ANALYSIS OF LEARNER PERFORMANCE ON CONTEXTUAL WORD-PROBLEMS IN MATHEMATICS EXAMINATIONS.

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Abstract

This study sought to analyse learner performance on contextual word-problems in mathematics examinations. The study was guided by the following objectives: (1) To assess learner performance on contextual word-problems in mathematics examinations; (2)To investigate what learners attribute their performance to on contextual word-problems in mathematics examinations and; (3) To assess learner ability to respond to contextual word-problems in mathematics examinations. It was carried out with 150 learners from three schools in Ndola district of the Copperbelt Province in Zambia and 5 School Certificate mathematics examiners accredited by the Examinations Council of Zambia. The mixed methods design was used. A questionnaire with 20 items and two different tests, a contextual word-problem test and a non-contextual word problem test both with 10 items were administered to the learner participants. The School Certificate Examiners answered a questionnaire. Descriptive and thematic analyses were used for qualitative data while quantitative data was analysed through the use of statistical package for social sciences where paired samples t-tests were employed. Additionally, the data received from the two questionnaires was analysed by Relative Importance Index (RII) method by using MS excel to determine the important factors affecting learner performance on contextual word-problems in mathematics examinations. The study concluded that: (i) learner performance on contextual word-problems was poor compared to learner performance on non-contextual (word) problem; (ii) contextual word-problems are difficult for both the learner and educator; (iii) non-contextual (word) problems and contextual word-problems scores are significantly positive correlated (r = .808). The following recommendations were made: (i) mathematics educators and examination setters to consider students cultural and learning backgrounds in choosing instructional strategies to use when teaching contextual word-problems; (ii) educators should invest more time in teaching learners the mathematical structure and mathematical language; (iii) a study to be undertaken to determine whether there is any relationship between teaching more in context and how learners perform in contextual word-problems.

Keywords: Learner performance; contextual word-problems; mathematics; examinations.

Introduction

Mathematics contributed greatly to the advancement of science and technology. As an important subject on the Zambian School curriculum, mathematics is one of the core subjects in all the options for both the academic as well as the practical career pathways (Ministry of Education, Science, Vocational Training and Early Education "O" Level Mathematics Syllabus (MESVTEE): 2013)[1]. The Zambian "O" level syllabus points out that, "mathematics fosters the development and improvement of learners' intellectual competence in logical

reasoning, spatial visualization, analysis and abstract thought" (MESVTEE: 2013)[2].Mathematics equips learners to live in the age of Science and technology and enable them to contribute to social and economic development of the country (MESVTEE): 2013)[3]. However, learner performance in mathematics and especially on contextual word problems is poor.

Kitta, (2004)[4] defines mathematics as the language that helps us to describe ideas and relationships drawn from the environment making the invisible to be visible, thereby solving problems that would otherwise be impossible. Department of Education (2006: 19)[5] emphasizes that "tasks and activities should be placed within a broad context, ranging from the personal, home, school, business, community, local and global". This is also true for the Zambian Mathematics Curriculum as indicated by the examination syllabus which states that learners shall be tested against the following objectives "express word problems into mathematical terms and apply appropriate techniques of solutions; apply mathematical concepts and skills in various situations, including daily life; recognize and apply relationships in two-and-three dimension shapes." (Examinations Council of Zambia: 2016:80)[6]. The Zambian "O" level syllabus stresses that, "the teaching of Ordinary Level Mathematics should expose learners to practical applications of mathematics in everyday life; Learners should be exposed to do more of practical work as much as necessary through contextual reference to the local environment" (Curriculum Development Centre: 2013)[7].Contextual word-problems to be used in the learning and teaching as well as assessment should include social, political, environmental, economic, health, cultural, and scientific issues, whenever possible.

Contextual word problems are problems which the problem situation is experientially real to the learners (Gravemeijer&Doorman, 1999)[8].These problems are formulated in a particular context which demands the respondent to understand the context and apply appropriate mathematical knowledge to solve the problem. Lave (1988)[9] suggested that the specific context within which the mathematical task is situated is capable of determining not only general performance but also a choice of mathematical procedure. Contextual word-problems test the higher level of the blooms cognitive domain. At the higher levels of the cognitive domain learners go beyond memorization and understanding and engage in higher order thinking like critical thinking and problem-solving (Teachers" Curriculum Implementation Guide, 14:2013)[10]. It is this higher order thinking that leads to deep learning as well as development of competences in learners. Relating mathematics to the context of everyday situation has been highlighted as one of the general objectives of teaching and learning of mathematics at both primary and secondary school level (TCIG;12; 2013)[11].

Contextual word problems emphasise the dynamic, active nature of mathematics and the way mathematics enables learners to make sense of their world. Contextual word-problems are designed to stimulate

mathematical thinking and promote discussion among learners in a mathematics class. Learners are encouraged to explore mathematical relationships, develop and explain their own reasoning and strategies for solving problems. Approaches to contextual word-problems are not straight forward where the respondent can recall a formula or equation and substitute the values to arrive at the answer (Sasman, 2010)[12]. The respondent is expected to know and understand the context of the question and the mathematical concept embedded in the question. Sometimes deductions and contextual analysis are made about the question before solving it.

Contextual word-problems are presented using grammatical sentences, rather than mathematical symbols. The intention behind the use of contextual word-problems is to support the reinvention process which enables learners to understand formal mathematics using experientially-real problem situations. In realistic mathematics education, contexts, models and representations play an important role in the educational process (Hoogland, Pepin, Koning, Bakker, & Gravemeijer, 2016)[13]. The central idea in Realistic Mathematics Education is that learners should be supported in reinventing mathematics with the support of the teacher and the curriculum materials (e.g. textbook). Hoogland et al go on to say that the starting points of such reinvention processes should be experientially real for the learners: Problems situated in every-day life contexts often fulfil this requirement. Hence in RME, situations from real life are not just used to prepare learners for solving applied problems but to offer a conceptual basis for reinventing the mathematics the learners are to learn.

Contextual word-problems are often seen as a way to bridge the gap between real life and the mathematics that is learnt in the classroom. However, learners across the world often perform poorly in mathematics tests and examinations on questions that involve contextual word-problem (TI-AIE: Reading, writing and modelling mathematics: word problems: 200X, 200Y The Open University)[14]. This may also be true for the Zambian setup. This is because learners seldom think realistically when applying real-world knowledge to mathematics contextual word-problems. In fact, many studies on learners' behaviour in solving contextual word-problems report that the steps of understanding the situation are often superficially executed by the learners (Verschaffel, Greer, & De Corte, 2000). Learners often display what seems to be a suspension of common sense, when solving mathematics contextual word-problems (Schoenfeld, 1991)[16]. More often than not, learners write non-realistic and logically inconsistent answers when attempting to solve contextual word-problems. The major reason for the difficulty experienced by learners with regards to contextual word-problems might be that real-life problems are inappropriately mathematized in the process of their conversion into contextual word-problems. This results in learners failing to identify the link between real-life problems and contextual word-problems. Consequently, learners fail to solve contextual word problems at various stages of problem solving.

