Relationship between Learners' Reading Comprehension, Arithmetic Skills and Ability to Solve Word-Problems: A Case of Secondary School in Nakuru County, Kenya

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Abstract: This study was about the relationship between Learners' Reading Comprehension, Arithmetic Skills and Ability to Solve Word-Problem in Nakuru County, Kenya. It used the descriptive and correlational designs. The population was 5183 secondary school learners in Naivasha sub-County. Through stratified sampling, a sample of 318 learners in Form II and 10 teachers of Mathematics was selected. Data was collected through a questionnaires, the Text Comprehension Skills Test (TCST) and the Arithmetic Skills Test (AST) and it was treated using descriptive statistics. Learners' arithmetic and reading proficiency were correlated using the Pearson product moment correlation coefficient. After the analysis and interpretation of data, the study concluded that learners and teachers faced some challenges in solving reading problems. The challenges were observed in the performance of the Text Comprehension Skills Test wherein the learners performed better in the arithmetic skills test than in the text comprehension skills test, which affects the arithmetic skills and ability to solve word-problems. Based on the conclusions, the study recommends that reading comprehension should be included in the Mathematics syllabus as an area of study in secondary schools. This will enable learners to perform better in word-problems at the Kenya Certificate of Secondary Education (KCSE). Similar study could be conducted in other counties in Kenya.

Keywords: Text comprehension; Reading Comprehension skills; arithmetic skills; word-problem.

Introduction

While learners' alarming decline in performance in Mathematics examinations has gained the attention of researchers and educators, researchers have linked Mathematics and reading comprehension skills as two important skills for learners' success in

all aspects of life (Salihu *et al.*, 2018). In Uganda, Ayebale *et al.* (2020) found that learners' low performance in Mathematics was influenced by many factors. Some of the factors were teachers' qualifications, knowledge for teaching, motivation level, methods of teaching Mathematics, learners' perceptions, attitudes, reading comprehension and parental influence. The 13th International Congress on Mathematics Education (ICME – 13) was held in Hamburg, Germany in 2016 and it focused on the way teachers could build learners' understanding mathematically as well as promoting logical reasoning (Maher *et al.*, 2018). When teachers work on learners' reading comprehension abilities, they strengthen their logical reasoning, which in turn strengthens their understanding in Mathematics. In Kenya, Koross *et al.* (2012) listed factors that effected learners' mathematical proficiency. Learners' behaviour upon arrival, the significance of grades, infrastructure and facilities, the absence of adequate human resources, the inadequate elucidation of mathematical ideas, and the degree of learners' reading comprehension were cited as factors.

According to Khoshaim (2020), problem-solving is an act of verbally describing situations in which one or more questions are raised and answered by employing Mathematical concepts. The ability to read has been considered by researchers as a mediator for learners' achievement in solving word-problems (Bullen *et al.*, 2020). Akin (2022) described reading comprehension as the most crucial determinant of learners' performance in Mathematics. Walkington *et al.* (2018) reported that reading comprehension is closely related to Mathematics because mathematical problems consider a wide range of reading domains.

Despite research evidence of learners' alarming decline in performance in Mathematics examinations and efforts by the government of Kenya to address the problem, learners' performance in the Kenya Certificate of Secondary Education (KCSE) has remained low. Karogo (2020) report shows that learners who sat the KCSE performed below the standard score of 50% in application problems. It was also reported that learners performed below the expected mean score of 50% in the questions in paper 1 and paper 2 that addressed real-life application problems written as text. According to Gomez *et al.* (2020), this is because the questions require reading and understanding what is required. Table 1 shows the average scores of learners who took the KCSE for the period 2016 to 2020.

Table 1: KCSE Data Reported by KNEC in 2020

Year	Paper	No. of Candidates	Maximum score	Mean score	Standard deviation
2016	1	570,398	100	23.74	21.24
	2		100	17.84	21.09
2017	1	609,525	100	24.49	22.03
	2		100	26.47	22.43
2018	1	658,904	100	24.07	21.16
	2		100	28.82	20.85
2019	1	694,445	100	31.00	24.04
	2	694,347	100	23.00	20.90
2020	1	742,796	100	22.27	19.41
	2	742,760	100	14.45	14.97

Data in Table 1 shows that learners' mean scores in paper 2 progressed from 17.84 in 2016 to 28.82 in 2018. The average scores of the learners dropped from 23.00 in 2019 to 14.45 in 2020. The KCSE report suggests that learners had some weaknesses in Geometry, Statistics, Transformation and real-life applications. The report emphasized the need for teachers to teach problem-solving by using examples from real-life experiences. Learners in Nakuru County have not performed as well as they should have in the last three years, especially on paper 1 and paper 2. The purpose of this study was therefore to establish the relationship between learners' reading comprehension and arithmetic and their ability to solve word-problems.

