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EXPLORING PROBLEM-SOLVING SKILLS AMONG JUNIOR HIGH SCHOOL ONE STUDENTS IN MATHEMATICS AT AKATSI SOUTH DISTRICT, GHANA

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Abstract

The purpose of this study was to explore how Junior High School (JHS) 1 students solve word-problems in Mathematics. A total of 112 JHS 1 students were purposively selected from 41 public basic schools in the Akatsi South District of Ghana. Interview guide and test items comprising questions on word-problems in Mathematics on "Fractions", "Perimeter" and "Area" were used to collect data. Percentages and frequency distribution tables as well as descriptive statistics (mean, mode, median and standard deviations) were used for data analysis. It was found that most of the students were able to read the word-problems in Mathematics but a majority of them could not read the concept names correctly. It was also found that a majority of the students could not solve the word-problems in Mathematics (fractions, perimeter and area) correctly resulting in very low performance. It is recommended that the Institute of Education, in collaboration with the Ministry of Education in Ghana, should include problem-solving skills in Mathematics as a course in the curriculum of Colleges of Education in the country. The Institute of Education should collaborate with the Ghana Education Service to organize in-service training programmes for teachers to equip them with the skills and strategies needed to enforce the teaching and learning of Mathematics using problem-solving approach.

Keywords: error analysis, mathematical concepts, problem-solving, word-problems.

Introduction

The development of students' problem-solving abilities is the primary concern of Mathematics education in most countries (Nelson, 2011). From 1989, international development partners such as Japan International Cooperation Agency (JICA) have embarked upon professional development programmes in Ghana to improve upon the level of teaching through problem-solving in an effort to add to the quality of teaching and learning in order to enhance students' achievement. Despite a decade of reforms, there are still concerns that student achievement in Mathematics and Science has not improved sufficiently to reflect the huge investment in Basic Education in Ghana, which is made up of two years of kindergarten, six years of primary school and three years of junior high school education (Ansu-Kyeremeh, Casely-Hayford, Djangmah, Nti, & Orivel, 2002).

Ghana participated in Trends in Mathematics and Science Study (TIMSS) 2003 to assess its educational system with other countries of similar curriculum aspirations and standards. According to Anamuah-Mensah, Mereku and Asabre-Ameyaw (2004), Ghana's participation in TIMSS 2003 was strategic, as it enabled the country to find out the performance of her eighth graders in Mathematics. However, Ghana performed poorly in TIMSS 2003, TIMSS 2007 and TIMSS 2011.

According to Fredua-Kwarteng (2005), Ghana's abysmal performance in TIMSS 2003 and TIMSS 2007 could be attributed to the idea that Mathematics teaching at Junior High Schools (JHS) was characterized by the transmission and command models. Students were not encouraged to pose questions or engage in problem-solving activities in order to attain both conceptual and procedural understanding of what they were being taught. Nabie, Akayuure and Sofo (2013) identified among teachers teaching Mathematics at the junior high schools that teachers did not involve students in real problem solving and investigations because these topics do not feature on West African Examination Council (WAEC) examinations. Teachers also perceived problem-solving to be cognitively demanding.

In order to promote problem solving, the Ministry of Education (Ministry of Education, 2007a) carefully designed the Mathematics curriculum content for education with the goal of helping learners develop problem-solving skills and Mathematical ideas to carry out investigations with diligence, perseverance and confidence. To enhance problem-solving, the Mathematics teaching syllabus for schools in Ghana requires that students are taught problem-solving skills in order to apply their knowledge, develop analytical thinking skills, develop plans, generate ideas and creative solutions, and address everyday Mathematical situations. Teachers are expected to incorporate problem-solving activities in every lesson to develop learners' competencies and skills for a functional life. Specifically, teachers are expected to include appropriate and realistic problems and Mathematical investigations that will require the use of mathematical processes and provide opportunities for students to explore mathematical ideas (Ministry of Education, 2007b).

Literature Review

Lester and Kehle (2003, p. 510) defined problem-solving as "an activity that involves the students' engagement in a variety of cognitive actions including accessing and using previous knowledge and experience to solve problems". Mayer (1987) also identified problem-solving as a process which uses different forms of knowledge that leads to the goal of solving the problem and such knowledge should consists of linguistic and factual knowledge, schema knowledge, algorithmic knowledge and strategic knowledge. Hence, it is understood that students who are looking for a solution to a given problem must think consistently with the contexts and content, among others to be able to arrive at parsimonious decisions. Non-routine problems are believed to have given opportunities for students to develop higher-order thinking in the process of understanding, exploration, and application of mathematical concepts.

