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Analysis of Students' Ability in Solving Linear Equation Worded Problem: A Sequential Explanatory Research Study

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Abstract

This paper determined the performance, difficulties, common errors, and strategies of grade 8 students in solving linear equation word problems. A sequential explanatory mixed method design was applied in this study: quantitative (n = 222) that identified the level and the comparison of performance of students and qualitative (n= 12) that used thematic analysis. Data consisted of self- developed test questionnaires. Results show that the performance of grade-8 students is low and differs significantly considering age, sex, parent's educational attainment, parent's occupation, and family income. The emergent themes for difficulties experienced by students were understanding and analyzing the problem, conceptualizing, comprehension, and creating equations. The common errors committed by students were negligence error, creating equation error, computational error, misinterpretation, and negligence error. The strategies used by students in solving linear equation word problems were mental calculations, organized notes, algebraic equations, experimentation, reading repetition analysis, and imitations. The study concludes that the ability of students in dealing word problems can be developed through constant practice.

Keywords: Linear Equation Word Problems, Math Performance, Math Difficulties, Math Common Errors, Solving Strategies

Introduction

Problem-solving abilities have become a necessity in today's challenging times. People can use these skills to their advantage in both their personal and professional lives. Employees are evaluated by companies based on their capacity to solve challenges, resulting in potential and successful careers (Kizer, 2021) [26]. Despite the advantages these skills provide, students continue to struggle with word problems (Verschaffel *et al*., 2020) [56].

The National Assessment of Educational Progress (NAEP) approximated that 20% of fourth-grade students in the United States did not achieve a basic level of competency in mathematics, while only 39% did (National Center for Education Statistics, 2017) [37]. According to the Organization for Economic Cooperation and Development (OECD), which ran the test for 15-year-olds, the Programme for International Student Assessment (PISA) in 2018 found that students in many countries had trouble with subjects that involved solving problems, especially math, and science (OECD, 2019). More than half of the countries that took part in PISA 2018 did not get the average score for the OECD. The bad news is that the Philippines came in last in reading and second to last in math and science (Punongbayan, 2019) [46].

According to the Trends in International Mathematics and Science Study 2019 findings, the Philippines had the lowest possible score in the grade 4 science and mathematics examination (Magsambol, 2020) [33]. Additionally, according to the results of the National Achievement Test (NAT) administered by the Department of Education (DepEd) in the Philippines, students' overall performance in all of the major subjects, including mathematics, demonstrated a low level of mastery (Estanislao, 2019) [13]. Even though there are various programs designed to help students improve their academic performance, many students continue to need help passing their courses despite the many initiatives that DepEd has implemented. The results of both tests indicate that learners in the Philippines could be more skilled in mathematics.

The assessments participated by students nationally and internationally shows a very alarming result. Those assessments measure students' capability in solving word problems (Graesser *et al*., 2017) [17]. Math educators should reconsider the experienced of students as the record reveals students' low performance. Understanding the experiences faced by students in dealing with word problems would give advantages to educators because problem-solving is an important skill not only in academics but also in real life. Though studies were conducted exploring common errors committed by students in a word problem, the overall experience of students in their performance, difficulties common errors and strategies in linear equation word problems is limited in the Philippine context.

Objectives of the Study

This research specifically aims to (1) determine the performance level of students in solving linear equation word problems; (2) identify the significant difference in the performance of the students in solving linear equation word problems considering age, sex, parent's educational attainment, parent's occupation, and parents' estimated monthly income;(3) determine the difficulties encountered by students in solving linear equation word problems based on the following categories: high performing, average performing, and low performing; (4) determine the common errors committed by students in solving linear equation word problems based on the following categories: high performing, average performing, and low performing; (5) determine the strategies used by students in solving linear equation word problems based on the following categories: high performing, average performing, and low performing.

Method and Materials

The sequential explanatory mixed design was used in this study. The design is divided into two phases: quantitative and qualitative. In this design, the researcher first collects quantitative data, including the demographic profile of the respondents, through the 25-item test of linear equation word problems to determine their performance and significant differences in their performance considering the demographic profile of the students.

The qualitative phase of this study aims to understand the student's difficulties, common errors, and strategies in solving linear equation word problems. It takes place after the tests have been checked and the scores have been ranked. Students' scores were categorized into three, namely, high performance, average performance, and low performance. Six students were chosen based on the category of scores for clinical interviews. Another set of interviews was given to six selected grade 8 math teachers to triangulate the data from the students.