Literature
This section reviews relevant literature on the relationship between learners' ability to read and understand word-problems, and their ability to solve the problems.

Learners' ability to read with understanding and arithmetic skills in solving word-problems

Reading and understanding what has been read is vital to solving word-problems. According to Atkinson et al. (2017), learners can comprehend text from a global point of view through the schema reading theory. Dore et al. (2018) emphasized that learners' text comprehension depends on their prior knowledge, vocabulary and decoding skills. The ability of learners to solve word-problems is vital to how well they can read and understand the text (Munsod-Fernandez, 2021). Furthermore, learners need to strengthen their cognitive abilities through the Theory of Mind to have commanding control over their ideas and behaviours when solving word-problems (Devine et al., 2016; Devine & Hughes, 2016).

According to Boonen et al. (2016) and Daroczy et al. (2015), ability to easily understand what is required and having a clear mental picture of the problem at hand are both essential building blocks for solving word-problems. The mental visualization of word-problems and comprehending the text was reported by Kurshumlia and Vula (2021) and Vula et al. (2017) to be one of the successful ways for learners to solve word-problems.

An advanced level of conceptual knowledge and the ability to decode text is needed to solve word-problems by incorporating mathematical application principles presented in text form. Mathematical exercises in the form of word-problems are presented to learners in written form rather than in the usual Mathematical notation (Boonen et al., 2016). According to Kendeou et al. (2015), to comprehend a text, one must identify and connect the phonological (speech sounds), orthographic (spelling) and semantic (language) representations of words. The problem should be read, analysed, conceptualised, solved and evaluated in a Mathematics context. Reading the problem will employ the reading comprehension theory and reading concepts reported by Fuchs et al. (2017, 2020), Gomez et al. (2020). The analysis and conceptualisation of the problem are made possible as the result of what was read and understood.

Boonen et al. (2016) added that Mathematics educators should add reading comprehension to Realistic Mathematics Education (RME), which they consider as a fundamental aspect of developing learners' ability to solve word-problems. Research conducted in Kenya and published by Karogo et al.

(2020) found that 98.3% of learners did not meet the minimal standard score of 50% in Algebra and Geometry, 99.9% never obtained the 50% benchmark in English and 93.2% did not meet the reading comprehension standard score of 50%. The study took samples from 7,353 participants in 244 Secondary Schools in 30 counties and 109 sub-Counties in the 30 Counties in Kenya. The 7,353 participants included 5,877 Form II learners, 1,232 teachers and 244 principals. Imam (2016) in a study with 665 sample size and with a predictive research design discovered that the reading comprehension skills of getting the main idea and drawing a conclusion influenced learners' success in science and Mathematics in private institutions in the Philippines while noting details and making inference as a skill that influenced learners' success in public schools. The study also found correlations of reading comprehension to be 0.670, 0.596 for mathematics and 0.682 for science.

Text Comprehension and Arithmetic Skill

Word-problems are verbal and written texts presenting mathematical concepts in a real-life situations. It leads learners to answer more questions by applying mathematical concepts and operations. Learners' capacity to fully grasp the text and use that knowledge to solve word-problems is crucial. To comprehend the words in the word-problems is necessary but not sufficient because learners also need conceptualization skills to derive mathematical equations from the words. Word-problems, reading proficiency and numeracy were all areas of inquiry in a study by Pongsakdi et al. (2020). The study was carried out using qualitative methods and the participants were learners from elementary schools. A total of 891 Finnish fourth graders were identified on the basis of their level of comprehension skills. The levels identified were: a) learners who were poor at the text comprehension but good at arithmetic; b) learners who were good at text comprehension but bad at arithmetic; c) learners who were bad at both; and d) learners who were good at both. The hypothesis was that elementary school pupils would gain from training their capacity to comprehend and use text in solving word-problems. The ability to solve word-problems ability was shown to be significantly correlated with both Mathematical and reading skills. Results obtained from a longitudinal study done in Turkey by Özcan and Doğan (2018) with 185 participants demonstrated a substantial correlation between reading ability and capacity to solve word-problems.

