention	.72			
2	First-year students are not motivated to learn core mathematics courses	.62			
3	My first-year core mathematics course tutor does not use variety of methods in teaching mathematics	.61			
4	My first-year core mathematics course tutor is harsh and moody in class	.59			
5	Most first year students do not understand what core mathematics course tutors teach in class	.58			
6	First-year students do not have access to instructional facilities for core mathematics in the college	.57			
7	First-year students are not given enough time to think and provide solutions to core mathematical problems	.52			
8	My first-year core mathematics course tutor does not provide prompt feedback on class exercises, quizzes and assignments	.50			
9	The teaching of my first-year core mathematics coursetutors encourages memorization of formulae	.45			
10	First-year students are not adequately resourced to learn core mathematics	.43			
11	The time allocated for learning first-year core mathematics courses is inadequate	.40			
12	I was not taught basic concepts of most core mathematics topics at S.H.S.				
13	First-year core mathematics courses are difficult		.74		
14	I do not like first year core mathematics		.64		
15	I feel extremely anxious and fearful when writing first-year core mathematics examinations at college		.61		
16	First-year core mathematics lessons at college are boring		.51		
17	Most students are not capable of learning first-year core mathematics courses with little support		.43		
18	First-year students do not participate in core mathematics activities in class			.56	
19	First-year students are not satisfied with how core mathematics course tutors answer their questions			.54	
20	Most students are not interested in first-year core mathematics courses		.41	.52	
21	Most first-year students do not concentrate when core mathematics lessons are taught			.51	
22	My first-year core mathematics course tutor is not good at mathematics			.49	
23	First year students who do not pay their fees promptly do not perform in first-year core mathematics courses			.41	
24	Students from homes with inadequate facilities do not perform in first-year core mathematics courses				.75
25	Students with weak pass in S.H.S. core mathematics perform poorly in first-year core mathematics courses				.73
26	My parents and siblings do not help me in learning first-year core mathematics courses				

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Rotation converged in 9 iterations.

From Table 3, items 1 to11 loaded strongly on component 1. These items were classified as pedagogical factors.Again, five items (items 13 to 17) loaded on component 2. These were also labeled as attitudinal factors. The five items (items 18, 19, 21, 22 and 23) that loaded strongly on component 3 were grouped as perceptual factors. Only two variables (items 24 and 25) loaded strongly on component four and they were considered as demographic factors. Table 3 also suggests that, there are four strands of factors that influence the performance of students in mathematics. These factors include pedagogical factors, attitude of students towards mathematics learning, perception of students about mathematics and demographic factors. This finding differs from the finding of Mbugua *et al.,* (2012) who suggested three factors as being responsible for poor performance of students in mathematics.

Do factors that affect the performance of pre-service teachers in mathematics differ across colleges?

A one-way multivariate analysis of the variance (MANOVA) was carried out to ascertain whether the factors that affect the performance of the students in mathematics differ colleges. Before MANOVA was run, the data was tested to see whether it met the assumptions of MANOVA. The first assumption is the equality of covariance.

4- Box's Test of Equality of Covariance Matrices

Box's M	F	df1	df2	Sig.
50.151	4.918	10	205232.599	0.03

From Table 4, a sig value 0.03 is an indication that the equality of covariance assumption was not violated because 0.03 is larger than .001 (Tabachnick and Fidell, 2001). Another assumption of MANOVA that was tested is equality of variance of the dependent variables.

5- Lavene's Test of Equality of Error Variances

Factor	F	df1	df2	Sig.
Pedagogical	1.85	1	232	.09
Attitude	2.314	1	232	.07
Perception	2.715	1	232	.07
Demographic	0.973	1	232	.33

According to Pallant (2005), values less than 0.05 are indications of violations of this assumption. From Table 5 however, none of the figures are less than 0.05. It was therefore assumed that the variances are equal. The descriptive statistics of the factors that affect the performance of the pre-service teachers in mathematics were run.