Contextual word-problems are among the most difficult kinds of problems that mathematics learners encounter. Solving contextual word-problems is complex as the complete process involves a number of phases (Niss 2015)[17]. Learners have difficulty solving contextual word-problems; (Verschaffel, Schukajlow, Star & Van Dooren, 2020; Amen, 2006;)[18]. A number of reasons have been proposed as to why learners have difficulty solving contextual word-problems: limited experience with word-problems (Bailey, 2002)[19], Learners lack motivation to solve contextual word-problems (Hart,1996)[20], irrelevance of contextual word-problems to learners' lives (Ensign, 1997)[21].

In view of the forgoing highlighted concerns above, the study sought to assess learner performance on contextual word-problems in mathematics examinations, to investigate what learners attribute their performance to on contextual word-problems in mathematic examinations and to assess learner ability to respond to contextual word-problems in mathematics examinations.

METHODOLOGY

Research Design and Approach

The study employed a mixed methods research design because it combines elements of qualitative and quantitative research approaches (e.g use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration (Johnson, Onwuegbuzie, & Turner, 2007)[22]. This research design was used because it helped expand and strengthen the conclusions of the current study. The use of the mixed methods research design also contributed to answering the research questions effectively. Quantitative approach helped to quantify the problem by way of generating numerical data or data from the field and transform them into useable statistics. Qualitative approach helped to study attitudes, opinions, behaviours, and other defined variables of the population.

Area of study

This study was based on learner performance on contextual word problems in mathematics examinations in Ndola district. Ndola district is the provincial capital of the Copperbelt province of Zambia. Ndola district was selected to be an area of study for this title due to the fact that there was no study done on learner performance on contextual word problems in mathematics examinations in this district. Secondly, a variety of secondary schools in Ndola district ranging from government, grant aided, community and private ones were sources of comprehensive amounts of information for the study.

Population and sampling

Participants

Participants comprised 150 twelfth-grade learners and 5 grade 12 mathematics examiners. All the grade 12 examiners who took part in the study were mathematics educators. The grade 12 examiners comprised one female and four males. The 150 learners included 74 boys and 76 girls from three different secondary schools situated in Ndola district. The examiners are all serving educators in government schools with varying teaching experience. The language of instruction in all the three schools is English. All the learners who took part in this study had different mother tongues but the most common Zambian language spoken in Ndola district is iciBemba.

The population, the data sampling, and the choice of instruments were purposively chosen to suit the study. The population for the qualitative aspect of the research is all the contextual word-problems included in the contextual word-problem test and the results obtained from the two questionnaires. The two tests, the two questionnaires, marking keys, documents that contain learner performances together with mathematics past examination papers from 2016 to 2019 were collected and analysed. The period from 2016 -2019 has been chosen because the previous Content Based syllabus was last examined in 2015 and the first examination for the current Outcome Based Syllabus was written in 2016.

The population for the quantitative aspect of the research is all the marks obtained by the 150 learners on the non-contextual (word) problems test and the contextual word-problems test. The learners' performances in the two tests were compared and possible interrelationships between their achievement and the given contextual word-problems were explored.

Sampling techniques

Sampling techniques refers to the process of selecting a sample such as participants from the population of interests so that the results gained by these participants can be fairly generalized to the population from which they were chosen (Nicholas, 2003)[23]. Purposive sampling, a non-probability sampling technique was used in this research. Purposive sampling also known as judgmental, selective or subjective sampling technique is a flexible method that meets multiple needs and interests. Purposive sampling means that respondents are chosen on the basis of their knowledge of the information desired (Calderon, 1993)[24]. Purposive sampling was also used in choosing the schools, the grade twelve examiners and the documents.

Instrumentation and data collection techniques

Luborsky (2017) believed that data collection techniques/methods are the accurate and systematic way of data collection critical to conduct scientific research. Instruments for data collection allow the researcher to collect

information that is needed to be collected about the research topic. Depending on the research type, methods of data collection include; documents review, observation, questioning, measuring, or a combination of different methods.

The study used both primary and secondary written sources of data. Primary sources of data are original records of events and experiences, as seen through the eyes of and as interpreted by the researcher. Primary sources of data allowed the researcher to be as close as possible to what actually happened. Primary sources of data that were used in this research include mathematics non-contextual (word) problem test, mathematics contextual word problem test, information obtained through the questionnaire, and the marking keys for the two tests.

Secondary sources of data are derived sources written by people who did not experience the event first hand. Secondary data sources can also be defined as existing data collected at an earlier time by a different person who had a different purpose (Johnson & Christensen, 2011)[25] for example, examination reports. Secondary sources of data that were used in this research included official documents, such as past examination question papers, past examination question papers and marking keys, mathematics curriculum guides, teacher's curriculum implementation guide, and examination reports.

Data Collection Instruments

The researcher applied both primary and secondary data collection instruments for this study. Primary data were collected through the two tests, learner questionnaire and educator questionnaire while secondary data were through documentary review. Most of the secondary data were obtained from relevant documents such as examiners reports, ECZ annual reports and many more. More than one instrument was used for this study because total dependence on one instrument may distort or may lead to biasness on a particular piece of information, (Kothari, 2000)[26].

Research design

All the learners were asked to complete two tests; a non-contextual (word) problems test, a contextual word-problem test and a questionnaire on what they attribute their performance on contextual word problems to. The grade 12 examiners were equally asked to complete a questionnaire which was different from that completed by the learners. Documents that document learner performance in mathematics in Zambia were also analysed.

Mathematics Contextual Word Problems Test

Learner performance on contextual word problem solving was measured with a contextual word problem test containing 10 items. These contextual word-problems were created with a standard that is exactly the same as

those posed in grade 12 examination papers set and administered by the Examinations Council of Zambia. The learners had exactly two hours in which to complete the contextual word-problem test. The mark allocation per question followed exactly that of the Examinations Council of Zambia. The number of words, irrelevant information, and implicit information, the use of realistic considerations, the required problem-solving steps and arithmetic operations were all noted in order to investigate contextual word-problem characteristics that may influence contextual word-problem difficulty level. SPSS version 23 was used to analyse the results of the test.