The instruments used in this study were a self-developed test questionnaire, an interview schedule for students, and an interview schedule for teachers. The self-developed questionnaire consisted of a demographic profile and a 25-item test of linear equation word problems. The validity of the test questionnaire was ensured by the guidance of the nine math experts at Adventist University of the Philippines. The instrument also went through a reliability test. The 25-item test served as the tool that categorized students as low, average, and high performers based on their scores. Low-performing students were those who had a score of 1 to 33, average-performing students were those who got 34 to 67 points, and lastly, high-performing students were those who got 68 to 100 points. The interview schedule for students and teachers is semi-structured to determine students' difficulties, common errors, and strategies for dealing with linear equation word problems.

The respondents of this study were grade 8 students and math teachers from six public schools in the DepEd Division of Cavite. The researcher utilized a convenient sampling technique in selecting 222 students. Six students were drawn randomly from 222 respondents for the clinical interview. School heads were involved in selecting the 6 teachers who participated in the triangulation interview.

Results and Discussions

This section includes the results and discussions of all the research questions in this paper. Phase 1 of the study was the assessment of the students' performance in solving linear equation word problems. It also considers the differences in students' performances concerning their demographic profile. Phase 2 of the study focuses on the experience of students, particularly in their difficulties, common errors, and strategies as they solve linear equation word problems.

All quantitative data was examined using the Statistical Package for Social Science (SPSS) version 22. Frequency, median, mean, mean rank, and standard deviation were utilized to assess students' performance and demographic profile. The Mann-Whitney U test was employed to see if there was a statistically significant difference in student performance based on gender. The Kruskal-Wallis test was used to detect the significant difference in pupils' performance when age, parents' educational attainment, parents' employment, and parents' anticipated monthly income were all taken into account. This study's qualitative data came from clinical interviews with students and interviews with grade 8 math teachers. Thematic analysis was utilized to assess the challenges, common mistakes, and methods of students in solving linear equation word problems based on the results of interviews.

Table 1: Students' Performance in Solving Linear Equation Word Problems

Category	N	%	Mean	SD	CV	Verbal Interpretation
High Performing	30	13.5	80.83	9.728	0.12	High
Average Performing	53	23.9	46.566	8.01	0.17	Average
Low Performing	139	62.6	15.4	8.25	0.54	Low
Overall	222	100	31.685	24.855	0.78	Low
CV = Coefficient of variation						

The table shows that only 13.5% belonged to the high performing category with a mean of 80.83 *(SD= 9.728, CV= 12%)*, 23.9% belonged to the average performing category with a mean of 46.566 *(SD= 8.01, CV= 17%)* and 62.6% belonged to the low performing category with a mean of 15.4 *(SD= 8.25, CV= 54%)* with regards to students' scores in solving linear equation word problems.

The coefficient of variation served as the gauge of dispersion of how scattered the data in the study are. A higher CV means more scattered data, while a lower CV means a concentration of data. The table above shows that low performing students had the highest CV (54%), which implies that the most scattered data among the three categories was in the low-performing category. One of the reasons was that low performing students have the highest frequencies of scores with high dispersion.

The table further shows that the overall mean of students' scores in solving linear equation word problems is only 31.685 *(SD= 24.855, CV= 78%)*. The result implies that grade 8 students perform low in solving linear equation word problems. The coefficient of variation conveys that there is a very wide dispersion of scores in the performance of students in solving linear equation word problems that show heterogeneity. This implies that the difference in skills between high performing students and low performing students is very far and wide, as reflected in the students' scores. This further suggests the necessity for math educators to somehow narrow down the wide dispersion of skills by elevating the abilities of low performing students through interventions.

The study by Yonson (2017) [59] explains that when students achieve a low score in problem-solving, it suggests that there was a certain difficulty in their manner of dealing with word problems.

Table 2: Kruskal-Wallis Test (Student's Performance to Age)

Age	N	Mean Rank	Kruskal-Wallis H	df	Asymp. Sig.
12 to 13	92	110.12	7.105	2	**0.029**
14 to 15	125	115.464			
16 to 17	5	37.8			
Total	222				

Table shows that there is a significant difference in the performance of students in solving linear equation word problems in terms of age *(H (2) = 7.105, p= 0.029)*. This implies that the performance of grade 8 students is affected by age.