Text comprehension as an important skill to solve word-problems

The skill of reading and comprehending mathematical notation is a prerequisite for success in any mathematical study. Khoshaim (2020) emphasized the significance of learners' text comprehension in determining how well they answer word-problems. Learners' ability to solve word-problems depends on their familiarity with and comprehension of the material. To fully absorb what they read, learners must first decode it into their minds, create a mental image and then write it down for a closer look (Fuchs *et al.*, 2015).

Learners in Tinderet sub-County in Kenya lacked Mathematical understanding, misunderstood operational terminology and were unable to develop proper mathematical expressions as reported by Ngeno (2020). The study urged mathematics teachers to assist learners improve their understanding of the subject matter. Mathematical and reading competences for teachers and learners in tackling word-problems were emphasized.

Methods

Design

The study used the descriptive and correlational designs. Descriptive design described variables under investigation (Siegle, 2015). The use of a correlational design, on the other hand, enabled the researchers to determine how learners' reading comprehension skills relate with their arithmetic skills in solving word-problems.

Population and Sampling

The target population of the study was 5183 secondary school learners in Naivasha sub-County in Nakuru County, Kenya. The location of the study was selected on the basis of consistent low performance of learners in Mathematics over the previous five years in the Kenya Certificate of Secondary Education (KCSE) administered nationally by the Kenya National Examinations Council (KNEC). Through the use of stratified sampling technique, a sample of 318 learners in Form II and 10 teachers of Mathematics was selected.

Instruments

Learners and Mathematics teachers' questionnaires, the Text Comprehension Skills Test (TCST) and the Arithmetic Skills Test (AST) were used to collect data. The study was piloted by randomly selecting 10% of the total sample. Cohen *et al.* (2018);

Creswell and Creswell (2018); Mugenda and Mugenda (2019) all agree that doing a pilot study aids in the development and refinement of the data collecting instruments. They also mentioned that for piloting purposes, a percentage of the research sample somewhere between 1% and 10% is ideal.

Validity and Reliability

Validating research instruments is important according to Creswell and Creswell (2018) and Creswell (2012) because it enables researchers to draw meaningful inferences from data collected. The instruments' validity creates a valid and meaningful link between the collected data and the variables of interest (Cohen *et al.*, 2018; Mugenda, & Mugenda, 2019). The instrument's content, construct and criterion were validated. Content validity was vital to this study because it allowed the researchers to test for the specific domain in the questionnaires and the Text Comprehension Skills Test (TCST) and Arithmetic Skills Test (AST). Piloting the instruments helped to ensure high level of validity and the appropriateness of the mechanics of language used.

The study used an internal consistency technique wherein a single test form was administered using the split-halves methods (Orodho *et al.*, 2016). Kuder-Richardson's method of rational equivalence was used to determine the internal consistency of the tools. The researchers applied the Kuder-Richardson correlation coefficient as appears below:
$KR_{20} = \frac{k(S^2 - \sum S^2)}{(k-1)S^2}$, wherein KR_{20} is the coefficient of

reliability of the internal consistency, K represents the count of indicators used to evaluate the idea, S^2 implies the squares of the variance of each item, $\sum S^2$ denotes the sum of the squares of variance of

all scores. The reliability coefficient of the instruments was α = 0.8977 which implies that the items correlated highly among themselves with high consistency (Cohen et al., 2018; Creswell & Creswell, 2018; Mugenda & Mugenda, 2019; Orodho et al., 2016) .

Statistical Treatment of Data

Data was analysed using Descriptive statistics. Learners' arithmetic and reading proficiency were correlated using the Pearson product moment correlation coefficient.

Ethical considerations

The researchers obtained all relevant legitimate documents before embarking on the study. A Permit from the National Commission of Science, Technology and Innovation (NACOSTI) was obtained. The County and sub-County educational offices issued separate letters to the researchers granting them final permission to access the schools.

