INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Assessing the Challenges of Ghanaian Pre-Service Teachers' in Their Learning of Geometric Transformation Concepts and Perception of Factors Inhibiting the Development of Their Mathematical Knowledge for Teaching

Samuel Acquah
Tutor, Department of Mathematics and ICT, OLA College of Education, Ghana
Mohammed Nurudeen Alhassan
Tutor, Department of Mathematics and ICT, OLA College of Education, Ghana

Abstract:
This study sought to assess the challenges of Ghanaian pre-service teachers' in their learning of geometric transformation concepts and perception of factors inhibiting the development of their mathematical knowledge for teaching. A sample size of 200 pre-service teachers was selected from Colleges of Education (CSE) in Eastern region of Ghana.
In seeking views from pre-service regarding their learning of geometric transformation concepts, the study employed the use of survey method. Sampling procedures for the purpose of this study was purposive and data collected was qualitative. The method that was used in obtaining data on the views of pre-service teachers on their learning of geometric transformation concepts was through questionnaire. Data collected was analyzed using descriptive statistics.
Findings from the study showed challenges of pre-service teachers were as a result of factors such as lecture approaches adopted by mathematics tutors in the teaching of geometric transformations, inadequate exercises on geometric transformation concepts taught to consolidate their understanding; and poor nature of assessment task given on geometric transformations. Further findings made with regards to difficulties of pre-service teachers in their learning of geometric transformation concepts were: reflection of figure in other mirror lines apart from $(x=0, y=0, y=-x, y=x)$*, rotation of figure with different centre apart from the origin and multiple transformations.*

Keywords: *Challenges, pre-service teachers, geometric transformations and colleges of education*

1. Introduction

In recent years, there has been a growing recognition that students should learn mathematics in such a way that they can see its relevance to the world in which they live and be able to use it to gain a better appreciation of the world. Often, mathematics has been learned as a set of routines to be carried out blindly in response to a stereotype examination questions (Bolt & Hobbs, 2005). The result of such teaching and learning of mathematics is that learners are unable to apply their knowledge outside the standard textbook sum. Furthermore, the motivation for learning becomes largely dependent on getting the ticks corresponding to right answers and has little to do with any intrinsic interest in the subject or whether or not the answers are meaningful (Bolt & Hobbs, 2005).

The inclusion of geometry as a component in the mathematics curriculum reflects its importance to man. Jones (2002) outlines some reasons why studies in geometry are of vital importance to the individual and for that matter its inclusion in the mathematics curriculum at all levels of education in every nation. In the view of (Jones, 2002), studies in geometry develop a person's ability to think critically. Besides geometry developing the mind, it is useful in a wide range of applications. Architects, astronomers, engineers and many more professionals make use of this aspect of mathematics in their field of endeavours. Walle (1998) also reflects on the importance of geometry with regards to its inclusion in the mathematics curriculum of various countries. The study of geometry to him brings about logical beauty to the individual and above all, gives deeper insight into the wonderful details and complexities of our world.