In addition, the highest mean rank belongs to students aged 14 to 15 (115.464) followed by students aged 12 to 13 (110.12). The table below shows the multiple comparisons on significant results in the Kruskal Wallis test.

Table 3: Pairwise Comparison (Student's Performance to Age)

Sample 1- Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
16 to 17- 12 to 13	72.32	29.487	2.453	0.014	0.043
16 to 17- 14 to 15	77.664	29.286	2.652	0.008	0.024
12 to 13 - 14 to 15	-5.344	8.821	-0.606	0.545	1

Though the frequency of the oldest students is limited, the overall analysis shows that there is a significant difference in the performance of students considering their ages. The table shows that there is a significant difference in students' performance between the oldest and the youngest group of students. Another significant difference is shown between the oldest and the middle-aged students. There is no significant difference shown between the youngest and the middle-aged students. The results show that younger students are performing well compared to older students.

The research by Jabor *et al*. (2011) [22] indicates a correlation between age and mathematical performance. According to the findings of Unal (2019) [55], there is a substantial association between a person's age and the mathematics scores they receive. On the other hand, this result runs counter to the findings that were published by Bedard and Dhuey (2006) [6] based on research conducted in Finland and Denmark. On the other hand, Coleman *et al*. (1966) [10] and White (1982) [58] found that as children get older, the link between their age and their overall academic achievement in school weakens.

Table 4: Mann- Whitney U Test (Student's Performance to Sex)

Sex	N	Median	Mean Rank	U	Z	r	p	VI
Male	80	19	99.975	4758	-2.007	0.135	0.045	Significant
Female	142	27	117.993					

The table shows that there is a significant difference in the performance scores for males *(Md= 19, n= 80)* compared to females *(Md= 27, n= 142), U =4758, Z= -2.007 p = 0.045,* with a small effect size *r= 0.135.* Female students solved linear equation word problems significantly better than males.

Brown and Kanyongo (2010) [7] concluded that the significant difference in mathematics performance by gender favoured females with a small effect size. On the other hand, these results contradict the work of McKeown *et al*. (2019) [35] in Ireland, which shows that there is no significant difference in gender with regards to their mathematics performance. According to Lee and Kung (2018) [29], sex differences in mathematics performance change or weaken in societies that practice sex equality.

Male students outscored female students in most participating nations in PISA 2018, yet it was the opposite case in the Philippines. In the study of Alcantara & Abanador (2018) [3], a significant difference was not found between male and female students in Grade 11 concerning their performance in the General Mathematics subject. The findings of Else-Quest *et al*. (2010) [11] and Lindberg *et al.* (2010) [30] both came to the same conclusion: Males and females have comparable mathematical abilities.

One of the probable reasons behind the different results is sex differences in the number of participants in the study. Another reason is the unequal number of participants between males and females. In this study, male participants made up only 36% of the 222 respondents. The contradicting sex differences give a significant point to always considering sex differences in a student's performance in math.

Table 5: Kruskal-Wallis Test (Student's Performance to Mother's Educational Attainment)

MEA	N	Mean Rank	Kruskal-Wallis H	df	Asymp. Sig.
Elementary Undergraduate	7	79.86	36.265	7	0. 000
Elementary Graduate	12	82.58			
High School Undergraduate	17	84			
High School Graduate	68	87.51			
Vocational Graduate	12	112.13			
College Undergraduate	31	140.44			
College Graduate	66	130.13			
Postgraduate	9	170.78			
Total	222				

Table 8 shows that there is a significant difference in the performance of students in solving linear equation word problems in terms of their mother's educational attainment *(H (7) = 36.265, p= < 0. 001).*
Furthermore, the table shows that the highest mean rank (170.78) are students whose mother attained a postgraduate level of education. On the other hand, the lowest mean rank (79.86) are students whose mothers have an elementary undergraduate level of education. The result implies that students whose mothers attained the highest education performed better than others. The table below shows the comparison of students' performances, considering their mother's educational attainment, using the Kruskal-Wallis test pairwise comparison.