Mathematics Non-Contextual (Word) Problems Test

Learner performance on non-contextual (word) problem solving was measured with a non-contextual (word) problem test containing 10 items. These non-contextual (word) problems were created with a standard that is exactly the same as those posed in grade 12 examination papers set and administered by the Examinations Council of Zambia. The learners had exactly two hours in which to complete the non-contextual (word) problem test. The mark allocation per question followed exactly that of the Examinations Council of Zambia. SPSS version 23 was used to analyse the results of the test.

Questionnaires

Questionnaire was chosen as one of the tool to be used in this study. Two questionnaires were developed; one for the learners and the other for the grade 12 examiners. The questionnaires were answered by grade 12 examiners and all the grade 12 learners who took part in this study. It was chosen because of the nature of this study so as to get opinion and views of the respondents. Respondents replied them on their own free will without any influence from another person; they were easy to be administered within a short time. Moreover its results could easily be tabulated and interpreted (Calderon & Gonzales, 1993)[27]. The questionnaires used are found in the appendices in this study.

Documentary Review

Documentary research is the use of outside sources, documents, to support the viewpoint or argument of an academic work (Omari, 2011)[28]. The researcher made review on the following documents: Mathematics examiners report, TCIG, mathematics past examination question papers from 2016 to 2019, mathematics marking keys, mathematics syllabus, Curriculum Framework and ECZ annual reports.

RESULTS AND DISCUSSION

Table 1: Statistics of Non-Contextual (Word) Problem Test and Contextual Word-Problem Test

	Non-Contextual (Word) Problem Test	Contextual Word-Problem Test
Mean	33.57	21.01
Median	31	18

Mode	40	16
Range	84	70
Minimum	2	0
Maximum	86	70

Table 12 above shows that 86% was the highest mark obtained by the learners in test one and the lowest being 2%; while in test two the highest mark was 70% and the lowest was 0%. The range for test one according to the table is 84 while for test two it is 70. The mean mark for test one was 33.57 while for test two it was 21.01. The median mark for test one was 31 while the median mark for test two was 18%. The medal mark for test one was 40 while the medal mark for test two was 16%.

Paired Samples T-Test Results and Analysis

Table 1: Paired Samples T-Test Results and Analysis of Non-Contextual (Word) Problem Test and Contextual Word-Problem Test.

		Mean	**Standard deviation**
Pair 1	Non-Contextual (Word) Problem Test	33.57	20.114
	Contextual Word-Problem Test	21.01	14.527

From table 13, the mean mark of Non-Contextual (Word) Problem Test (Test 1) is 33.57 while the mean mark of Contextual-Word Problem Test (Test 2) is 21.01. This shows that learners had a better average mark in Non-Contextual (Word) Problem Test compared to Contextual Word-Problem Test (test 2). The standard deviation of Non-Contextual (Word) Problem Test is 20.114 and that of Contextual Word-Problem Test is 14.527. This implies that there was more variability in marks in Non-Contextual (Word) Problem Test compared to Contextual Word-Problem Test and this can be clearly illustrated by the box and whisker plots below.

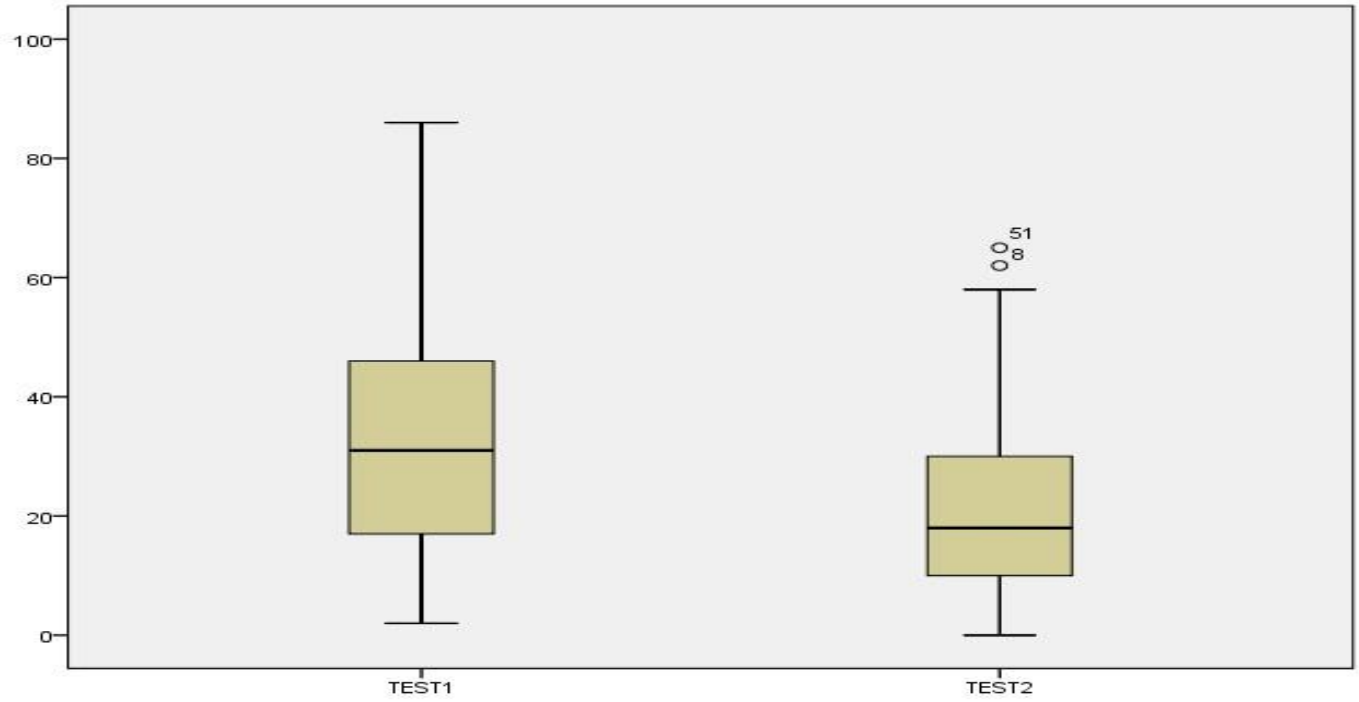

Figure 1: Box Plot of Learners' Performance on Non-Contextual (Word) Problem (Test 1) and Contextual (Word) Problem (Test 2)

It can be seen from the box plot above that the centre of Test 1 scores is much higher than the centre of Test 2 scores, and that there is slightly more spread in Test 1 scores than in Test 2 scores.

