



Pre-SHS Students' Perception of Difficult Concepts in Junior High School Mathematics Curriculum in Ghana

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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Abstract

This study employed the survey research design aimed at investigating difficult concepts in Junior Secondary School mathematics curriculum as perceived by Pre-Senior High School students in Ghana. The study was guided by two research questions and the sample for the study was 70 consisting of 34 females and 36 male students. The instrument used for the collection of data was a 27-item questionnaire tagged Difficult Concept Identification Questionnaire in Mathematics (DCIQM). The data obtained were analyzed using mean with the criterion mean set at 2.1 for identifying difficult topics and 3.9 for identifying possible causes of the perceived difficulty. Test-Retest Reliability (Pearson's r) of the study was found to be 0.837. The findings of the study revealed that students identified some mathematics topics such as Sets and Operations ($\bar{X}:2.9>2.1$), Real Number System ($\bar{X}:2.3>2.1$), Business Mathematics ($\bar{X}:2.2>2.1$), Functions and Mapping ($\bar{X}:3.9>2.1$), Ratio and Proportion ($\bar{X}:2.2>2.1$) as difficult topics. The highest contributing factor to the perceived difficulty in mathematics was identified as the inability of the students to practice mathematics on their own on regular basis outside lesson hours. Again, students agreed to have developed problems in mathematics from the Primary School. It was also evident from the study that more females perceived mathematics concepts as more difficult than males. Based on the findings of the study, it was recommended among others that workshops should be organized to train mathematics teachers on the effective and efficient strategies that should be adopted for the teaching of the identified difficult mathematics concepts.

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1 Introduction

Ghana presently has a 6-3-3-4 education system. Pre-school is not compulsory. Children are expected to enter the first year of primary school at age 6. The first nine years that make up basic education consists of primary education of 6 years and 3 years of junior secondary school. Basic education is supposed to be compulsory for all children of the relevant age group. Unfortunately as this study will show universal primary education has still to be achieved in Ghana. An official selection process occurs at the end of the ninth year of basic education when all pupils take the Basic Education Certificate Examination (BECE). Individuals who want to continue their formal education have the option of attending senior secondary schools, technical schools or vocational schools [1].

The Basic Education Certificate Examination (BECE) is the main examination that is used to give students admission into secondary or vocational schools in Ghana. It is written after three years of junior high school education. BECE is organized by the Ghana Education Service under the Ministry of Education. Candidates in the third year of junior high schools approved by the Ghana Education Service are eligible to take part in this examination. The examination conducted nationwide in June each year and usually lasts for a week unless there is cancellation or postponement. Subjects taken include English language, Mathematics, Integrated Science, Social Studies, Religious and Moral Education (R.M.E), French, Ghanaian language (any Ghanaian language offered at candidate's school), Basic Design Technology (B.D.T), Information Communication and Technology (I.C.T). Schools approved by the Ghana Education service are eligible to register students to take the BECE each year [1].

The Ghanaian Government, like all other stakeholders in Education recognizes high quality basic education as critical since it enhances the development of the individual in society [2]. Other Ghanaian scholars over the years have also underscored how essential basic education is to the development of the human capital of the nation [1,3,4,5]. To promote quality education and resolve the poor academic achievement of students from rural basic schools, the Government, through its Ministry of Education and the Ghana Education Service (GES), implemented series of education reform schemes. Notable among these were the 1987 education reform to improve access to basic and secondary education, and the introduction in 1996 of the Free Compulsory Universal Basic Education (FCUBE) policy to address access to education and quality concerns in basic education. In spite of these educational reforms, Ghana's basic schools regularly fail to produce knowledgeable graduates, capable of pursuing further education There is evidence of declining academic performance [3,6,7,4,8].

