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Secondary School Students' Attitudes towards their Learning of Geometry: A Survey of Bindura Urban Secondary Schools

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ABSTRACT

This study explores secondary school student's attitudes towards their learning of geometry. The study adopted a quantitative descriptive survey design using simple frequency and percentages in analyzing the data as part of descriptive statistics. A sample of 100 'O' level pupils were drawn, using stratified random sampling, from three urban high schools. The research was done quantitatively using a questionnaire that comprised of 15 closed questions which were adapted and then modified from Fennema-Shermann Mathematics Scale (1977). The study revealed that the students' attitudes towards the usefulness of geometry were positive and that many of them believed that geometry is a valuable and necessary topic which can help them in their future careers. The result also showed that the majority of the students in Bindura urban, (80%) did not like solving geometrical problems. It also emerged that geometry is not a difficult topic to both male and female students and that though most students did not like solving geometry; they considered geometry to be useful.

INTRODUCTION

Mathematics in general is linked with the development of any nation in the world. Mathematics as a discipline, opens and shuts more doors for men and women than any other content area we have got (Burton, 1999). Whether it's in science, engineering or technology, it is tremendously important that a person be well-armed with mathematics if they are going to have options in their lives (Thompson, 1993). Mathematics is one of the core subjects to be offered to all students till the tertiary levels of education (Salau, 1995). In Zimbabwe, both primary and secondary teacher training colleges have ordinary level mathematics as requirement for enrolment to prospective teachers. Furthermore, Mandebvu (1996) stated that most employers in Zimbabwe expect a job – seeking school leaver to have passed Mathematics, Science and English language, among other subjects at ordinary level. This compulsory nature of Mathematics carries with it the assumption that the knowledge of the subject is essential for all members of our society. In Zimbabwe, Mathematics competence is a critical determinant of the Post-Secondary educational and career options available to young people (Barrow and Woods, 1987).

Despite the relative importance of Mathematics, it is very disappointing to note that the student's performance in the subject in both internal and external examinations has remained consistently poor (Ojo, 1986). The chief examiner's annual reports in Mathematics in the Senior School Certificate Examinations (SSCE) conducted by the West African Examinations Council (WAEC) and National Examinations Council (NECO) are good testimonies of the Facts that the poor performance is affecting the parents, government and the teachers themselves (Obodo, 2000). The above stated testimonials also concur with the Zimbabwean School Examinations Council (ZIMSEC) and its stake holders which stated that poor results in Mathematics deny many pupils the opportunity to have careers in science related courses. Mathematics educators have put up noble and spirited efforts aimed at identifying the major problems associated with learning of geometry in the nation's schools (Thompson, 1993). Despite all these noble efforts, the problem of poor achievement in Mathematics has continued to rear its head in the nation's public examinations and geometry is part of it (Cooney, 1994). Bloom (1986) found that twenty-five percent (25%) of the variance in achievement could be attributed to pupils' attitude towards geometry. Kempa and Dude (1984) reported that pupils' interest in geometry is associated with their achievement in geometry. In addition, Olatoye (2009) found that students attitude towards geometry had a direct effect on student achievement in the topic. Adesokan (2002) and Onwu (1981) asserted that in spite of the recognition given to geometry among the Mathematics topics, it is evident that students still show negative attitude towards geometry thereby leading to poor performance. Bolaji (2 0 0 5) in a study of the influence of students' attitude towards geometry found out that the teachers' method of geometry teaching and his personality greatly accounted for the students' positive attitude towards geometry.

Geometry helps us to describe and define the world systematically (Cantürk-Günhan and Baer, 2007). Geometry helps us to acquire abilities such as making new discoveries, analyzing problems and making connections between Mathematics and real life situations (Bindak, 2004). Plato's quote "Let no man ignorant of geometry enter here" is a wakeup call for everyone to be well conversant with geometry and emphasizes the importance of geometry (Burton, 1999; p.79). Geometry is seen as a natural place for the development of students' reasoning and justification skills in school Mathematics. Geometry also helps in developing good reasoning and it as applicable to solving human and natural problems like everyday life problems (Utely, 2004).

This research examines the secondary school students' attitudes towards the learning and teaching of geometry. Attitude is often considered in educational research since the development of a positive attitude is desirable because of its association with achievement (Nkwe, 1985). Ma and Kishor (1997) supports this by indicating that there is a general belief that children learn more effectively when they are interested in what they learn and that they will achieve better in Mathematics if they like Mathematics. Similarly, if students have positive attitude towards geometry they are expected to like geometry, participate in the classroom activities and to be high achievers in geometry (Bindak, 2004).