A number of studies have indicated that difficulties students face in solving word problems lie not only in one stage but in two or more stages. For example, the study of Marinas and Clements (1990), Ellerton and Clements (1996) and Singhatat (1991) noted that a large proportion of errors first occurred at the comprehension or transformation stages. They likewise reported that approximately 71% of errors made by Grade-7 students on Mathematical questions were at the comprehension or transformation levels. Considering all variables, the high percentage of errors in comprehension and transformation levels suggested that students have considerable difficulty in understanding and developing appropriate mathematical representation of word problems.

Similarly, Trance (2013) used Newman's error analysis and found that higher proportion of errors made on the transformation stage accounted for almost 50% of the total number of errors committed. In fact, at least 45% of students' errors were on the transformation stage. It was also found that most participants were able to identify the topics and concepts related to the questions raised, However, many could not read the mathematical symbols used in the instruments.

Singhatat (1991) also observed that students made 68% of errors at the comprehension or transformation stages. However, it was reported that no student in the sample made any reading error. Clements (1980) analysed 6,595 errors made by 634 students using Newman Error Analysis model and realised that 70% of errors belonged to transformation or carelessness categories. The Mathematics procedure level of process skills registered 25% and encoding accounted for about 5%.

Kaur (1995) also studied students' errors when solving word problem and found that students experienced at least three problem-solving difficulties: (1) lack of comprehension of the problem; (2) inability to translate the problem into Mathematical form; and (3) lack of strategy in solving the problem. Such difficulties were very evident when students' errors were classified into categories by topics. Students have not related well to basic topics taught at elementary level. A closer look at the given questions revealed that students could not answer the problems given simply because they did not know how to read the mathematical symbols included in such questions.

It is important to assess students holistically to capture the demonstration of what they know, how they know it, and their ability to apply the knowledge acquired. Monaghan, Pool, Roper, and Threlfall, (2009) pointed out that while most of Mathematics requires convergent thinking, problem-solving requires some degree of divergent thinking which is best assessed by authentic assessment approaches. As far as problem-solving is concerned, formal assessment alone cannot capture holistic information about a student's thinking processes (Kennedy, Tipps & Johnson, 2004), as paper and pencil tests offer only a glimpse of what students know and think (Glanfield, Bush & Stenmark, 2003). Therefore, to tap the full range of student information, teachers need to utilize a wide range of assessment strategies. According to Monaghan et al. (2009), assessment of problem-solving requires access to evidence of processes in which students produce extended responses from which the problem-solving process can be inferred.

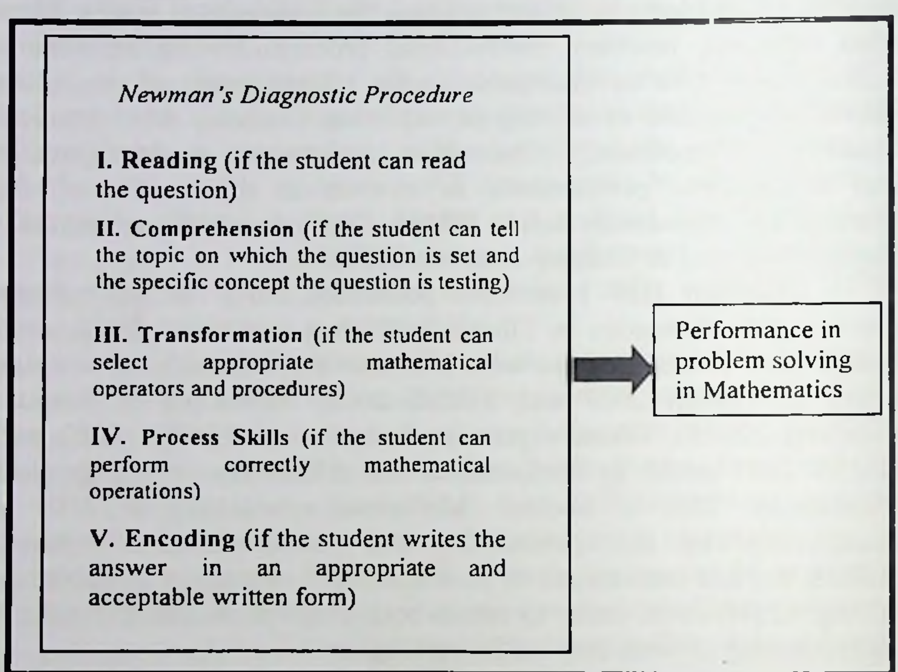
However, no study in Ghana has particularly examined how students undertake problem-solving activities in order to explore the errors that the students make and the extent to which the students can solve word problems in Mathematics at the basic school levels. More often than not, teachers' instructional problem-solving assessment techniques tend to be insensitive to the ultimate goal of producing individuals capable of solving or exploring everyday Mathematical situations. Instructionally, insensitive assessments in Mathematics lead to abysmal performance as evident in the results of the international assessment tests- TIMSS, 2003 and 2007 (Anamuah-Mansah, Mereku, & Ghartey-Ampiah, 2008).