For example, in 2011, over 40% of candidates who sat for the BECE (Basic Education Certificate Examination) failed the examination and could not gain placement in any of the second cycle institutions, representing a below average performance. Enrolment rates have however increased at the basic level. This clearly shows a gain in access without any corresponding action to improve learning [9]. As mentioned in the introduction, within the last decade, Ghana continues to perform significantly below other African nations in cross-national comparisons in the Trends in International Maths and Science Study (TIMSS) 2003 [10]. A 2008 Ghana News Agency Report had this to say: 'Five Junior High Schools in the Twifo-Hemang-Lower-Denkyira District in the Central Region (of Ghana) scored zero percent in the 2008 Basic Education Certificate Examination (BECE). Mr. Samuel Agyeibie-Kessie, the District Chief Executive, disclosed this at the assembly's general meeting at Twifo Praso on Friday' [11]. Thus, the zero percent score above refers to the fact that no individual student from the schools mentioned had an aggregate score of 30 or lower in the six core and elective subjects at the BECE (<http://ro.ecu.edu.au/cgi/viewcontent.cgi?article=1494&context=theses>) There are other unreported cases in the other basic schools of Ghana. The Ministry of Education in Ghana, recognizing the seriousness of the poor performances in our public basic schools despite the numerous interventions by government, puts it this way: 'Despite the numerous interventions to improve education, achievement levels of school children, especially at the basic level, were low. The results of public schools in the Criterion Reference Tests (CRTs)

conducted from 1992 to 1997 in English and Mathematics indicated an extremely low level of achievement in these subjects' [12].

2 Literature Review

The conceptions, attitudes, and expectations of the students regarding mathematics and mathematics teaching have been considered to be very significant factor underlying their school experience and achievement [13]. Beliefs might be thought of as lenses through which one looks when interpreting the world. There is a lack of interest in mathematics or a relatively higher tendency of mathematics avoidance among many of the Ghanaian students. Most students hold the belief or myth that being good in mathematics is mainly due to ability than effort [14]. Many students admit this lack of achievement in mathematics as a permanent state over which they have little control. According to Tobias (2003), millions of adults are blocked from professional and personal opportunities because they fear or perform poorly in mathematics, for many these negative experiences remain throughout their lives. Research revealed that many students relate mathematics mainly with computations [5]. Many students tend to identify mathematics with arithmetic. Doing mathematics is normally associated with calculations. It is widely maintained in the literature that negative images and myths of mathematics are widespread among the students. Many students view mathematics as a difficult, cold and abstract subject. It is perceived by many students as an exclusive discipline [15]. From epistemological and pedagogical perspectives, it is perceived as a subject that involves a lot of work. The subject is seen as an obstacle, often dreaded and as hard work. Mathematics is also viewed as a static and objective discipline, available for discovery by mathematicians, in turn to be transmitted by teachers and received by the students. Many believe that mathematical activity includes procedures that are divorced from real life, from discovery and from problem solving. The fact that mathematics is usually presented as a body of absolute truths which exists independently of the learners and taught in a hierarchical, linear and prescriptive fashion reinforces the view that mathematics is a difficult subject. There is also a claim that mathematics is only for the clever ones, or only for those who have inherited mathematical ability. Being mathematically knowledgeable is often treated as an indicator of general intelligence, as evidenced by the widespread use of mathematics in entrance tests. This view causes many people to believe that learning mathematics is a question of ability rather than effort and that there is an inherent natural ability for mathematics. This perception leads students to accept their lack of accomplishment in mathematics as a permanent state over which they have little control.

In 2003, Ghana for the first time participated in TIMSS in order to find out how the performance of her eighth graders (JSS2) in science and mathematics compared with those of other countries. This paper presents an overview of the performance of the JSS2 students in the TIMSS-2003 in mathematics, with particular reference to the released items. The analysis of the Ghanaian students' performance on the released items indicated that Measurement, Geometry and Algebra were the candidates' weak content areas. The mean percentage of Ghanaian students making correct responses to the released items in Algebra, Measurement and Geometry were 13.6, 17.3 and 13.4 percent, respectively. For Number and Data, the mean percentage making correct responses to the released items were 22.6 percent and 27 percent. The Ghanaian students found the constructed response items more difficult than the multiple-choice items. The mean percentage of students who were able to provide the correct responses to the multiple-choice items was 21.6 percent while that observed for the constructed response items was 12.1 percent.