6- Descriptive Statistics

College/Factor	Kaka College		Tala College		Overall	
	Mean	SD	Mean	SD	Mean	SD
Pedagogical	2.21	0.58	3.13	0.78	2.59	0.81
Attitude	2.55	0.70	3.30	0.90	2.86	0.87
Perception	3.37	0.87	3.58	0.64	3.46	1.21
Demographic	3.83	1.07	2.96	1.21	3.46	1.21

Results from Table 6 indicate that, demographic factors recorded the highest mean score of 3.83 out of five in Kaka College. This suggests that, most students in Kaka College of education do not consider demographic factors as the leading cause of poor performance in mathematics among students. In Tala College however, demographic factors recorded the least mean score of 2.96 which suggests that more students dismissed the demographic related factors than those who accepted them. Again, pedagogical factors recorded the least mean score in Kaka College. A mean score of 2.21 indicates that, most of the students accepted pedagogical factors as being responsible for students' poor performance. A mean score of 3.13 recorded for students of Tala College on pedagogical factors however shows that, most of the students do not consider pedagogical factors as being responsible for students' poor performance. On the issue of attitude, it can be elicited from Table 6 that students of Tala College had better attitudes towards mathematics learning than their counterpart in Kaka College. Whereas in Kaka College, the mean score of 2.55 indicates that most of the students had negative attitude towards mathematics learning, in Tala College, it recorded a mean score of 3.30 which shows that most of the students dismissed attitudes as being a factor for their poor performance. In the same vein, students of Tala College (M = 3.58) had a more positive perception about mathematics than those in Kaka College (3.37). The mean scores however suggest that, most of the students from both colleges do have positive perception about mathematics. In conclusion, pedagogical and attitudinal factors account for the poor performance of students in Kaka College whereas in Tala College it is demographic. Students' perceptions about mathematics do not play a significant role in determining the performance of the students in both colleges of education. The study further explored whether there are statistically significant differences among the groups on a linear combination of the dependent variables. Table 7 presents the multivariate tests of significance.

7- Multivariate Test

Effect	Value	F	Sig.	Partial eta squared
Wilk's lambda	0.569	43.369	0.000	0.431

Results from Table 7 show Wilks' Lambda value of .569, with a significance value of .000. This is less than .05; therefore, there is a statistically significant difference between Kaka College and Tala College in terms of the factors that are responsible for the poor performance of students in mathematics. This suggests that, the factors that cause poor performance in mathematics are peculiar to each college. Having obtained a significant result on the multivariate test of significance, the study further investigated each of the dependent variables to ascertain whether Kaka College and Tala College differ on all of the dependent measures, or just some. In order to reduce the chance of Type 1 error, the Bonferroni adjustment was applied. In its simplest form, this involves dividing your original alpha level of .05 by the number of analyses that you intend to do (Pallant, 2005). In this study, there are four dependent variables to investigate; therefore, we would divide .05 by 4, giving a new alpha level of .0125. Table 8 presents the results of the test between-subject effect.

8- Test of Between-Subject Effect

Source	Dependent variable	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
College	Pedagogical	48.622	1	48.622	107.968	0.000	0.318
	Attitude	32.768	1	32.768	52.308	0.000	0.184
	Perception	2.488	1	2.488	4.076	0.045	0.017
	Demographic	42.915	1	42.915	33.577	0.000	0.126

From Table 8, pedagogical, attitudinal and demographic factors recorded a sig. value of 0.000 each. Since the sig. value of 0.000 is less than the adjusted alpha level of 0.0125, we can conclude that, there is a statistically significant difference between the pedagogical, attitudinal and demographic factors in both colleges of education. However, there was no statistically significant difference between Kaka College and Tala College on students' perception about mathematics. This is because it recorded a sig. value of 0.045 which is greater than the adjusted alpha level of 0.0125. From Table 8, pedagogical factors had the most significant impact on the performance of the students as it recorded the highest partial eta square value of 0.318. This explains that, pedagogical factors account for about 31.8% of the performance of the students across the two colleges of education.

CONCLUSIONS

Based on the findings, it can be concluded that the factors that influence the performance of pre-service teachers is multi-faceted. However, these factors differ significantly across the different colleges.

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