Ghanaian JHS 1 students performed better in the content domain in Mathematics in TIMSS 2007 than in TIMSS 2003, even though their average scores were less than the International average scores in TIMSS 2007 and TIMSS 2003. According to Fredua-Kwarteng (2005), Ghana's poor performance in TIMSS 2003 and TIMSS 2007 could be attributed to the differences in pedagogical orientations. This is because Mathematics teaching at JHS is characterized by the transmission and command models where students are not encouraged to pose questions or engage in problem-solving activities in order to attain both conceptual and procedural understanding of what they are being taught.

Thus, the recurring student failures in problem-solving tests warrant investigations into the problem-solving techniques of Ghanaian students. This study sought to investigate problem-solving skills among JHS 1 students in word problems in Mathematics (fractions, perimeter and area) using Newman's (1977, 1983) Error Analysis Model (NEA) to capture the holistic information on how JHS1 students go through the five hurdles of Reading (or decoding), Comprehension, Transformation, Process Skills, and Encoding when solving word problems in Mathematics.

Conceptual Framework

The study was based on Newman's (1977, 1983) Error Analysis Model' (NEA model). The model allows researchers to identify and analyze students' errors made when solving word problems in order to know the extent to which students can solve word problems in Mathematics. Newman's' five fixed sequence as shown in Figure 1 includes: Reading (or Decoding), Comprehension, Transformation (or Mathematizing), Process Skills, and Encoding.



The first stage of the sequence is *Reading*. It is concerned with the student actually decoding the question. This is concerned with the student recognizing the words or symbols within the question. The second stage of the diagnostic procedure is *Comprehension*. Thus, once the student has decoded (or read) the words or symbols, he or she needs to understand the question in terms of general understanding related to the mathematical topic and specific mathematical concepts and symbols as well as the demands of the question. The third stage is the *Transformation*, which demands that the student indicate how she or he is going to solve the question. The student needs to choose an appropriate process or algorithm to solve the problem. The fourth stage is the *Process Skills*. The student should accurately do the operation(s) he or she has selected at the transformation stage. The fifth stage of the procedure is *Encoding*. The student should relate his or her answer back to the original question to record the answer in an appropriate written form.

Research Questions

In order to answer the four research questions, a conceptual framework of Newman's Error Analysis (1977, 1983) model was adapted. The ideas in this model were used because they enable the researchers to explore problems students encounter and errors they make when solving word problems in Mathematics. The questions framed are the following:

1. To what extent can JHS 1 students read word-problems on fractions, perimeter and area in Mathematics?
2. To what extent can JHS 1 students comprehend word-problems on fractions, perimeter and area in Mathematics?
3. What errors do JHS 1 students make when solving word problems on fractions, perimeter and area in Mathematics?
4. To what extent can JHS 1 students solve word-problems on fractions, perimeter and area in Mathematics?

Methodology

Research Design

The research made use of descriptive survey to provide detailed description of errors students make when solving word-problems in Mathematics. This method was used to help the researchers ascertain the errors students make in solving mathematical word-problems among JHS 1 students in Akatsi South District in the Volta Region of Ghana.