Paired Samples Correlations

TABLE 3: Paired Samples Correlations of Non-Contextual (Word) Problem and Contextual Word-Problem

	Correlation	**Sig.**
Pair Non-Contextual (Word) Problem Test & Contextual Word-Problem Test	0.808	0.000

The paired samples correlations shows that Non-Contextual (Word) Problem and Contextual Word-Problem scores are significantly positive correlated (r = .808).

Pearson's Correlations

Table 4: Pearson's Correlations of Non-Contextual (Word) Problem and Contextual Word-Problem

		Non-Contextual (Word) Problem	Contextual Word-Problem
Non-Contextual	Pearson Correlation	1	0.811**

(Word) Problem			
	Sig.(2-tailed)		0.000
Contextual Word-Problem	Pearson Correlation	0.811**	1
	Sig. (2-tailed)	0.000	

Based on the results from table 15, the following can be stated: Non-Contextual (Word) Problem Test and Contextual Word-Problem Test scores have a statistically significant linear relationship ($r = 0.811$, $p < 0.001$). The direction of the relationship is positive (i.e., Contextual (Word) Problem Test and Contextual Test scores are positively correlated), meaning that these variables tend to increase together (i.e., greater Non-Contextual (Word) Problem Test score is associated with greater Contextual Word-Problem Test score). The strength of the association is approximately large $0.5 < |r|$

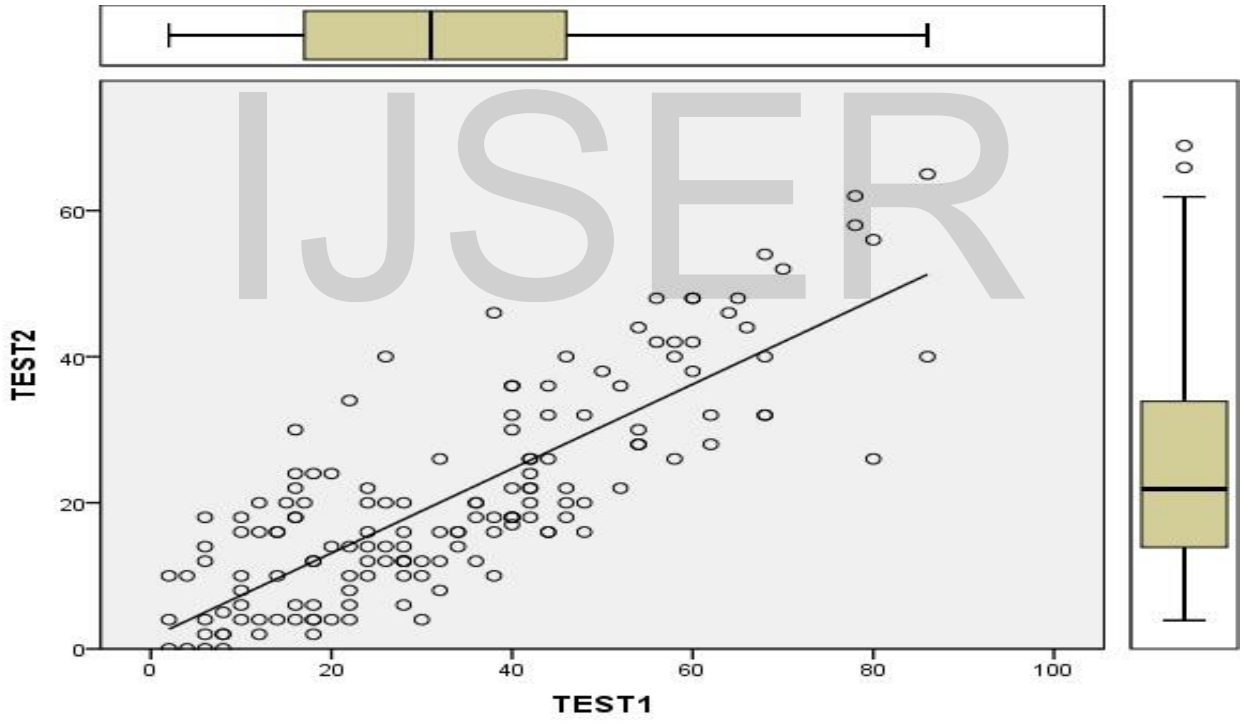

Figure 3: Scatter Plot of Learners' Performance in Non-Contextual (Word) Problem Test (Test 1) and Contextual Word-Problem Test (Test 2).

The scatter plot above shows that there is a strong positive correlation between the results obtained in Non-Contextual (Word) Problem Test (test 1) and those obtained in Contextual Word-Problem Test (test 2).

T-Test Pairs= Non-Contextual (Word) Problem Test with Contextual Word-Problem Test

Table 5: T-Test Pairs=Non-Contextual (Word) Problem Test with Contextual Word-Problem Test (Paired)/Criteria=CI (.9500).

	Mean	Std Deviation	Std Error Mean	95% confidence interval of the difference		t	df	Sig(2tailed)
				Lower	Upper			
Pair 1Non-Contextual word Test & Contextual word Test	12.553	11.986	0.979	10.619	14.487	12.8	149	.000

Based on the results presented in table 16, the following Decisions and conclusions of paired t-Test were made: Non-Contextual (Word) Problem and Contextual Word-Problem Test scores were strongly and positively correlated ($r = 0.808$, $p < 0.001$). There was a significant average difference between Non-Contextual (Word) Problem and Contextual Word-Problem scores ($t_{150} = 12.8$, $p < 0.001$). On average, Non-Contextual (Word) Problem scores were 12.553 points higher than Contextual Word-Problem Test scores (95% CI [10.619, 14.487]).

Learner performance on non-contextual (word) problems test interpreted using the examinations council of Zambia grading system.

Table 6: Learner Performance on Non - Contextual (word) Problems (Test 1) Interpreted According to ECZ Grading System

Range	Standard	Grade	Frequency	Percent
75-100	Distinction	1	5	3.3
70-74	Distinction	2	3	2.0
65-69	Merit	3	6	4.0
60-64	Merit	4	7	4.7
55-59	Credit	5	5	3.3
50-54	Credit	6	6	4.0
45-49	Satisfactory	7	7	4.7
40-44	Satisfactory	8	21	14.0
0-39	Unsatisfactory	9	90	60.0
Total			150	100.0

The table above shows that 5 learners got marks ranging from 75% to100% (distinction,) in the test which translates to 3.3%;3 learners got marks ranging from 70% to74% translating to 2.0%; 6 learners got 65%-69%

translating to 4.0%: 5 learners got marks from 60%-64% translating to 3.3%: 2 learners got marks ranging from 55% to 59% translating to 1.3%; 4 learners got marks ranging from 50% to54% translating to 2.7%; 7 learners got marks ranging from 45% to 49% translating to 4.7%; 21 learners got marks ranging from 40% to 44% translating to 14%; 90 learners got marks ranging from 0% to 39% translating to 60%.