Findings

This section presents the findings in tables, followed by a discussion of the results. Data was collected from four (4) male and six (6) female Mathematics teachers, 137 male learners and 181 female learners. The data shows the perspectives of teachers and learners on the reading comprehension and the way in which this has aided learners in solving word-problems. The data also shows results of tests administered to learners to compare their reading comprehension and arithmetic skills in solving word-problems.

Research Question 1: What is teachers' perspectives on reading comprehension?

Findings in Table 2 show that according teachers, learners had some challenges in reading comprehension. One reason that might have contributed to this could be inadequacy in one or more of the abilities listed by Dore *et al.* (2018), learners' previous experience, vocabulary skills and their ability to decode words.

Table 2: Teachers' perspectives on reading comprehension

S/N	Items in the Questionnaires	Frequency	%
1	Learners in my class have strong arithmetic skills		
	Agree	6	60.0
	Not Sure	0	0.0
	Disagree	4	40.0
	Total	10	100.0
2	Reading comprehension helps my learners to solve word-problems		
	Agree	5	50.0
	Not Sure	0	0.0
	Disagree	5	50.0
	Total	10	100.0
3	I do not see any relationship between reading comprehension and arithmetic skills, because they are two different concepts		
	Agree	3	30.0
	Not Sure	0	0.0
	Disagree	7	70.0
	Total	10	100.0
4	I believe that the learners' arithmetic skills and reading comprehension will support them in solving word-problems		
	Agree	7	70.0
	Not Sure	0	0.0
	Disagree	3	30.0
	Total	10	100.0
5	My learners find some difficulties translating the text into arithmetic concept before solving		
	Agree	6	60.0
	Not Sure	0	0.0
	Disagree	4	40.0
	Total	10	100.0
6	When problems are given in arithmetic form, learners can response well		
	Agree	9	90.0
	Not Sure	0	0.0
	Disagree	1	10.0
	Total	10	100.0

The suggest that 50% of the teachers perceived reading comprehension as an important skill for learners, which assists them in solving word-problems while 50% of the teachers considered that reading comprehension has no benefit to learners in solving word-problems. The findings in Table 2 item 2, confirm the suggestion by Boonen *et al.* (2016) to include reading comprehension in the Mathematics curriculum. Responses to item 3 validates the fact that reading comprehension is vital to learners' ability to solve word-problems. According to Kurshumlia and Vula (2021) and Vula *et al.* (2017), learners need to have a strong mental visualization ability of a word-problem which will help them comprehend it and subsequently solve the problem. Word-problems are incredibly challenging to solve without a solid foundation in reading comprehension.

A total of 60% of the Mathematics teachers who responded to item 5 agree that learners have some difficulties in translating text problems into solvable arithmetic form. This result is in line with what was found by Karogo *et al.* (2020) that 93.2% of learners who participated in a study could not attain the benchmark score of 50% in a reading comprehension test. According to the study, 98.3% of the participants could not attain the benchmark score of 50% in Algebra and Geometry. These findings suggest that learners might have challenges in decoding the text or inadequate skills in reading comprehension.

Research Question 2: What is Learners' perspectives on reading comprehension?

In response to items in Table three, 56.3% of the learners agree to item 1 that they find it easier to solve problems that are not written in text. The responses to item 2 show that 53.8% of the learners agree that when Mathematics is given as text, it tests their reading comprehension skills. The findings of item 2 agree with Munsod-Fernandez (2021) that the ability of learners to solve word-problems is vital to their reading comprehension skills. The reading comprehension skills enhance critical thinking skills and in turn help learners in solving word-problems.

Table 3: Learners' perspectives on reading comprehension

S/N	Items to the questionnaires	Frequency	% of Frequency
	I can solve the problems when they are not written as text		
1	Agree	179	56.3
	Not Sure	10	3.1
	Disagree	129	40.6
	Total	**318**	**100.0**
	I love the Mathematics being given as text because it tests my reading comprehension		
2	Agree	171	53.8
	Not Sure	8	2.5
	Disagree	139	43.7
	Total	**318**	**100.0**
	I believe that my reading comprehension and arithmetic skills have helped me to solve word-problems		
3	Agree	183	57.5
	Not Sure	8	2.5
	Disagree	127	39.9
	Total	**318**	**100.0**
	I am good at solving arithmetic problems, but find some challenges in converting the text into arithmetic concepts before solving		
4	Agree	198	62.3
	Not Sure	10	3.1
	Disagree	110	34.6
	Total	**318**	**100.0**