The paper also presents the results of analyses of Ghanaian mathematics curriculum (textbooks and what teachers taught); and also the BECE-2004 and TIMSS-2003 test items. It was observed that the Ghanaian curriculum places a great deal of emphasis on number and in addition, most (77%) of the items in the BECE elicited responses in the lowest cognitive domain, i.e. 'knowledge of facts and procedures'. The BECE included only few (12.1%) items that required the students to solve routine problems. None of the BECE items can be classified as one that required some higher level reasoning from the students. The TIMSS on the other hand devoted 36 and 21.6 percent of its items to solving routine problems and reasoning, respectively.

2.1 Statement of the problem

Mathematics education has changed over time as educators and policymakers strive to produce more knowledgeable students in the area of mathematics. Emphasis has been put on math and science in an effort to raise national test scores of BECE in these content areas.

There are many challenges in Ghana's education sector; one of the major challenges in the education sector is the low BECE pass rate of Ghanaian children in Junior High schools (JHS). The critical need to investigate and find appropriate responses to this issue is informed by a number of considerations. There have calls from public officials as well as students for academic assistance such preparation classes and extra classes for the Basic Education Certificate Examination (BECE); low examination performance levels of pupils in many public basic schools with 40% of JHS pupils failing to pass the examinations. The situation has persisted in spite of Ghana's obvious commitment to education as evidenced by its policies and budgetary allocations to the education sector. Mathematics is one of the 9 subjects that a candidate is expected to pass in order to obtain placement into some courses or into some specific Senior High Schools. The vast majority of Ghanaian students attend public boarding schools, many of which are highly competitive. Educational research in the area of mathematics that analyzes students' perception on the content of the mathematics curriculum could provide more detailed data as to what strategies teachers could put in place to lessen students problems. It also enables teachers to identify topics students perceive as difficult in the JHS mathematics curriculum.

Ghana continues to perform significantly below other African nations in cross-national comparisons. For example, in the Trends in International Math and Science Study (TIMSS) 2003, Ghana's scores fell well below all of the others that took part in the assessment, including South Africa, Botswana, Morocco, Tunisia, and Egypt. In TIMSS 2007, Ghana's scores were also among the lowest, behind Algeria, Botswana, Egypt, and Tunisia as well as falling short of the scores of countries at similar income levels in other regions, as well as the upper and middle income countries that participated [10].

In addition, between 2003 and 2006 the Gross Enrolment Rate in Ghana increased from 87 to 94% in the primary schools and the junior high school enrolment rate from 73 – 77%. The completion rate of primary school is currently 85% and the completion rate in Junior High School (JHS) is 65%. These are significant accomplishments in relation to the 2003– 2015 Education Sector Plan, yet this enrolment does not match with achievement for which reason this plan is scheduled to be replaced with a new plan which would guide Ghana's Education Sector from 2010 to 2020 (ibid).

The WAEC chief examiners' report has shown that there is over a decade-long poor performance of students in mathematics despite improved teaching methods and motivational learning strategies. This trend is frustrating to students' aspiration for higher education in areas where a credit in mathematics is required and general cognition of the subject. It is therefore, necessary to allow the student indicate what constituted their difficulty in the subject area and the possible cause of such difficulties.

2.2 Purpose of the study

The purpose of the study was to investigate the difficult concepts in junior secondary school core mathematics curriculum as perceived by students.

Specifically, the objectives of the study are to:

1. Find out the difficult concepts in mathematics in the junior secondary school curriculum as perceived by the students.
2. Ascertain the causes of the identified difficult mathematics concepts in the junior secondary school curriculum as perceived by the students.

2.3 Significance of the study

Findings of this paper will be significant to the Ministry of Education of Ghana, the Ghana Education Service, social and educational policy makers, basic school teachers, parents and all other stakeholders in education. Findings of this research will also contribute to the already existing literature on basic school performance in Ghana. The general trends in the data will help to point towards which areas in basic education where there is a need for devoting more funding and to utilizing current available resources more efficiently.