Learner Performance on Contextual Word-Problems Test Interpreted using the Examinations Council of Zambia Grading System.

Table 7: Learner Performance on Contextual Word-Problems (Test 2) Interpreted According to ECZ Grading System

Range	Standard	Scale	Frequency	Percent
75-100	Distinction	1	0	0
70-74	Distinction	2	2	1.3
65-69	Merit	3	4	2.7
60-64	Merit	4	4	2.7
55-59	Credit	5	8	5.3
50-54	Credit	6	7	4.7
45-49	Satisfactory	7	3	2.0
40-44	Satisfactory	8	10	6.7
0-39	Unsatisfactory	9	112	74.7
Total			150	100

The table above shows that none of the learners got marks ranging from 75% to100% (distinction,) in the test which translates to 0%;2 learners got marks ranging from 70% to74% translating to 1.3%; 4 learners got 65%-69% translating to 2.7%: 4 learners got marks from 60%-64% translating to 2.7%: 8 learners got marks ranging from 55% to 59% translating to 5.3%; 7 learners got marks ranging from 50% to54% translating to 4.7%; 3 learners got marks ranging from 45% to 49% translating to 2.0%; 10 learners got marks ranging from 40% to 44% translating to 6.7%; 112 learners got marks ranging from 0% to 39% translating to 74.7%.

The Null Hypothesis Results

There is no statistically significant difference between the learners score on contextual word-problems and non-contextual (word) problems in mathematics examinations.

The level of significance α is the maximum probability for rejecting a null hypothesis. According to McMillan and Schumacher (2010)[29], the level of significance is used to indicate the probability of being wrong in

rejecting the null hypothesis. It is also known as the level of probability (p-level), and is expressed as a decimal that indicates how many times out of a hundred or a thousand one would be wrong in rejecting the null hypothesis assuming it is true. In other words, the level of significance tells one the probability of finding differences between the means. According to McMillan and Schumacher (2010)[30], the lower the level of significance, the more confident one is that it is safe to reject the null hypothesis. In this study, the calculated P- value was 0.000. From table 16, $\alpha = 0.05$, using the paired samples t-test for equality of means, we reject H_o since the P-value = $0.000 < 0.05$ and conclude that there was a significant difference in performance in non-contextual word-problems (test 1) and contextual word-problems (test 2). This means that there was a significant difference between the mean scores of Non-contextual (Word) problem test and that of contextual word-problems. Learners performed significantly better in Non-contextual (Word) problem (mean = 33.57) than in Contextual Word-Problem Test (mean = 21.01) as indicated in table in table 12. These results suggest that learner performance on contextual word-problems is generally poor compared to learner non-performance on non-contextual word-problems. Poor learner performance on contextual word-problems to some extent impacts negatively on the overall learner performance in mathematics examinations.

RELATIVE IMPORTANCE INDEX FOR LEARNER PERFORMANCE ON CONTEXTUAL WORD-PROBLEMS IN MATHEMATICS EXAMINATIONS.

The data received from the two questionnaires was analysed by Relative Importance Index (RII) method by using MS excel to determine the important factors affecting learner performance on contextual word-problems in mathematics examinations.

TABLE 8: LEARNER'S QUESTIONNAIRE ANALYSIS USING RELATIVE IMPORTANCE INDEX

	RELATIVE IMPORTANCE INDEX	IMPORTANCE
1. I enjoy solving contextual word-problems.	0.445	19
2. Contextual word-problems are hard to read.	0.495	17
3. Mathematics is not important in everyday life.	0.392	20
4. When I get stuck on a contextual word-problem, I stop working.	0.673	8
5. My teacher shows smartness, confidence and firmness in teaching contextual word-problems.	0.765	1
6. Contextual word-problems cause me to get frustrated	0.653	11
7. Contextual word-problems are too difficult for me.	0.675	7
8. I know and can use a variety of ways to solve a contextual word-problem.	0.533	15
9. Solving contextual word-problems betters my math.	0.719	4
10. Solving contextual word-problems helps boost my confidence in mathematics	0.737	2
11. I am good at solving contextual word-problems in mathematics.	0.495	17
12. Contextual word-problems teach me organisational skills.	0.719	4
13. After I study a topic in math and feel that I understand it, I have difficulty solving contextual word-problems on the same topic in examinations.	0.647	12
14. There is usually only one correct approach to solving a math contextual word-problem.	0.511	16

15. Solving contextual word-problems in math changes my ideas about how the world works.	0.703	6
16. No matter how much I prepare, I am still not confident when answering contextual word-problems in math examinations.	0.639	13
17. Nearly everyone is capable of understanding contextual word-problems in math if they work at it.	0.663	9
18. Being good at solving contextual word-problems in math examinations requires natural (i.e. innate, inborn) intelligence in math.	0.579	14
19 When I am solving a math problem, if I can see a formula that applies then I don't worry about the underlying concepts.	0.725	3
20. If I am stuck on a math contextual word-problem for more than five minutes, I give up or get help from someone else.	0.660	10

From table 8, it can be noted that "My teacher shows smartness, confidence and firmness in teaching contextual word-problems" ranked highest among all the factors. This in itself shows that learners have confidence in the manner in which educators handle contextual word-problems in mathematics. The importance of contextual word-problems was equally ranked highly by the learner participants. This is evident from the importance attached to the statements "Solving contextual word-problems helps boost my confidence in mathematics", "Contextual word-problems teach me organisational skills" and "Solving contextual word-problems in math changes my ideas about how the world works". Learner participants were fully aware of the benefits that contextual word-problems have in their school as well as out of school life.

"When I am solving a math problem, if I can see a formula that applies then I don't worry about the underlying concepts". This is one of the factors that have to do with solving mathematics which was ranked highly amongst the learner participants. This factor highlights the aspect of how mathematics word-problems are handled in mathematics classrooms to an extent. For as long as there is a formula that can be applied to solve the question, the learner must not worry about the underlying concepts.

The questionnaire item, "Mathematics is not important in everyday life" was given least importance by the learners. This can be attributed to the fact that learners know and understand that mathematics is very important in all aspects of life.

The other questionnaire item which was given least importance by the learner participants is "I enjoy solving contextual word-problems". This to a large extent suggests that a good number of learners do not enjoy solving contextual word-problems.

"Contextual word-problems are hard to read". This is another item that was ranked lowest. This item brings out the aspect of how language affects learner performance in mathematics. It also brings out the issue of the reading culture among our learners and the society at large. Reading needs to be promoted in the mathematics classrooms.