Participants

The population of the study was 1,110 JHS 1 students in public basic schools in Akatsi South District in the Volta Region of Ghana. The sample comprised 112 students systematically selected using a 5% quota assigned to each basic seven class in the district. JHS 1 students were selected for the study because they were usually selected to represent Ghanaian students in TIMSS and other national and international assessments.

Measures

The instruments used for the study were an interview guide, and achievement test comprising four questions on word-problems in Mathematics (Fractions, perimeter and area). The questions were adapted from the students' Mathematics book 7 and were further validated by test-experts.

Data Collection

In the first week of February 2016, the researchers visited all the 41 public basic schools in the Akatsi South District with a letter to seek permission to carry out the study. The purpose of the visit was explained to the head teachers in order to prepare the school environment to cooperate with the researchers. The mode of sample selection was also explained to the head teachers to systematically select 5% of students in each basic seven class in their schools to be included in the sample for the study. In all, 112 students were selected to take part in the study.

On February 8, 2016, the researchers moved round the schools with a bus to convey the students to Akatsi College of Education campus. On arrival, the students were briefed after which they were divided into four groups and interviewed. During the interview each student was required to read the problems aloud to enable the researchers identify those students who could mention the concept correctly. Also, each student was asked to mention the topic and the specific concept the problem was testing. Immediately after the interview session, answer booklets and the question papers were given to all the students to solve the word-problems in Mathematics. After the examination the students were conveyed to their various homes. The answered scripts were later rated independently using a numerical scale to determine the extent to which the students could solve word-problems in Mathematics. The students' solutions were also analyzed using Newman's five fixed- sequence of error analysis.

Data transformation, encoding and analyses

In the analysis in relation to reading, a stroke (/) each was given a student who was able to read the problem and the concept names correctly (R) and a cross (x) was given to a student who read the problem but could not read the concept names correctly (R^1). In the analysis in relation to comprehension, a stroke (/) each was given to a student who was able to mention (have an idea of) the topic and the specific concept the question was testing (C) and a cross (x) was given to a student who could not mention (did not have an idea of) the topic and the specific concept the question was testing (C^1).

In the final analysis, a stroke (/) each was given to a student who was able to transform the problem (T), carry out the process skills (P) and encode the answer correctly (E) at each stage while a cross (x) each was given to a student who failed to transform the problem (T^1), failed to carry out process skills (P^1) and failed to encode the answer correctly (E^1) at each stage. In addition, students' solutions to the problems were scored independently using a numerical scale and the scores were later analyzed to determine the extent to which JHS 1 students could solve word problems in Mathematics. Data were then analyzed using percentages and frequency distribution tables. To be able to determine the extent to which students could solve word-problems in Mathematics, descriptive statistics (mean, mode, median and standard deviation) were used to determine the direction of performance. In addition, histogram and frequency polygon were used to determine the direction of performance.

Results

Research Question 1

To what extent can JHS 1 students read and comprehend word-problems in Mathematics?

Research Question 1 sought to find the extent to which JHS 1 students can read and comprehend word-problems in Mathematics in *Problem 1* which states:

"Jack and Joan bought a bar of chocolate. Jack ate $\frac{1}{2}$ of the chocolate and Joan also ate $\frac{1}{3}$ of the chocolate. What portion of the chocolate did they eat?"

As shown in Table 1, it was evident that 90 students representing 80.4% were able to read Problem 1 correctly but failed to pronounce the concept names correctly. Of the 112 testees, only 22 students representing approximately 20% read the problem and pronounced the concept names correctly.

Table 1: Percentage of students who could read and comprehend Problem 1

Level	Successful at level	Not Successful at level
Reading	R (%)	R^1(%)
	22 (19.6%)	90 (80.4%)
Comprehension	C (%)	C^1(%)
	95 (84.8%)	17(15.2%)

On the contrary, it was revealed that 95 students, constituting about 85% could mention the topic and the specific concept the question was testing. Only 17 students constituting about 15% could not mention the topic and the specific concept the question was testing.

Problem 2:

In a school of 250 students, $\frac{3}{5}$ are boys and the rest are girls. How many students are girls?

It was evident that 90 students representing about 80% were able to read Problem 2 correctly but failed to pronounce the concept name correctly (see Table 2). Out of the 112 students who took the test, 22 students, representing 19.6% read Problem 2 and pronounced the concept name correctly.