1.1. Statement of the Problem

Although geometry is an important area and much effort is exerted in teaching geometry, evidence from numerous research studies makes it clear that many students' geometrical understanding is not at the level they need or are expected to be (Prescott, Mitchelmore & White, 2002). Learning of geometrical transformations which is included in course outlines of both content and methodology in mathematics at the Colleges of Education (CsE) has been affected by poor performance on the part of pre-service teachers. Chief examiner's reports from a University on a course in geometry titled "FDC122: Geometry and Trigonometry" which geometric transformations forms part reflected on pre-service teachers' difficulties in geometric transformations. In question 17 of this paper (FDC122, 2009) which was on geometric transformation, report by chief examiner revealed that most students who attempted this question were with serious difficulties. Most candidates according to the report failed to draw line $y = -x$ (axis of reflection) before doing the reflection. This made it difficult for them to obtain the equation of the line correctly. In the chief examiner's report for 2007 on this same paper, it was noted that candidates could not copy the angle at a given point and others could not differentiate between pyramids and prism. The methodology aspect of geometry was also not without difficulties. In 2006, course for CsE titled "Methods of Teaching JHS Mathematics" showed that most of the students who attempted question nine of this paper could not explain the term rotational symmetry. Currently, most pre-service teachers admitted into the CsE are mainly from the Senior High School (SHS). Over the years, chief examiner's report in mathematics indicated that performance of students in geometry had been rather weak (WAEC, 2000, 2001, 2002, 2003, 2004, 2005). These remarks from chief examiners' are a clear indication that some pre-service teachers who enter the CsE to train as teachers already have a feeble base in geometry of which geometrical transformations forms part of it. These pre-service teachers, if nothing is done, may be the very ones who graduate as teachers and are likely to pass on the same weak content levels in geometry to pupils they may teach. The cycle of weak content levels would then continue from the primary through to the SHS to the CSE and even perhaps to the Universities. The question which is constantly being ask by the researcher and many other mathematics educators is why this trend in low performance in geometry with special emphasis on geometric transformations over these years? It is in this regard that the study assesses what account for challenges of pre-service teachers' in their learning of geometric transformations concepts.

1.2. Objectives

The following were the objectives which guided the study with respect to challenges of pre-service teachers' in their learning of geometric transformation concepts and perception of factors inhibiting the development of their mathematical knowledge for teaching:

- Assessing thebackground knowledge of pre-service teachers' geometric transformationat the SHSand difficulty areas.
- Teaching approach adopted and usage of teaching learning materials
- The nature of assignment given to students in their learning of geometric transformation concepts.

2. Research Methodology

In seeking views from pre-service regarding their learning of geometric transformation concepts, the study employed the use of survey method. First year pre-service teachers in all the 46 CsE in Ghana constituted the population for the study. Samples were selected from first year pre-service teachers all in the Eastern Region of Ghana. Sampling procedures for the purpose of this study was purposive and data collected was qualitative. The method that was used in obtaining data on the views of pre-service teachers on their learning of geometric transformation concepts was through questionnaire. With respect to pre-service teachers' difficulty levels in the various geometric transformations, a Likert-type rating scale was used to obtain views of pre-service teachers on their difficulty levels of geometric transformation concepts. Descriptive statistics was employed in the analysis of data collected.

3. Findings

The questionnaire answered by students sought to identify contributing factors leading to pre-service teachers' difficulties on geometric transformations. One section of the questionnaire requested for pre-service teachers' background knowledge on whether they were taught geometric transformations at the SHS, areas covered and difficulty areas of geometric transformations. Statistics gathered indicated that 98% (197) of pre-service teachers were taught geometric transformations at the SHS as against only 1.5% (3) who were not taught. This clearly showed that geometric transformation was a popular topical area in mathematics that was taught by most tutors at the SHS level. On the coverage of specific areas of geometric transformations, it was revealed that apart from multiple transformations which 1.3% (7) of the respondent indicated that they were not taught; all other areas of geometric transformations had higher percentages comparatively, which meant they were taught these areas as shown in table1.

Transformations	Number of respondents	Frequency	Percent
Rotation	200	111	21.3
Reflection	200	107	20.6
Translation	200	105	20.2
Enlargement	200	108	20.8
Multiple transformation	200	7	1.3
All Above	200	82	15.8

Table1: Areas of Geometric Transformation Taught at the SHS

In the area of difficulty levels of pre-service teachers' in geometric transformations covered, indications from Table 2 were that, 24.6% (65) and 20.5% (54) of respondents agreed that multiple transformations and translation were difficult areas respectively.

Transformations	Number of Respondents	Frequency	Percent
Rotation	200	32	12.1
Reflection	200	29	11
Translation	200	54	20.5
Enlargement	200	26	9.8
Multiple transformation	200	65	24.6
None Above	200	58	22

Table2: Difficulty Areas of Geometric Transformation at SHS Level

Again with respect to specific areas of challenges of pre-service teachers under the broad areas of geometric transformations mentioned, participant responded as having challenges in rotating an object with the centre of rotation changed to a different location from the origin, rotating an object involving different angles other than (90^0, 180^0 & 270^0), reflecting an object with the mirror line on y = k, reflecting an object with the mirror line on x = k, multiple transformation and enlargement with a fraction as scale factor respectively. This is evident in table 3 since in all these areas of geometric transformations mentioned, the response on the Likert-type was below normal.