The other questionnaire items which were given less importance by the learner participants include: "I am good at solving contextual word-problems in mathematics" and "I know and can use a variety of ways to solve a contextual word-problem." A good number of the learner participants suggest that there are not good at solving contextual word-problems. This may be attributed to the fact that learners have limited strategies to use when working out contextual word-problems as indicated from the results obtained through the questionnaire.

EDUCATOR'S QUESTIONNAIRE ANALYSIS USING RELATIVE IMPORTANCE INDEX.

The educators questionnaire was analysed using relative importance index. Table 9 below provides the details of the results and interpreted immediately after the table itself.

Table 9: Educator's Questionnaire Analysis Using Relative Importance Index.

	RELATIVE IMPORTANCE INDEX	IMPORTANCE
1. Learners enjoy solving contextual word-problems.	0.440	19
2. Learner performance on contextual word-problems in examinations is generally poor	0.720	9
3. Learner performance on contextual word-problems is poor due to lack of understanding mathematical language and structure.	0.840	4
4. Learner performance on contextual word-problems in mathematics examinations is poor due to learners' lack of English proficiency.	0.720	9
5. Contextual word-problems are too difficult for learners.	0.560	15
6. Learners know and can use a variety of strategies to solve a contextual word-problem.	0.680	12
7. Contextual word-problem solving requires the learners' ability to read, process, and solve mathematical situations. This ability is usually not cultivated by educators in learners.	0.560	15
8. Solving contextual word problems helps learners to develop the skill of knowing when and how to apply classroom mathematical knowledge in their daily life problems.	0.880	2
9. Solving contextual word-problems helps boost learner's confidence in mathematics.	0.840	4
10. Solving contextual word-problems betters learners' math.	0.840	4
11. Contextual word-problems teach learners organisational skills.	0.840	4
12. Contextual word-problems equip learners with problem solving skills that are necessary for other subjects.	0.840	4
13. Contextual word-problems enable learners to make connections between classroom mathematical knowledge and knowledge from everyday life.	0.880	2
14. Being good at solving contextual word-problems in math examinations requires natural (i.e. innate, inborn) intelligence in math.	0.480	17
15. School mathematics has little to do with what learners experience in the real world.	0.400	20
16. Showing intermediate steps for a math contextual word-problem is not important as long as learners can find the correct answer.	0.480	17
17. Reasoning skills used to understand contextual word-problems in math can be helpful to	0.920	1

learners in everyday life.		
18. Most educators have a mastery of the subject matter especially in contextual word-problems.	0.600	14
19. Most educators do not explain contextual word-problem solving effectively.	0.720	9
20. Educators show smartness, confidence and firmness in teaching contextual word-problems.	0.640	13

Questionnaire items that dealt with the importance of solving contextual word-problems in mathematics where ranked highly by the educator participants. These questionnaire items according to the way the educator participants ranked them from the highest to the least include; "Reasoning skills used to understand contextual word-problems in math can be helpful to learners in everyday life", "Contextual word-problems enable learners to make connections between classroom mathematical knowledge and knowledge from everyday life", "Solving contextual word problems helps learners to develop the skill of knowing when and how to apply classroom mathematical knowledge in their daily life problems", "Solving contextual word-problems helps boost learner's confidence in mathematics".

The questionnaire items that talked about language were also highly ranked among the educator participants. The influence that language has on learner performance on contextual word-problems is great. Language in this research work can be viewed from two angles, that is, the language of mathematics and the language of teaching and learning. The language of teaching and learning in Zambian secondary schools is English which is different from the home language used by the learners. Learners use their home language during the learning and teaching of mathematics, and they participate in their mother tongue or home language. This leads to poor performance because the learners fail to read contextual word-problems with understanding during examinations. The literature confirmed that a significant factor that affects learners' performance in mathematics is the language of learning and teaching in the subject and the learners' home language. It is difficult for the learner to read the questions with understanding and interpret the questions in the correct way since the language used in the question paper is English. This leads to poor performance, because learners will give incorrect answers as they do not understand the language. The literature also confirms that when learners are taught in a language that is different from their mother tongue, learning becomes too difficult for them (Baker & Jones, 2011). The language of mathematics needs to be cultivated in learners by mathematics educators.

Questionnaire items talking about educator related factors in the teaching and learning of mathematical contextual word-problems were lowly ranked by the educator participants. Items like "Most educators have a mastery of the subject matter especially in contextual word-problems" and "Educators show smartness, confidence and firmness in teaching contextual word-problems". A number of educator participants are really not confident about their knowledge in as far as teaching contextual word-problems is concerned.

"School mathematics has little to do with what learners experience in the real world", "Learners enjoy solving contextual word-problems" and "Showing intermediate steps for a math contextual word-problem is not important as long as learners can find the correct answer" were the lowly ranked items. School mathematics has everything to do with what the learners experience in the real world. Mathematics is linked to all aspects of human life. Educators are fully aware that learners do not enjoy solving contextual word-problems in that they lack perseverance and motivation. Solving contextual word-problems involves multiple steps which require learners to show all the necessary steps. Showing intermediate steps calls for the learner to understand threshold concepts in mathematics. Lack of conceptual understanding is what makes learners to heavily rely on formulas. Over reliance on the part of the learners also reflect the way mathematics is taught in our schools.

Conclusions

Based on the findings, the study concluded that:

Learner performance on contextual word-problem in mathematics examinations is generally poor. The poor performance on contextual word-problems affects the overall performance in mathematics.

Learners attribute poor performance on contextual word-problems in mathematics examinations to; lack of confidence, lack of interest as these questions are hard to read, lack of perseverance, weak conceptual understanding, weak understanding of mathematical language and structure, limited experience with contextual word-problems, limited strategies to solve contextual word-problems, inadequate learner preparation to handle contextual word-problems in examinations by educators are not well prepared either in Colleges or Universities during teacher training to handle contextual word-problems.

The learners' ability to respond to contextual word-problems in mathematics examinations is poor. Contextual word-problem solving is complex and requires an understanding of threshold concepts. Learners have a weak conceptual understanding as well as a weak mathematical language. Contextual word-problems are difficult for both the learner and the educator. Contextual word-problems are hard for the educator to teach (mainly because of time constraints, lack of adequate resources and big class size) and difficult for learners to solve in mathematics examinations due to weak conceptual understanding, weak understanding of the mathematical language and structure. The learner participants said that: contextual word-problems are hard to read; a majority of them do not enjoy solving contextual word-problems; Contextual word-problems are too difficult for the majority of them as indicated in the data**.** The bigger section of the educator participants agreed with all the points raised by the learners but went state that contextual word-problems are not easy to teach.