Table 2: Percentage of students who could read and comprehend Problem 2

Level	Successful at level	Not Successful at level
Reading	R (%)	R^1(%)
	22 (19.6%)	90 (80.4%)
Comprehension	C (%)	C^1(%)
	95 (84.8%)	17(15.2%)

With regards to comprehension, it was revealed that 95 students, constituting 84.8%, could mention the topic and the specific concept the question was testing. Only about 17 students constituting about 15% could not mention the topic and the specific concept the question was testing. This result was the same as the results of Problem 1 because the topic tested in both problems were the same and seem to be one-dimensional in ability.

Problem 3:

Mr. Azumah wants to build a rectangular fish pond that is 30 metres long and 5 metres wide. Find the total length of wire mesh that he can use to fence the entire fish pond.

As shown in Table 3, all the 112 students were able to read the problem correctly. However, 85 students, constituting about 76% could not mention the topic and the specific concept the question was testing.

Table 3: Percentage of students who could read and comprehend Problem 3

Level	Successful at level	Not Successful at level
Reading	R (%)	R^1(%)
	112 (100%)	-
Comprehension	C (%)	C^1(%)
	27(24.1%)	85(75.9%)

Only 27 students constituting approximately 24% could mention the topic and the specific concept the question was testing. This was due to the fact that most of the students said the question was on *area of a rectangle* instead of *the perimeter of the rectangle* and thus could not tell the demands of the question.

Problem 4:

A path is designed between two rectangular play grounds. The outer play ground is 70 metres long and 50 metres wide and the inner play ground is 50 metres long and 30 metres wide. Calculate the space occupied by the path.

Concerning Problem 4, all the 112 students, representing 100% were able to read the problem correctly. In the same vein, all 112 students, representing 100% were able to mention the topic and the specific concept the question was testing.

Research Question 2

What errors do JHS 1 students make when solving word-problems in Mathematics?

Problem 1:

Jack and Joan bought a bar of chocolate. Jack ate $\frac{1}{2}$ of the chocolate and Joan also ate $\frac{1}{3}$ of the chocolate. What portion of the chocolate did they eat?

As shown in Table 4, 98 students representing about 88%, were able to transform Problem 1. Only 14 students, constituting about 13%, could not transform the problem. At the stage of process skills, 67 students representing 59.8% could process the problem correctly while 45 students representing about 40% failed to process Problem 1. Even though, 98 students (87.5%) were able to transform the Problem 1, 66 (58.9%) were able to reach the final destination of encoding the answer correctly. This brought a deficiency gap of some 32 students, constituting about 32.6%, who even though were able to transform Problem 1, failed to follow through to the final destination of encoding.

Table 4: Percentage of students who could read and comprehend Problem 1

Level	Successful at level	Not Successful at level
Transformation	T (%)	T^1(%)
	98 (87.5%)	14 (12.5%)
Process Skills	P (%)	P^1 (%)
	67 (59.8%)	45 (40.2%)
Encoding	E (%)	E^1(%)
	66 (58.9%)	46 (41.1%)

Problem 2:

In a school, there are 250 students. Three-fifths ($\frac{3}{5}$) are boys and the rest are girls. How many students are girls?

As shown in Table 5, 83.9% of the students could not transform Problem 2, a sharp deviation from what was revealed in Problem 1. Only 18 students, constituting about 16%, were able to transform Problem 2.

Table 5: Percentage of students who could read and comprehend Problem 2

Level	Successful at level	Not Successful at level
Transformation	T (%)	T^1(%)
	18 (16.1%)	14 (12.5%)
Process Skills	P (%)	P^1 (%)
	3 (2.7%)	109 (97.3)
Encoding	E (%)	E^1(%)
	3 (2.7%)	109 (97.3)

Out of the 18 students who were able to transform Problem 2, 15 (83.3%) of them could neither process nor represent the final answer correctly in a written form.

Problem 3:
Mr. Azumah wants to build a rectangular fish pond that is 30metres long and 5 metres wide. Find the total length of wire mesh that he can use to fence the entire fish pond.

As shown in Table 6, of the 112 students, 75, representing about 67% could not transform Problem 3, a similar trend of what happen happened in Problem 2.