	Not at All	Very Little	Not Sure	Well	Very Well
	N (%)	N (%)	N (%)	N (%)	N (%)
Rotating an object/figure with the centre of rotation changed to different locations from the origin.	37 (18.5)	67 (33.5)	38 (19)	42 (21)	16 (8)
Rotating an object/figure involving different angles other than those stated above.	49 (24.5)	45 (22.5)	53 (26.5)	24 (12)	29 (14.5)
Reflection of an object/figure when the mirror line is on the line y = k	55 (27.5)	98 (48.5)	19 (9.5)	21 (10.5)	7 (3.5)
Reflection of an object/figure when the mirror line is on the line x = k	45 (22.5)	97 (48.5)	19 (9.5)	33 (16.5)	6 (3)
Rotation of an object/figure followed by translation.	67 (33.5)	52 (26)	24 (12)	43 (21.5)	14 (7)
Enlargement of an object/figure with fraction as a scale factor.	71 (35.5)	70 (35)	23 (11.5)	21 (10.5)	15 (7.5)

Table 3: Challenges of Pre-Service Teachers in Aspects of Geometric Transformations

Teaching learning material plays a very crucial role in the teaching and learning process. According to Akkoyunlu (2002), instructional materials motivate students, and encourage them to study lesson providing them with opportunity to have an access to information and to evaluate it. Instructional materials are a significant element in raising the quality of education. Concepts are well developed when the right type of teaching materials are used. On the contrary, when teaching learning materials are not employed in the development of mathematical concepts, understanding these concepts becomes difficult to learners. Respondents were of the view that it was not always that tutors used teaching learning materials in lessons on geometric transformations. Pre-service teachers who claimed their tutors always used teaching learning materials in lessons on geometric transformations were only 11% (22) as against tutors who sometimes and never used teaching learning materials. The large percentage in the "sometimes" and "never" categories implied that some difficulties of pre-

service teachers in learning geometric transformations may be attributed to lack of use of teaching learning materials in such lessons as indicated in table 4

Response	Frequency	Percent
Always	22	11
Sometimes	119	59.5
never	59	29.5
Total	200	100

Table4: Use of Teaching Learning Materials in Lessons Involving Geometric Transformations

Teaching approach adopted by tutors in lesson delivery to a large extent help to facilitate understanding of concepts in learners. Fletcher (2003) reiterated that indeed, irrespective of the level at which mathematics was taught; the role of the Ghanaian mathematics teacher has almost always been that of a lecturer and explainer, communicating the structure of mathematics systematically. What was lacking in this approach, even at its best, was a sense of genuine enquiry, or any stimulus to curiosity or appeal to the imagination (Ernest, 1991). Statistics in figure one pointed out that 61% (123) of pre-service teachers described their tutors approach of teaching geometric transformations as more of a lecture method as against 16% (32) and 23% (45) for discovery and group activity oriented approaches to teaching respectively. Instruction such as lecture method has proved insufficient for generating a deep understanding of mathematics for all students (Battista, 1999). Analysis of responses on tutors' approaches of teaching geometric transformations as shown in figure 1 suggested that tutors approaches in delivery such topics was among some of the factors contributing to difficulties of pre-service teachers in geometric transformations concepts.