Despite all that has been mentioned contextual word-problems help learners to form new mathematical models and to gain new experiences in mathematics. Contextual word-problems also provide a convenient atmosphere

for learners‟ language development, reasoning, mathematical development and mutual interaction. In this situation, the contextual word-problems also contribute to enable learners to transfer the formal mathematical knowledge and skills that they learn at school into their day to day lives. Contextual word-problems should therefore be used as the basis for teaching mathematical concepts so that children construct their own knowledge (Peterson, Fennema & Carpenter, 1989)[31].

RECOMMENDATIONS

The following recommendations arose from the research findings, discussions and conclusions drawn in this study.

Mathematics educators

The study recommends mathematics educators and examination setters to consider students cultural and learning backgrounds in choosing instructional strategies to use when teaching contextual word-problems. This will help to promote interest as well as motivate the learners to do better on contextual word-problems. If learners have interest and are motivated, they are likely to perform better on contextual word-problems in mathematics examinations leading to better performance in mathematics.

The study further recommends that mathematics educators should invest more time in teaching learners the mathematical structure and the mathematical language. Learner performance on contextual word-problems is poor owing to the fact that learners have a very weak understanding of the mathematical structure and the mathematical language. It is vital for mathematics educators to realise that there is no learning of mathematics without language. Educators should pay attention to the language of learning and teaching, the language of mathematics and the language used in the area where they are based so as to promote the learning of mathematics. If mathematics educators believe what Durkin says, there is no learning of mathematics without language then special attention shall be paid to language. Durkin (1991)[32] quoted in Manual: the language of Maths suggests that “mathematics education begins in language, it advances and stumbles because of language, and its outcomes are often assessed in language”.

It is also highly recommended that more in-service seminars, trainings and workshops be provided for the educators focusing more on how to teach contextual word-problems in mathematics. This would enable the educators to align their instructional strategies to the learning preferences and capacities of the learners.

Teacher Training Institutions.

Educators having training in mathematics are seldom prepared to teach and assess mathematics in context (Giambalvo & Gattuso, 2008)[33]. Teacher training institutions need to intensify the preparation of pre-service educators for the teaching and assessing of mathematics in context. Teacher training should also be structured in a way that encourages and promotes conceptual understanding and not just computational skills in learners. Many serving educators do not have training in teaching and assessing mathematics in context (Giambalvo & Gattuso, 2008)[34] and this group of educators should continue being trained through CPDs.

Recommendations for further possible research

The focus of the study was on learner performance on contextual word problems in mathematics examinations. It would therefore be of interest to determine whether there is any relationship between teaching more in context and how learners perform in contextual word-problems.

A study can also be undertaken to determine the educators' beliefs and ability to teach and examine mathematical contextual word-problems.

Ethics approval and consent to participate

The ethical guidelines of the Copperbelt University were followed. Permissions were obtained from the Examinations Council of Zambia, the District Education Board Secretary and the three schools where the study was conducted.

To obtain the population of study, data collection and dissemination of the findings, the researcher was sensitive to research ethics and its values as outlined by the Coppperbelt University. Being sensitive to research ethics and its values helps to ensure that good image of research enterprise in the world to be maintained (Omari, 2011)[35]. The researcher obtained a permission letter to pursue research activity from the Copperbelt University. The letter from the Copperbelt University was then submitted to the District Education Board Secretary (DEBS) together with an application by the researcher seeking permission to conduct research in the schools within the district. The clearance letter from DEBS was issued to the researcher after 13 working days. The letter was in turn submitted to the Head teachers of the three schools were the study were conducted. These letters are found in the appendices of this work. The letter from the Copperbelt University was also submitted to the research department of the Examinations Council Zambia.

The freedom of participants was ensured by adhering to the principal of informed concert. This principal required the researcher to ensure that participants are aware of the purpose of the study so as to get their concern and participate freely. The statement of the research purpose, description of any potential risks or discomforts, description of potential benefits and the description of confidentiality were assured to the respondents.

List of abbreviations

CAPS	Curriculum and Assessment Policy Statement
CDC	Curriculum Development Centre
CPD	Continuing Professional Development
DEBS	District Education Board Secretary
ECZ	Examinations Council of Zambia
MESVTEE	Ministry of Education, Science, Vocational Training and Early Education
NCERT	National Council of Education Research and Training
OBE	Outcomes Based Education
RME	Realistic Mathematics Education
RII	Relative Importance Index
RWCF	Real-World Contextual Framing
TCIG	Teachers' Curriculum Implementation Guide
WNCP	Western and Northern Canadian Protocol for Collaboration in Education.

Data Availability

The data underlying the findings of the study can be accessed by contacting the authors of the article on the following links: [1] alexandernadzye@yahoo.com and [2] nkhatalp@gmail.com

Conflicts of Interest

"The author(s) of this research article ***Analysis of Learner Performance on Contextual Word-Problems in Examinations*** do hereby declare that there is no conflict of interest regarding the publication of this paper."

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Authors' contributions

AEN carried out the research and wrote the paper. NL supervised the entire work done in this research work and also helped with the editing, data analysis and structure of the theisis.

Supplementary Materials

The two questionnaires used to collect data with the responses per item.

References

Amen, J. (2006). Using Math Vocabulary Building to Increase Problem Solving Abilities in a 5th Grade Classroom. *Math in the Middle Institute Partnership Heaton Action Research Project*. Available at www.digitalcommons.unl.edu/mathmidactionresearch/ (Accessed 2021/02/17)

Bates, E. T. & Wiest, L. R. (2004). Impact of personalization of mathematical word problems on student performance. *Mathematics Educator, 14*(2), 17-26.

Blessman, J., Myszczak, B. (2001). Mathematics Vocabulary and its Effect on Student Comprehension. *Action Research Project*. www.eric.ed.gov

ÇİL, E1 & ÇEPNİ, S. (2014). The Association of Intended and Attained Curriculum in Science with Program for International Students Assessment. *International Education Studies;* Vol. 7, No. 9; 2014.Cambridge Assessment International Education. Getting started with Assessment for Learning. Available: www. Cambridgeinternational.org. Retrieved 2021/03/14

Curriculum Development Centre. (2013). Ministry of Education, Science, Vocational Training and Early Education: "O" Level Mathematics Syllabus (Grades 10 to 12). Zambia Education Publishing House. Lusaka.

Powell,S.R.,andFuchs,L.S.(2014).Does early algebraic reasoning differ as a function of students' difficulty with calculations versus word problems? *Learn. Disabil.Res.Pract.* 29, 106–116.doi:10.1111/ldrp.12037

Department of Education. (2006). Monitoring Evaluation Report on the Impact and Outcomes of the Education System on South Africa's Population: Evidence from Household Surveys. Pretoria: Department of Education.