Affective factors such as attitudes also have profound impact on students' geometry achievement. Burstein (1992) in a comparative study of factors influencing geometry achievement found out that there is a direct link between students' attitudes towards geometry and student outcomes. He also found out that 25% in England and 26% in Norway accounted for the variation in students' attitude towards geometry that were due to student gender, maternal expectation, expectations of the students friends and success attribution. Jaji (2002) supports this by propounding that resource shortage, teacher quality, poor teaching, repeated subject failure, peer influence, inadequacy of textbooks, cultural background and language also contribute to poor performance in geometry. Solarin (2001) observed on a general note, that secondary schools lack facilities and equipment for teaching geometry. According to him, in such a situation, teachers are forced to discuss theoretically, practical aspects of geometry is not good enough to both boys and girls.

Attitudes towards geometry include liking, enjoying and interest in geometry, or the opposite, and at worst geometry phobia (Ernest, 1989). This means that the students have to like geometry, enjoy the activities performed in geometry and have interest at heart for geometry. On the other hand, attitudes play an important role on students' geometry achievement.

Those who lack confidence in their geometry academic skills envision a low grade before they begin an examination (Pajares, 2002).

Students' attitudes towards geometry

The attitudes of pupils can be influenced by the attitudes of the teacher and his/her method of teaching. Studies done by Thompson (1993) had shown that the teachers' method of geometry teaching and his/her personality greatly accounted for the students' positive attitude towards geometry and that without interest and personal effort in learning geometry by the pupils, they can hardly perform well in the topic. According to Betiku (2001), teachers' content knowledge has a significant impact on students' performance. Mayberry (1983) stated that geometry content knowledge among pre-service and in-service middle school teachers is not adequate. The quality of instruction is one of the greatest influences on the students' acquisition of geometry knowledge in Mathematics classes. Chappell (2003, 294) said, "Individuals without sufficient backgrounds in Mathematics or Mathematics pedagogy are being placed in middle school Mathematics classrooms to teach". In this study, the researcher will focus on secondary school students' attitudes towards learning of geometry as another reason behind students' poor performance in geometry.

Mogari (1999) examined four components of attitudes in the attempt to investigate more components of attitudes in Euclidean Geometry. These were enjoyment, motivation, perception of the importance of geometry and freedom from fear of geometry. His results showed that there were very weak relationship between achievement and each of the four variables mentioned above. Geddes and Fortunato (1993) documented that many students encounter difficulties and performed poorly in geometry.

Students' positive attitude towards geometry

Forgasiz (2005) found that students had greater confidence about their geometric skills and are aware of its usefulness; they have a more positive perception of the topic. In this research, the researcher wants to concentrate on students' attitudes towards learning of geometry irrespective of other factors which could have contributed to students to have those attitudes.

Students' negative attitude towards geometry

Mogari (1999) propounds that conventional wisdom and some research suggest that students with negative attitudes toward geometry have performance problems simply because of anxiety. (Geddes and Fortunato, 1993) noted that students' attitudes about the value of learning geometry may be considered as both an input and outcome variable because their attitudes towards the subject can be related to educational achievement in ways that reinforce higher or lower performance. Onafowokan (1998) differs in her report of two separate studies carried out by Pickens (2005) when she linked higher achievement in geometry to positive attitude on the part of the students. In addition, Mogari (1999) while reporting on the state of pre-college education in Mathematics and Geometry, described the situation as worrisome in the sense that students do not particularly like geometry and the dislike it's acquired early in life.

Usefulness of geometry

Geometry is an important area in the school Mathematics curriculum throughout history; it has had great importance in people's lives, originating with the need of human beings to specify quantities, to measure figures, land and earth, and makes maps. In order to represent and solve problems in topics of Mathematics like trigonometry and in daily life situations, sound geometry knowledge is necessary. Geometry is also used in other discipline such as science (e.g., optics), geography (e.g., making maps), music (e.g., the pattern of the notes), art (e.g., making models), construction, architecture, gardening and traffic signs. Artists, builders, designers, masons, machinists, structural engineers and writers all make use of geometry daily.