3 Methods and Materials Used

This study employed a questionnaire approach. Based on construction of the questionnaire, Reid (2006) stated the reliability in a questionnaire as: if the questionnaire is carefully constructed and is administered under the circumstances where respondents are able to be honest in answering and the sample size is large enough to draw some clear conclusion, then the reliability is likely to be good. In this study, all traits are met to ensure the reliability of the research instruments. Also, validity measures that all the questions designed to measure a particular trait are indeed measuring the same trait in this study [2,16]. The sample was selected by the convenience sampling technique. The students used in this study were Pre-Senior High School students who graduated from various Junior High Schools across the country who had come to Ideal College for preparatory classes (towards entry into SHS) as they waited for their BECE results to be released. The study consisted of 70 respondents out of which 34 were females and 36 were male students. Microsoft Excel and SPSS software were used in the analysis. The four point -Likert scale were coded as Very Difficult = 4, Difficult = 3, Less Difficult = 2, Not Difficult = 1. Data analysis is performed using Microsoft Excel (windows 10) and IBM SPSS STATISTICS (2015), V23.0, SPSS Inc.

The criterion mean was calculated as follows:

$$\text{Criterion mean or Grand mean, } \bar{X} = \frac{\sum_{i=1}^n \bar{X}_i}{n}, \text{ where } n \text{ is the number of means.}$$

$$\text{Where } \bar{X} = \frac{\sum_{i=1}^n X_i}{N}, \text{ where } N \text{ is the sample size.}$$

Test-Retest Reliability was used in estimating reliability where the test was administered twice to the same set of subjects and then correlate the two measurements (that at Time 1 and that at Time 2). Pearson r is the index of correlation most often used in this context. If the test is reliable, and the subjects have not changed from Time 1 to Time 2, then we should get a high value of r .

4 Discussion of Results

From Table 1, the concepts Sets and Operations ($\bar{X}:2.9>2.1$), Real Number System ($\bar{X}:2.3>2.1$), Business Mathematics ($\bar{X}:2.2>2.1$), Functions and Mapping ($\bar{X}:3.9>2.1$), Ratio and Proportion ($\bar{X}:2.2>2.1$) were perceived by Junior High School students as difficult.

Sets and Operations on Sets were perceived by students as difficult ($\bar{X}:2.9>2.1$). This means the Junior High School students have problems in the following areas:

- i. Definition of set and ways of describing sets
- ii. Types of sets (as finite, infinite, unit and empty sets and Subsets)

- iii. Equal and equivalent sets
- iv. Union and Intersection of sets
- v. Application of sets (use of Venn diagram in problem solving) on two sets problems
- vi. Cardinality (number of elements in a set) and number of subsets in a set

The core points in Sets and Operations on Sets should clearly be taught to students to enable them neutralize any shred of misconception they have about the topic as a whole. Proper sequencing of mathematics topics can help curb the situation. Certain topics in the JHS curriculum are the prerequisite concepts to other topics. Before teaching Sets and Operations on Sets, topics such as simultaneous equations, linear equation and inequality should have been taught.

Another topic perceived as difficult by the Junior High School Students in the mathematics curriculum is Real Number System ($\bar{X}:2.3>2.1$). This alludes to the fact that the students have problems with at least one of the following areas:

- i. Place value, comparing and ordering numbers
- ii. Rounding numbers
- iii. Prime and Composite numbers
- iv. Prime factors, HCF, LCM and applications
- v. Properties of operations
- vi. Estimates of sum, Product, and quotient of natural numbers
- vii. Integers and Operations on integers
- viii. BODMAS
- ix. Rational and irrational numbers and operations on them
- x. Decimal Fractions and operations on decimal fractions
- xi. Standard
- xii. Approximations

The teaching of this topic should involve the use of physical mathematical manipulative tools such as improvised Abacus, place value chart or color-coded materials and Base ten blocks to enable students grasp the concept well.