Department of Education. (2014). Manual: The Language of Maths. Ermelo: Mpumalanga Provincial Education Department.

Examinations Council of Zambia, (2017).*Examinations performance report – General performance analysis*. Lusaka: ECZ

Examinations Council of Zambia, (2016).*Examinations performance report – General performance analysis*. Lusaka: ECZ

Examinations Council of Zambia, (2017).*Annual Report – General.* Lusaka: ECZ.

Examinations Council of Zambia. (2017).*School Certificate Examination Syllabus*. Lusaka: ECZ.

Goldberg, P. D. & Bush, W. S. (2003). Using metacognitive skills to improve 3rd graders' math problem solving. *Focus on Learning Problems in Mathematics*, 25(4), 36. https://www.questia.com/library/journal/1G1-117322859/using-metacognitive-skillstoimprove-3rd-graders

Gravemeijer, K.P.E., 1994, *Developing Realistic Mathematics Education,* Utrecht: Freudenthal Institute

Gravemeijer, K.P.E., 1999, "How emergent models may foster the constitution of formal mathematics", *Mathematical Thinking and Learning,* **1**(2), pp 155-177

Greer, B. (1997). Modelling reality in mathematics classrooms: The case of word problems. *Learning and Instruction,* 7(4), 293–307.

Hart, J. M. (1996). The effect of personalized word problems. *Teaching Children mathematics,* 2, (8), 504 – 505.

Heinze, K. *The Language of math.* Presentation handouts from TESOL conference. Retrieved from www.rtmsd.org/74411258318268/lib/74411258318268/Language of Math.doc

Hoogland, K., Pepin, B., Bakker, A., de Koning, J., & Gravemeijer, K. (2016). Representing contextual mathematical problems in descriptive or depictive form: Design of an instrument and validation of its uses. *Studies in Educational Evaluation,* 50, 22–32. doi:10.1016/j.stueduc.2016.06.005

Johnson. B. and Christensen. L. (2011). *Educational research: Quantitative, qualitative and mixed approaches* (4th ed). USA:Thousand Oaks, CA: SAGE Publications.

Johnson, R. B., Onwuegbuzie, A. J. & Turner, A. L. 2007. Toward a definition of mixed methods research. *Journal of Mixed Methods Research* 1:112-133.

Jones, I. & Ingris, M. (2015). *The problem of assessing problem: can comparative judgment help?* Published online: 29 May 2015. Springer Science + Business Media Dordrecht 2015.

Kitta, S. (2004). *Enhancing Mathematics Teachers' Pedagogical Content Knowledge and Skills in Tanzanina*. Print Partners- Ipskamp: Enschede.

Kothari, C. K. (2004). *Research Methodology; Methods and Techniques (2nd Edition).* New Age.

Lave, J. (1988) *Cognition in practice. Mind, mathematics and culture in everyday life,* New York, NY, Cambridge University Press.

Little, C. (2010) (in press). *The use of Real-World Contextual Framing in UK University Entrance, Level Mathematics examinations, PhD Thesis.* University of Southampton.

Lerman, S. (2001). Cultural, Discriptive Psychology: A Sociocultural Approach to Studying the Teaching and Learning of Mathematics. *Educational Studies in Mathematics* **46**, 87 – 113.

Lopez, C.L., and Sullivan, H.J. (1992). Effects of personalized math instruction for Hispanic students. *Contemporary Educational Psychology*, 16, 95-100.

Meyer, M., Dekker, T., and Querelle, N. (2001). Contexts in Mathematics Curriculum. *Mathematics Teaching in the Middle School*, *6*(9), 522–527.

Ministry of Education. (2013). *Teachers' Curriculum Implementation Guide*: *Guidance to enable teachers to make best use of the Zambia Education Curriculum Framework.* British Council: Lusaka.

Niss, M.(2015). Presciptive modeling-challenges and opportunities. In G.A. Stillman, W. Blum, & M. S. Biembengut (Eds). *Mathematical modeling in education research and practice, international perspectives on the teaching and learning of mathematical modeling* (pp. 67-79). Champ: Springer.

Noyes, A., Wake, G., Drake, P., & Murphy, R. (2011). *Evaluating Mathematics pathways final report. DfE Research Report* 143. London: Department for Education. In Jones, I. & Ingris, M. (2015). *The problem of assessing problem: can comparative judgment help?* Published online: 29 May 2015. Springer Science + Business Media Dordrecht 2015.

Omari, I. M. (2011). *Concept and Methods in Educational Research "A Practical Guide Based on Experience".* Dar es Salaam: Oxford University Press.

Onabanjo, C.F (2004). *A survey of some Behavioural and Attitudinal Factors Affecting Senior Secondary School Female Students' Mathematical Ability and Achievement*. A PhD Research Post-Field, Report, University of Ibadan.

Parvanehnezhad, Z. & Clarkson, P. C. (2008). *Iranian Bilingual Students' Reported Use of Language Switching When Doing Mathematics*. Mathematics Education Research Journal, 20(1), 52 – 81.

Puchalska, E. & Semadeni. (1987). Children's Reactions to Verbal Arithmetical Problems with Missing, Surplus or Contradictory Data. *For the learning of mathematics* (**7)** 3, 9 – 16.

Sasman, M. (2011). *Insights from NSC Mathematics examinations.* 17th Annual AMESA National Congress, 11 July 2011, Johannesburg, Gauteng. Volume 1.

Schoenfeld, A.H. (1991). On mathematics as sense making: An informal attack on the unfortunate divorce of formal and informal mathematics, In J.F. Voss, D. N. Perkins, and J.W. Segal (Eds.), *Informal reasoning and education*. Hillsdale, NJ: Erlbaum.

Seifi, M., Haghverdi, M, & Azizmohamadi, F. (2012) *Recognition of Students' Difficulties in Solving Mathematical Word Problems from the Viewpoint of Teachers*. Department of Education, Islamic Azad University, Arak Branch, Arak, Iran

Sepeng, P. & Sigola, S. (2013). Making sense of errors made by learners in mathematical word problem solving. *Mediterranean Journal of Social Sciences*, 4(13), 325-333. https://doi.org/10.5901/mjss.2013.v4n13p325

Sepeng, P. & Webb, P. (2012). Exploring mathematical discussion in word problem-solving. *Pythagoras*, 33(1), Art. #60. https://doi.org/10.4102/pythagoras.v33i1.60

Verschaffel, L., Greer, B., & De Corte, E. (Eds.) (2000). *Making sense of word problems*. Lisse, the Netherlands: Swets & Zeitlinger.

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