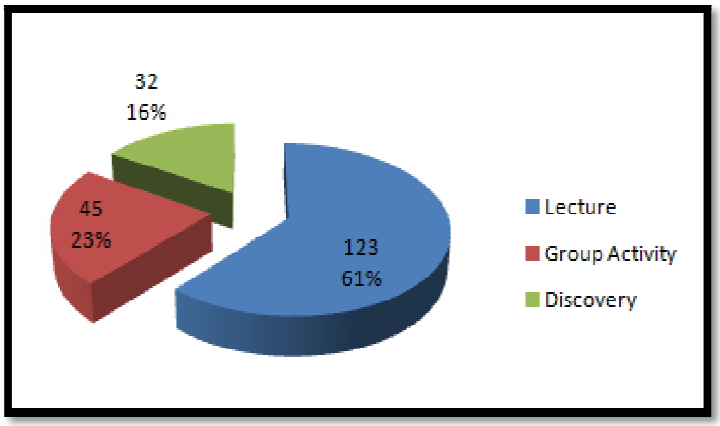

Figure 1: Teaching Approaches Used in Teaching Geometric Transformation

Nevertheless, although teaching approaches adopted by tutors in the teaching of geometric transformation was very important, consolidation of these concepts through assignments and quizzes were equally important. The nature of assignment given to learners should not be that of only recall of formulae to solve questions but should involve tasks that would require them to do further investigations expected at enhancing their understanding. Embedding authentic activities in students' stimulate students' abilities to create and apply a wide range of knowledge, rather than simply engaging in acts of memorization and basic skill development (Stiggins, 1997). Assignments given to learners in the form of task or portfolios gave learners the opportunity to explore more in a particular mathematical concept (Marzano et al., 1993). However, information gathered from pre-service teachers indicated that the nature of assignments was more of essay and objectives with less investigational task and portfolio based assignment as indicated in Table 5. The high response of 67.5% (135) for essay and 8.5% (17), 7.5% (15) for investigational task and portfolios respectively with regards to the nature of assignment on geometric transformations point to the fact that the nature of assignment given to students did not give them the opportunity to do further discovery on given concepts.

Response	Frequency	Percent
Objectives	33	16.5
Essay	135	67.5
Investigational task	17	8.5
portfolios	15	7.5
Total	200	100

Table 5: Nature of Assignment on Geometric Transformations

4. Discussion of Findings

Statistics gathered in the study revealed that 98% of pre-service teachers claimed that they were taught geometric transformations at the SHS. Therefore difficulties of pre-service teachers in the learning of geometric transformations at the CsE were not due to the issue of not being taught this topic in mathematics at SHS level. However, considering pre-service teachers' views on the approaches that were employed by their tutors' in teaching topics in geometric transformations, it was revealed that 61% were of the view that tutors employed more of the lecture method in lesson delivery. This finding was in line with Fletcher (2003) and Osafo-Affum (2001), who reiterated that indeed, irrespective of the level at which mathematics was taught; the role of the Ghanaian mathematics teacher has almost always been that of a lecturer and explainer, communicating the structure of mathematics systematically. The lecture approach which was claimed by pre-service teachers as employed by tutors in the teaching of geometric transformation was quite at variance with the view of (Crowley, 1987) on the method of instruction in geometry. Teaching and learning of geometry to her should be more informal, involving exploration, discovery, guessing and problem solving.

Also, in the area of usage of teaching learning materials in teaching geometric transformations, it was evident that tutors needed to do more if they were really mindful of its importance. Results on the Likert-type scale on the use of teaching learning materials in lessons on geometric transformations revealed that pre-service teachers disagreed that their tutors made use of teaching learning materials in the course of lesson delivery to enhance understanding of geometric concepts. This result relates to the view of Akkoyunlu (2002), that instructional materials motivate students, and encourage them to study lesson providing them with opportunity to have an access to information and to evaluate it. The use of teaching learning materials is also a significant element in raising the quality of education, according to (Akkoyunlu, 2002).

Other grey areas that were identified to have influenced pre-service teachers' learning of geometric transformation were lack of adequate exercises to consolidate concepts taught and the mode of assessment of geometric concepts taught did not promote further research on the part of students to enhance their understanding of concepts. These findings were consistent with observation made in the 2008 TIMSS report by (Anamuah-Mensah et al., 2008) that in Ghana, teaching was largely by exposition with little opportunities for learners to engage in practical and problem solving activities.