Table 6: Percentage of students who could read and comprehend Problem 3

Level	Successful at level	Not Successful at level
Transformation	T (%)	T^1(%)
	37 (33.0%)	75 (67.0%)
Process Skills	P (%)	P^1 (%)
	22 (19.6%)	90 (80.4%)
Encoding	E (%)	E^1(%)
	21 (18.8%)	91 (81.3%)

Even though 37 students representing 33.0% were able to transform Problem 3, 15 of them constituting about 40.5% were not able to process Problem 3. The majority of the students (81.3) could not encode the problem correctly.

Problem 4:
A path is designed between two rectangular play grounds. The outer play ground is 70 metres long and 50 metres wide and the inner

play ground is 50 metres long and 30 metres wide. Calculate the area of the path.

As shown in Table 7, 65 students representing about 58%, were able to process Problem 4. It was also clear that 47 students constituting about 42% were not able to process the problem. It was indeed revealing that out of the 65 students who were able to transform Problem 4, 60 (92.3%) of them could not process the problem. Out of the total sample, 98.2% could not encode the problem as well.

Table 7: Percentage of students who could read and comprehend Problem 4

Level	Successful at level	Not Successful at level
Transformation	T (%)	T^1(%)
	65 (58%)	47 (42%)
Process Skills	P (%)	P^1 (%)
	5 (4.5%)	107 (95.5%)
Encoding	E (%)	E^1(%)
	2 (1.8%)	110 (98.2%)

Research Question 3

To what extent can JHS 1 students solve word problems and represent the answer correctly in Mathematics?

Frequency distribution of the scores obtained by students in the group was discussed. 86 students, constituting 76.8% had scores below 10. Also 19 students representing 17.0%, had scores ranging from 10 to 14. Only seven students constituting 6.3%, had scores from 15 to 19 and no students, representing 0%, had scores from 20 to 24. The skewness of the obtained scores from the sample is presented in Figure 2.

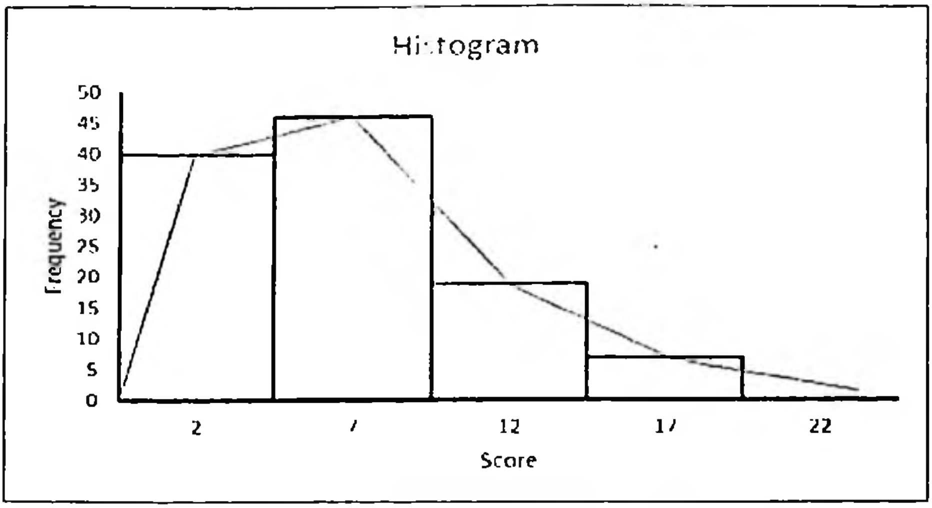


Figure 2: **A *distribution of Students' correct answers***

As indicated in Figure 2, students' performance on the achievement test is skewed to the right (positive skewness) indicating that the group performed very low in solving word-problems on fractions, perimeter and area in Mathematics. Furthermore, the group statistics indicated that mean (6.7) > median (6.2) > mode (5.4). This also confirmed that the majority of the students had scores below the mean indicating low performance in solving word-problems on fractions, perimeter and area in Mathematics. The high standard deviation of 23.5 indicated that the group is heterogeneous, hence, students performed at different or varying ability levels.