Business Mathematics ($\bar{X}:2.2>2.1$), was also perceived as difficult. This topic includes areas such as the following:

- i. Percentages
- ii. Profit or Loss , Loss percent, Profit percent
- iii. Rates (Simple Interest, Discount, Commission)
- iv. Money and Taxes (VAT/ NHIS)

One of the findings of this study is that JHS students have problem with at least one of the above concepts in Business Mathematics.

Functions and Mapping ($\bar{X}:3.9>2.1$), is another area where students have problems understanding. Students have problems understanding at least one of the following sub-areas:

- i. Relations (Domain, Co-domain, Range as ordered pair, Range as relation)
- ii. Mapping (Rule of mapping, Inverse mapping, making table for a given rule)
- iii. Applications of functions

Functions and Mapping ($\bar{X}:3.9>2.1$) was found to be the concept most JHS students perceive as difficult.

Lastly but not the least, Ratio and Proportion ($\bar{X}:2.2>2.1$) was also found to be one of the topics perceived as

difficult. This means students have problems with at least one of the following areas:

- i. Comparing two quantities in the form a:b
- ii. Expressing two equal ratios as a proportion
- iii. Direct and Indirect Proportions
- iv. Applications of ratio and proportion
- v. Scale drawing and using proportions

It is evident from Table 2 that Mathematics teachers at the JHS level did not use discouraging words while teaching the subject. Class size above 40 did not contribute to the perception that math is difficult. Teachers' inability to complete the mathematics curriculum also was not identified as one of the factors contributing to why students perceive math as difficult. Students agreed to have developed problems in mathematics from the Primary school. The highest contributing factor to the perceived difficulty in math was identified as the inability of JHS students to practice math on their own on regular basis. Math teachers in the JHS were not so punctual to class and so would rush through the days' work creating difficulty for the students to understand the concept. Students think some topics are just so difficult for them no matter what they do. The JHS students are also of the view that non-marking and correction of assignment to find out students strengths and weaknesses in mathematics concepts do not make the have a sense of difficulty for the subject. Students also were of the view that holding an office in school whilst a student can make one have the impression that math is difficult. This is probably due to lack of time management skills on the part of the students.

From Table 3, there was a significant difference ($\chi^2 = 50.000^a$, $df = 45$, $p > 0.05$) between concepts perceived by male and female students as difficult. From Table 4, more females perceived more concepts more difficult than the male students (Mean: 60.60 > 12.77). The perceptions of the male students were found to be more spread about the mean ($\bar{X} = 12.77$, $\sigma = 7.124$). However, the female students' perception of difficult concepts in Mathematics were found to be tightly clustered about the mean ($\bar{X} = 60.60$, $\sigma = 3.893$).

Tables 5 and 6 show the results of Test-Retest Reliability which was used in estimating reliability of the study. The test was administered twice to the same set of subjects and the two results were correlated at times T1 and T2. A high Pearson r of 0.837 was obtained.

Table 1. Identification of difficult concepts in the Junior High school mathematics curriculum

Topic	Very difficult	Difficult	Less difficult	Not difficult	Mean	Decision
Sets and Operations	32	27	132	14	2.928571	Difficult
Real Number System	48	45	56	12	2.3	Difficult
Business Mathematics	32	48	66	11	2.242857	Difficult
Algebraic Expressions	32	54	40	15	2.014286	Not difficult
Functions and Mapping	144	81	44	6	3.928571	Difficult
Ratio and Proportion	32	72	40	13	2.242857	Difficult
Vectors	32	18	60	16	1.8	Not Difficult
Probability	0	27	40	21	1.257143	Not Difficult
Statistics	32	45	36	19	1.885714	Not Difficult

Topic	Very difficult	Difficult	Less difficult	Not difficult	Mean	Decision
Transformation	64	36	16	21	1.957143	Not Difficult
Construction	16	0	44	22	1.171429	Not Difficult
Indices	0	45	40	17	1.457143	Not Difficult
Plane Geometry	32	9	48	17	1.514286	Not Difficult