The National Council of Teachers of Mathematics (NCTM, 2000, 41) has emphasized the importance of geometry in school Mathematics by stating, "Geometry and spatial sense are fundamental components of Mathematics learning. They offer ways to interpret and reflect on our physical environment." Geometry allows students to develop insight to understand other mathematical concepts and connect ideas across different areas of mathematics (Mammana and Villiani, 1998; Muschla and Muschla 2000; NCTM, 2000). Furthermore, many ideas like symmetry or generalization can help students increase insights into the nature and beauty of Mathematics (NCTM, 2000). Even if one does not plan to become a mathematician, he or she needs to develop visualization and reasoning abilities and appreciation of nature. The importance of geometry is best stated by an inscription above the door of Plato's school, "Let no one destitute of geometry enter my doors" Burton (1999, 79).

The usefulness of geometry in everyday life is obvious in areas like measuring and estimating to both male and female students (Aiken, 1990). Geometry is one of the most important branches of Mathematics and it is concerned with the properties and relationships of lines, angles, curves and shapes, etc. Geometry helps both male and female students to describe and define the world systematically. In addition, it helps them to acquire abilities such as making new discoveries, analyzing problems and making connections between mathematics and real life situations.

Regardless of the utility of geometry in real life situations, students continue to dislike the geometrical concepts and hence they perform poorly in examinations. However, Olatoye (2009) developed and evaluated some of such strategies directed at improving students attitudes to geometry subjects which include a strong relation between geometry contents and students everyday experiences (Geddes and Fortunato, 1993); learning opportunities to integrate difference pre-existing knowledge, a variation in teaching methods, enhancing co-operation and communication in the

classroom and training of teachers. Not only this, students need to develop the attitudes and habits of mind that are considered for meaningful work in geometry. These include commitment to accuracy, precision and integrity on observation, experimentation and respect for evidence and many others (Visser, 1987). It was therefore the objective of this study to find out the attitudes of secondary school students towards geometry.

Attitudes towards geometry by Gender

Sex-role type of education and gender differentiation in traditional society has serious undesirable effects on females' attitudes towards geometry (Obodo, 1992). Another common feature of these studies was the inclusion of the attitudes of parents and teachers towards gender differences in geometry as part of the influence on the students' attitudes (Fennema,1990).

Some studies reported a significant difference in geometry ability between students of different gender (Benbow and Stanley, 1983), whereas others stated that the difference was insignificant (Fennema and Carpenter, 1981). Researchers have found that a few gender differences manifest themselves already in elementary school geometry (Hyde, Fennema and Lamon, 1990). In general, girls fall behind boys in geometry learning in the middle school, and, further on, in the high school (Armstrong, 1981). In the later elementary school years, girls are better at calculation and boys are better at problem solving (Marshall, 1984). More gender differences begin to emerge in the junior-high school (Hall and Hoff (1988)). For instance, moderate-sized differences in problem solving favoring boys start to appear in high school (Hyde, 1981). These findings suggest that girls and boys have different geometrical skills and knowledge. Gender differences are also related to specific skills or tasks. Girls and boys make different errors when they solve problems in geometry (Marshall and Smith, 1987). A number of empirical studies have shown that boys tend to outperform girls in measurement, proportion, geometry, spatial geometry, analytic geometry, trigonometry and application of Mathematics (Battista, 1990). On the other hand, girls perform better than boys in computation, set operation and symbolic relations (Brandon and Newton, 1987). Ethington and Wollfle (1984) found out that women generally scored lower than men on a combined Mathematics test even after controlling for the effects of parental education, spatial and perceptual abilities, and high school grades, attitudes towards geometry and exposure towards mathematics courses. Baharvand (2001) also found out that males perform better than females on geometry problems and that in many cases, tests themselves affect the students' performance rather than the students' attitudes or genetic dispositions. It was noted that from the previous studies male students performed much well as compared to their female counterparts in mathematics particularly in geometry.

Context of study

Researchers observed that most geometry questions in both paper one and paper two of ordinary level mathematics syllabus (4008) are rarely attempted and if attempted they are badly tackled. Some students give up in taking 'O' level mathematics examinations after failing yet many employment opportunities have mathematics as the first requirement.

In Zimbabwe, it has become a tradition that when 'O' Level results come out, it is the mathematics subject that receives the lowest pass rate. According to statistics from A high school, of the 293 students who sat for the November 2011 'O' Level mathematics syllabus (4008), only 11.3% passed with a grade C or better and the rest failed. The poor performance of students in mathematics and geometry in particular had been a thing of concern to mathematics educators, parents and government (Burton, 1999). Zimbabwean schools are also affected by the poor performance in geometry and as a result leading to the high failure rate in Mathematics (Jaji, 2002). Mammana and Villiani (1998) also discovered that students' geometry achievement was always lower than the other areas of Mathematics. It has been also observed that students shy away from the study of geometry (Betiku, 2001). This shows the negative attitude and poor performance of students in geometry.