5. Conclusion

The study sought to assess the difficulties of pre-service teachers' in their learning of geometric transformation concepts. On the contrary, the researcher found out that tutors approach in the teaching of geometric transformations was based more on the lecture method. The lecture method of teaching geometric transformations accounted for some of the difficulties of pre-service teachers in this area of mathematics.

Furthermore, in the area of assignment on geometric transformations, the researcher found out that the nature of assignments given to pre-service teachers' lack opportunities to research further on them. In other words, assignment given to pre-service teachers required just the use of formulae to solve them which did not involve serious investigative task. In addition, the frequency at which these assignments were given to pre-service teachers was on the average instead of being regular.

Another important finding that was discovered by the researcher was on the issue of teaching learning material used in teaching geometric transformations. Pre-service teachers who responded to this issue in the questionnaire were of the view that although teaching learning materials was used in lessons of geometric transformations, it was not always used but rather sometimes used. These identified challenges of pre-service teachers if well address could go a long way to improve their knowledge in geometric transformations.

6. References

i. Akkoyunlu, B. (2002). Educational Technology in Turkey: past, Present and Future. Educational Media International , 2 (39), 165-174.
ii. Anamuah-Mensah, J., Mereku, D.K. & Ghartey -Ampiah, J. (2008). Ghanaian Junior Secondary School Students' Achievement in Mathematics and Science: Results from Ghana's participation in 2007 Trends in International Mathematics and Science Study. Accra.: Ministry of Education Youth and Sports.
iii. Basttista, M. (1999). The mathematical miseducation of America's youth. Phi Delta Kappan , 80(6), 425-433.
iv. Bolt, B. & Hobbs, D. (2005). Mathematical projects. United Kingdom: Cambridge University Press.
v. Crowley, M. (1987). The Van Hiele Model of development of geometry. In M.M.Lindquist, Learning and teaching geometry, K-12 (pp. 1-16). Reston,Va: National Council of Teachers of Mathematics.
vi. Ernest, P. (1991). The philosophy of mathematics education. London: Falmer.
vii. Fletcher, J. (2003). Constructivism and mathematics education in Ghana. Journal of the mathematics Association of Ghana , (5), 29-38.
viii. Jones, K. (2000). Issues in the teaching and learning of geometry. In L. Haggarty, Aspects of teaching secondary mathematics: Perspective of practice (pp. 121-139). London: Routledge Falmer.
ix. Marzano, R.J., McTighe, J. & Pickering, D. (1993). Assessing student outcomes: Performance assessment using the dimensions of learning model. Alexandra,VA: Association for Supervision and Curriculum Development.
x. Osafo-Affum, B. (2001). Mathematics crisis in our schools. Mathematics Connection , (2), 4-6.

xi. Prescott, A., Mitchelmore, M. & White, P. (2002). Students' difficulties in abstracting angles from physical activities with concrete materials. In the proceedings of the Annual Conference of Mathematics Education.Research Group of Austrialia. Austrialia: Incorporated Eric Digest (ED 472950).
xii. Stiggins, R. (1997). Student-centred classroom assessment. Englewood Cliffs,NJ: Prentice-Hall.
xiii. Welle, J. (1998). Elementary school mathematics and teaching developmentally. New York: Addison-Wesley.
xiv. West African Examination Council. (2000). Senior High School Certificate Examination Chief Examiner's Report for Core Mathematics.
xv. West African Examination Council. (2001). Senior High School Certificate Examination Chief Examiner's Report for Core Mathematics.
xvi. West African Examination Council. (2002). Senior High School Certificate Examinations Chief Examiners Report for Core Mathematics.
xvii. West African Examination Council. (2003). Senior High School Certificate Examinations Chief Examiner's Report for Core Mathematics.
xviii. West African Examination Council. (2004). Senior High School Certificate Examinations Chief Examiner's Report for Core Mathematics.
xix. West African Examination Council. (2005). Senior High School Certificate Examinations Chief Examiner's Report for Core Mathematics.