Responses to item 3 show that 57.5% of the learners believe that both their skills in reading comprehension and arithmetic have helped them to solve word-problems. The data might agree with Pongsakdi *et al.* (2020) wherein learners were categorized on the basis of the level of their reading comprehension skills, with one group of learners having good skills in both text comprehension and arithmetic. Although, the findings in this item only suggest how reading comprehension and arithmetic

skills have helped the learners, it was not clear whether the learners are good in anyone of the two skills.

Learners' responses to item 4 shows that 62.3% of the learners agreed that they are good at arithmetic skills but have challenges in converting text into arithmetic concepts. This result shows that learners need more reading comprehension skills to help them understand the word-problems and be able to solve them. It agrees with the findings by Ngeno (2020) that learners might attain low scores in the word-problems in examinations due to challenges in conversion of text into arithmetic concepts.

Research Question 4: What is the mean scores of learners for Text Comprehension Skills Test (TCST) and Arithmetic Skills Test (AST)?

The researchers gave the learners two tests, one on text comprehension skills and the other on arithmetic skills to establish their performance in reading comprehension skills and arithmetic skills. This was important in order to establish the correlation between learners' reading comprehension and arithmetic skills.

Table 4: The mean scores of learners for Text Comprehension Skills Test (TCST) and Arithmetic Skills Test (AST)

		Text Comprehension Skills Test (TCST)	Arithmetic Skills Test (AST)
Total	Mean	41.13	49.64
	N	**318**	**318**
	Standard. deviation	24.859	18.940

The scores of the two tests administered show some important findings. In Table 4, the mean score of the learners for Text Comprehension Skills Test (TCST) was 41.13 while that of Arithmetic Skills Test (AST) was 49.64. The scores in the AST were higher, implying that learners are more confident in solving problems in AST than in TCST. Pongsakdi *et al.* (2020) found grade 4 learners in Finland into four categories according to their levels of reading comprehension skills: a) difficulties with text comprehension but were skilled at arithmetic; b) struggled with arithmetic but were good at text comprehension; c) excellent in both; and d) struggled with both. The result shows that the learners performed better in the AST than the TCST. This study considers reading comprehension ability as one of the factors that contributes to learners' low performance in word-problems.

Research Question 4: Is there a correlation between Text Comprehension Skills Test and Arithmetic Skills Test?

The Pearson Product Moment correlation coefficient of the two tests show a moderate positive correlation and statistically significance at r = .613 and p< .001. This shows that reading comprehension and arithmetic skills enhance learners' ability to solve word-problems.

Table 5: Correlation between Text Comprehension Skills Test and Arithmetic Skills Test

		Text Comprehension Skills Test	Arithmetic Skills Test
Text Comprehension Skills Test	Pearson Correlation	1	.613[**]
	Sig. (2-tailed)		.000
	N	**318**	**318**
Arithmetic Skills Test	Pearson Correlation	.613[**]	1
	Sig. (2-tailed)	.000	
	N	**318**	**318**
** Correlation is significant at the 0.01 level (2-tailed)			

The findings agree with Hadianto et al. (2021) where three school were categorized as A, B, and C, found a weak correlation of 0.45 between reading comprehension and learners' performance in Mathematics in School category A, while schools B and C showed a strong correlation of 0.79 and 0.76 respectively. These findings suggest that reading comprehension is very key for learners' word-problem solving ability.

Conclusions and Recommendations

Learners and teachers faced some challenges in solving reading problems. The challenges were observed in the performance of the Text Comprehension Skills Test wherein the learners performed better in the arithmetic skills test than in the text comprehension skills test, which affects the arithmetic skills and ability to solve word-problems.

These challenges have served as one of the factors influencing learners' low performance in the KCSE paper 1 and paper 2, which have real-life applications. The findings are significant and imply that inculcating reading comprehension and arithmetic skills into teaching and learning may improve learners' performance in solving word-problems.

The study recommends that reading comprehension should be included in the Mathematics syllabus as an area of study in secondary schools. This will enable learners to perform better in word-problems at the Kenya Certificate of Secondary Education (KCSE).

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