It is this backdrop that prompted the research into the students' attitudes towards learning of geometry in secondary schools. The study is aimed at investigating secondary school students' attitudes towards the learning of geometry by providing answers to the following questions:

1. What are the students' attitudes towards their learning of geometry?
2. Is there gender disparity on students' attitudes towards learning of geometry?

RESEARCH METHODOLOGY

This study followed the quantitative research prototype which involved descriptive survey design.

Research Instrument

A self administered questionnaire containing fifteen likert type closed questions relating to attitude towards their learning of geometry concepts was used, which was modified from Fennema-Shermann Attitudes scale. Three questions (1, 4, and 10) were on positive attitudes towards geometry, eight questions (3, 5, 8, 9, 11, 12, 13 and 15) were on negative attitudes of geometry and finally four questions (2, 6, 7, and 14) were measuring the usefulness of geometry. In this study, a questionnaire was advantageous in that it includes the number of subject in diverse locations (Burns, 2000). Content validity was employed in the evaluation of "what" was measured by using Fennema-Shermann Attitudes scale. This ensured that correct aspects of geometry attitudes were addressed when students

answer the questions. A pilot study was carried out on 10 learners before the disbursement of the questionnaire. Mathematics experts also examined the questionnaires to improve on content validity. This also helped the researcher to check the target on the clarity of instructions. Stratified random sampling was used by the researcher to ensure that the sample was a representative of the population.

Population and sample

There are three high schools in Bindura urban which were purposively sampled. The study comprised of 1 000 'O' level students, of which 505 were girls and 495 boys. The distribution of the participants across the schools is shown in table 1 below.

Table 1: The distribution of pupils for the three Bindura urban schools

School	Girls	Boys	Total
A	300	280	580
B	105	110	215
C	100	105	205
Total	505	495	1 000

From the targeted population, a sample of 100 'O' level students comprising of 51 girls and 49 boys was drawn from the three Bindura urban high schools as indicated in the table below using stratified random sampling. The researcher considered the three urban schools as strata and the total number of strata is 3 which would enable every student to get a chance to be selected into the sample. School A had the highest number of participants of 60, followed by B and C with equal number of participants totaling to 20. B had 20 students of which 10 were boys and 10 were girls, another 20 from C high school where 10 were girls and 10 were boys and 60 from A where 31 were girls and 29 were boys. The sampled students had covered the topic of geometry.

DATA PRESENTATION, ANALYSIS AND DISCUSSION

Students' attitudes towards learning of geometry.

Table 2: Students' attitudes towards geometry as measured on closed questions on the questionnaire.

Key 1=Strongly Agree 2=Agree 3=Disagree 4=Strongly Disagree M=Missing

A. Positive attitudes towards geometry	1 %	2 %	3 %	4 %	M %
1.I like solving geometry	4	6	17	73	0
4. I think I will do well in geometry	50	40	5	4	1
10. Geometry teaches me to be logical in thinking	36	46	9	5	3
B. Negative attitudes towards geometry					
3.Geometry will not be important to me in future	5	8	30	57	0
5.Geometry is a very difficult subject	4	24	40	32	0
8.Doing geometry is a waste of time	4	6	17	73	0
9.Geometry is too technical for me to understand	13	27	38	20	2
11. Geometry is not useful in the society	9	15	32	41	3
12. Only brilliant students can understand geometry	12	15	27	44	2
13. Geometry is my worst topic in mathematics	8	9	40	41	2
15. I would like to avoid using geometry in college.	9	7	46	36	2
C. Usefulness of geometry					
2.Knowing geometry will help me improve my mathematics results	14	26	37	20	3
6.Geometry help me to develop good reasoning	54	20	16	10	0
7.Geometry is applicable to solving human and natural problems	20	32	19	27	2
14. Geometry is a worthwhile and necessary subject	34	46	8	11	1

Students' Positive Views about geometry

The results showed that 10% of the students agreed that they liked solving geometry problems, while 73% students strongly agreed that they liked solving geometrical problems. This result implies that majority of the students in Bindura urban did not like solving geometrical problems while very few students liked solving geometry problems which concurred with Gardner (1983) who discovered that students' geometry achievement was found to be affected by students who did not like solving geometry problems.

Five percent strongly agreed that geometry will not be important to them in future, while 57% strongly disagreed with this view which is an indication that geometry will be very important to them in their future endeavors. This is in agreement with the opinion of Toumasis (1993) that sees geometrical knowledge as essential not only for living effectively in the society but also for making useful contributions towards the development of one's environment.