Criterion mean = 2.1 Sample size = 70

Table 2. Causes of difficulty of concept in mathematics

S/N	Causes of difficulty of concept in mathematics	Strongly agree	Agree	Disagree	Strongly disagree	Mean	Decision
1	Math teacher used discouraging words	150	48	24	12	3.342857	Disagree
2	Class size was too large (Above 40)	75	124	32	10	3.442857	Disagree
3	The syllabus was not completed	100	64	28	9	2.871429	Disagree
4	Math is just difficult	150	16	36	8	3	Disagree
5	I had math problem since primary	125	80	32	9	3.514286	Agree
6	I don't practice math regularly	100	460	8	2	8.142857	Agree
7	Lack of math teachers	0	16	28	22	0.942857	Disagree
9	My math teacher had difficulty with some topics in math himself/herself	50	48	28	17	2.042857	Disagree
10	Math teacher not punctual	50	176	36	14	3.942857	Agree
11	There are some mathematics concepts that do not interest me	300	0	36	3	4.842857	Agree
12	Deliberate skipping of some mathematics concepts by teachers	100	64	48	11	3.185714	Disagree
13	Lack of adequate time to learn due to holding an office in school	125	96	32	14	3.814286	Agree
14	Non marking and correction of assignment to find out students strengths and weaknesses in mathematics concepts	125	48	36	13	3.171429	Disagree
15	My math teacher was not of a specific gender	150		36	11	2.814286	Disagree

Criterion mean = 3.5 Sample Size =70

Table 3. Test of significance among concepts perceived by male and female students as difficult

	Value	df	P-value
Pearson Chi-Square	50.000 ^a	45	0.281

Table 4. Descriptive statistics

	No. of concepts perceived difficult	Mean	Std. deviation
Male	10	12.77	7.124
Female	10	60.60	3.893
Valid N (listwise)	10		

Table 5. Descriptive Statistics of test-retest method of testing reliability of questionnaire at times T1 and T2

	Mean	Std. deviation	N
T1	150.2143	55.31891	14
T2	135.0000	44.10477	14

Table 6. Measure of reliability coefficient for difficult topics by test-retest method

Measure of reliability coefficient by Pearson's r			
		T1	T2
T1	Pearson correlation	1	.837**
	Sig. (2-tailed)		.000
	N	14	14
T2	Pearson correlation	.837**	1
	Sig. (2-tailed)	.000	
	N	14	14

** . Correlation is significant at the 0.01 level (2-tailed)

5 Conclusion

This study concludes that there are mathematics concepts that are difficult although the difficulty varies from concept to concept as perceived by Pre-Senior High School students and that students are aware of the factors that can attribute to the concept difficulty.

Firstly, the concepts Sets and Operations ($\bar{X}:2.9>2.1$), Real Number System ($\bar{X}:2.3>2.1$), Business Mathematics ($\bar{X}:2.2>2.1$), Functions and Mapping ($\bar{X}:3.9>2.1$), Ratio and Proportion ($\bar{X}:2.2>2.1$) were perceived by Junior High School students as difficult.

Secondly, Mathematics teachers at the JHS level used discouraging words while teaching the subject. Students also alluded to the fact that Class size above 40 contributed to the perception that math is difficult. Teachers' inability to complete the mathematics curriculum also was identified as one of the factors contributing to why students perceive math as difficult. Students agreed to have developed problems in mathematics from the Primary school.

Lastly, there was a significant difference ($\chi^2 = 50.000^a$, $df = 45$, $p > 0.05$) between concepts perceived by male and female students as difficult where females were found to have perceived more topics as difficult.

Based on the findings of this study, the following are recommended:

1. Workshops should be organized for mathematics teachers to train them on how to effectively teach the identified difficult mathematics concepts which students struggle with.
2. School authorities should endeavor to reduce class-sizes to about 25 or 30. This will enable the teacher to mark exercises and would encourage the teacher to set quality and standard test for students.
3. Students should cultivate the habit of solving more questions on their own after they have been taught math.
4. Academic Counselling should be organized regularly for students
5. Measures should be put in place to enable teachers to complete the syllabus before students write their final examinations.
6. Professional teachers should be engaged in the Primary School to make the teaching of mathematics effective.

Competing Interests

Author has declared that no competing interests exist.

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