Discussion

From Tables 1, 2, 3 and 4 it was found that generally students were able to read the word problems in Mathematics but the majority of them could not read the concept names correctly. Our finding on reading was consistent with the study of Marinas and Clements (1990), Ellerton and Clements (1996) and Singhatat (1991), who found out that, reading (decoding) errors accounted for less than 5% of initial errors. However, our finding was not consistent with that of Trance (2013) who reported in his study that many students could not read the mathematical symbols included in his instruments. In our case, students were able to read similar symbols used.

It was revealing that most of the students were able to mention the topic and the specific concepts the problems were testing (comprehension) but this could not reflect very well in the transformation of the problems. This finding is consistent with that of Trance (2013) who reported in his study that most participants were able to identify the topics and concepts related to the questions. However, they relatively failed to convert this knowledge when highly needed at the transformation stage.

Our findings on comprehension contradicted the findings of Marinas and Clements (1990), Singhatat (1991), Ellerton and Clements (1996), and Clements (1980) who reported that approximately 70% of errors made by Grade-7 (12-13 year olds) students on Mathematical questions were at the comprehension level. These differences might have arisen owing the to the level of difficulty of the items on the tests.

From Tables 5, 6 and 7, it was evident that on the average students had difficulty in transforming word-problems in Mathematics. Indeed, out of a total number of 448 cases in transformation involving 112 students, 230 cases, representing 51.3%, could not transform the word-problems in Mathematics which was supposed to be the first stage in the process of finding solution to the word-problems. Only 218 cases, representing about 48.7% successfully transformed the word problems.

In fact, only 97 cases out of 448 cases representing about 21.7% were able to process the word problems. Indeed, 351 cases out of 448 cases representing about 78.3% failed to process the word-problems. In addition, it was found out that 356 cases out of 448 cases representing about 79.5%, failed to encode the final answer correctly. Furthermore, out of the total number of 448 cases of transformation involving 112 students, only 218 cases, representing about 48.7%, successfully transformed the word-problems. Out of the 218 cases of successful transformation, 121 cases, representing about 55.5%, were not able to reach the process skills stage. Only 97 cases out of 218 cases, representing about 44.5% were able to reach the process skill stage.

Moreover, out of the 97 cases, of processing, only 5 cases, representing about 5.2% failed to encode the answer correctly. These findings were in agreement with the findings of Marinas and Clements (1990), Singhatat (1991) and Ellerton and Clements (1996) who reported that approximately 70% of errors made by JHS 1 students on Mathematical questions were at the transformation levels. It was also consistent with the findings of Trance (2013) who also reported in his study that high proportion of errors made on the transformation stage accounted for almost 50% of the total number of errors committed with at least 45% of students' errors committed on the transformation stage. It was also in line with Clements (1980) who analyzed 6,595 errors made by 634 students using Newman Error Analysis model and found that 70% of errors belonged to transformation category. The Mathematics procedure level of process skills registered 25% and encoding accounted for about 5%. As shown in Figure 1 and the analyses for Research Question 3, the students performed very low (the group performance was positively skewed) in solving word-problems in Mathematics on topics such as fractions, perimeter and area.

Conclusions

As in the case of empirical studies, only some of our findings add to the contextual and theoretical understandings in the area and that caution is required when considering generalizations to other situations. That having been said, we proceed on some findings that we think are of particular significance in the area of Mathematics teaching and learning. To provide the necessary background, the study explored problem solving skills among Junior High School Grade 1 Students in Mathematics at Akatsi South District, Ghana.

To conclude, this study has revealed the strengths and weakness of JHS 1 students in solving word-problems in Mathematics. The findings show that most of the students were able to read the word-problems in Mathematics but a majority of them could not read the concept names correctly. Again, the majority of the students could not solve the word-problems in Mathematics (fractions, perimeter and area) correctly with regards to transformation, processing and encoding. These challenges that the students are facing could be as a result of the weaknesses in the teaching and learning processes in Ghanaian classrooms.

Recommendations

Based on the findings and conclusions, the following recommendations are made:

1. The Institute of Education in collaboration with the Ministry of Education should include problem-solving skills in

Mathematics as a course in the curriculum of Colleges of Education to equip teacher trainees with problem-solving skills and strategies in order to teach problem-solving in the basic schools in Ghana.

2. The Ministry of Education in collaboration with Ghana Education Service and other stakeholders in education should organise in-service training programmes for teachers already on the field on problem-solving skills in order to equip them with the skills and strategies needed to enforce teaching and learning of Mathematics using problem-solving.

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