Students' views about usefulness of geometry

Question 2, 6,7,14 are stressing on the importance and usefulness of geometry. 54% of the students strongly agreed that geometry teaches them to think logically while 10% strongly disagreed. The views expressed here by these students are in line with the idea of Mogari (1999) who sees geometry as a particularly powerful and concentrated example of the functioning of human intelligence.

Only 11% of the students strongly disagreed with the statement that geometry is a worthwhile and necessary topic while 34 % students strongly agreed that the topic is a worthwhile and necessary subject. This is in agreement with the opinion of Bindak (2004) who saw geometrical knowledge as essential not only for living effectively in the society but also for making useful contributions towards the development of one's environment.

Gender disparity in attitudes towards geometry

Table 3: Students' attitudes towards geometry as measured on closed questions on the questionnaire.
Key 1=Strongly Agree 2=Agree 3=Disagree 4=Strongly Disagree M=Missing m=male f=female

A. Positive attitudes towards geometry	1 %		2 %		3 %		4 %		M %	
	m	f	m	f	m	f	m	f	m	F
1. I like solving geometry	2	2	4	2	8	9	35	38	0	0
4. I think I will do well in geometry	24	26	21	19	3	2	2	2	1	0
10. Geometry teaches me to be logical in thinking	17	19	22	24	4	5	5	1	2	1
B. Negative attitudes towards geometry										
3. Geometry will not be important to me in future	3	2	4	4	16	14	29	28	0	0
5. Geometry is a very difficult subject	2	2	13	11	20	20	17	13	0	0
8. Doing geometry is a waste of time	1	3	4	2	8	9	37	36	0	0
9. Geometry is too technical for me to understand	6	7	13	14	19	19	11	9	1	1
11. Geometry is not useful in the society	4	5	7	8	17	15	20	21	2	1
12. Only brilliant students can understand geometry	6	6	8	7	13	14	23	21	0	2
13. Geometry is my worst topic in mathematics	5	3	4	5	19	21	20	21	1	1
15. I would like to avoid using geometry in college.	5	4	3	4	24	22	17	19	2	0
C. Usefulness of geometry										
2. Knowing geometry will help me improve my mathematics results	7	7	14	12	18	19	10	10	1	2
6. Geometry help me to develop good reasoning	26	27	11	9	7	9	4	6	0	0
7. Geometry is applicable to solving human and natural problems	8	12	15	17	10	9	17	10	2	0
14. Geometry is a worthwhile and necessary subject	14	20	26	20	4	4	6	5	1	0

Positive views about geometry by gender

The results showed that 2% of both male and female students strongly agreed that they liked solving geometric problems while 38% female students and 35% male students strongly disagreed. These results showed that majority of the students do not like solving geometry problems. This is supported by (Aiken, 1990) when he said that equity in geometry was achievable when there are no perceivable differences on how females and males feel about themselves and geometry. This applies in the learning of geometry as a Mathematics topic.

On the question of geometry being a very difficult subject, 2% of both male and female students strongly agreed with the view while 13% of the female students and 17% male students strongly disagreed with this view. This implies that to the students under review, geometry was not a difficult subject to both male and female students. This did not agree with Geddes and Fortunato (1993) who documented that both boys and girls think that geometry is a difficult topic. These students perceived geometry as a topic that is not difficult.

Gender views about usefulness of geometry

Three percent of the male students and 2% female students strongly agreed that geometry will not be important to them in future while 29% male students and 28% female students strongly disagreed with this view. This view is an indication that geometry will be very important to them in their future endeavors. Bindak (2004) agrees with the above view that sees

geometrical knowledge as essential to both sex not only for living effectively in the society but also for making useful contributions towards the development of one's environment.

Twenty percent of the male students and 21% female students strongly disagreed with the question that geometry is not useful in the society while 4% male students and 5% female students strongly agreed that geometry is not useful in the society. The usefulness of geometry in everyday life is obvious in areas like measuring and estimating to both male and female students (Aiken, 1990).

CONCLUSION AND RECOMMENDATIONS

Generally, the majority of students indicated that they do not like solving geometric problems and on the other hand many of them agreed that geometry will be very important and useful to them in their lives. This finding also came from both boys and girls whose indications had a slight difference.

It is recommended that the students themselves should first develop positive attitudes towards geometry in order to perform well in geometry. From the findings, schools can build up a positive attitude towards geometry with the help of teachers. Teachers can do this by ensuring conducive environment for learning like taking the pupils step by step slowly through a concept trying to relate all geometric concepts to real life situations.

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