Table 6: Pairwise Comparison (Student's Performance to Mother's Educational Attainment)

Sample 1- Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
High School Undergraduate- Postgraduate	-86.778	26.471	-3.278	0.001	0.029
High School Graduate-College Graduate	-42.621	11.096	-3.841	0.000	0.003
High School Graduate- College Undergraduate	-52.928	13.916	-3.803	0.000	0.004
High School Graduate- Postgraduate	-83.27	22.777	-3.656	0.000	0.007

The results reveal that among eight classifications of a mother's educational attainment, with a total of 28 comparisons between each classification, four of those comparisons have a significant difference. The comparison between high school undergraduate and postgraduate, high school graduate and college graduate, high school graduate and college undergraduate, and lastly, high school graduate and postgraduate.

The students' performance in solving linear equation word problems was affected by their mother's educational attainment. The significant difference transpires from college level to postgraduate. Based on these results, a mother with at least a college level of education can somehow integrate and impart her mathematics skills to her children as they go to school.

Table 7: Kruskal-Wallis Test (Student's Performance to Father's Educational Attainment)

FEA	N	Mean Rank	Kruskal-Wallis H	df	Asymp. Sig.
Elementary Undergraduate	11	72.59	21.988	7	0. 003
Elementary Graduate	8	97.25			
High School Undergraduate	8	80			
High School Graduate	70	97.93			
Vocational Graduate	16	106.5			
College Undergraduate	26	121.48			
College Graduate	72	124.42			
Postgraduate	11	169.14			
Total	222				

The table shows that there is a significant difference in the performance of students in solving linear equation word problems in terms of their father's educational attainment *(H (7) = 21.988, p-value = 0.003).*
Moreover, the table shows that the highest mean rank (169.14) are students whose father attained a postgraduate level of education. On the other hand, the lowest mean rank (72.59) are students whose fathers have an elementary undergraduate level of education. The result implies that those students whose father attained the highest education perform better compared to others. Table 11 shows which comparison of students' performances considering their father's educational attainment is significant using the Kruskal Wallis test pairwise comparison.

Table 8: Pairwise Comparison (Student's Performance to Father's Educational Attainment)

Sample 1- Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Elementary Undergraduate- Postgraduate	-96.545	27.381	-3.526	0	0.012
High School Graduate- Postgraduate	-71.208	20.827	-3.419	0.001	0.018

The table shows that among eight classifications of fathers' educational attainment, with a total of 28 comparisons between each classification, only two comparisons have significant difference.

The result implies that students' performance in solving linear equation word problems was influenced by their father's educational attainment. The significant impact is reflected in the highest educational attainment, which is postgraduate. Both parents' educational attainment significantly affects students' performance in solving linear equation word problems. This implies that the education of both parents can affect the performance of their children. This result further implies the importance of education in this generation and the future.

This result supports the findings of Kodippili (2011) [27], which concluded that a parent's educational level is positively related to a student's math achievement because educated parents can always help their children with their assignments and academic activities.

Table 9: Kruskal-Wallis Test (Student's Performance to Mother's Occupation)

MO	N	Mean Rank	Kruskal-Wallis H	df	Asymp. Sig.
BLUE	157	104.67	10.247	2	0.006
WHITE	56	134.53			
PINK	9	87.39			
Total	222				

The result shows that there is a significant difference in the performance of students in solving linear equation word problems when their mother's occupation is considered (H (2) = 10.247, p-value = 0.006). The highest mean rank favors students whose mothers perform white-collar jobs. The table below shows which comparison of students' performance considering their mother's occupation is significant using the Kruskal Wallis test pairwise comparison.

Table 10: Pairwise Comparison (Student's Performance to Mother's Occupation)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
PINK- BLUE	17.28	22.009	0.785	0.432	1.000
PINK- WHITE	-47.138	23.06	-2.044	0.041	0.123
BLUE- WHITE	-29.858	9.995	-2.987	0.003	0.008

The table shows that, among the three comparisons, there is a significant difference in the performance of students whose mothers worked in blue-collar jobs and white-collar jobs. It implies that students' performance in solving linear equation word problems is significantly affected by their mother's occupation.

Table 11: Kruskal-Wallis Test (Student's Performance to Father's Occupation)

MO	N	Mean Rank	Kruskal-Wallis H	df	Asymp. Sig.
N/A	19	137.474	16.168	3	0. 001
BLUE	147	99.129			
WHITE	47	135.255			
GOLD	7	134.500			
Total	222				

The table shows that there is a significant difference in the performance of students in solving linear equation word problems when the father's occupation is considered (H (3) =16.168, p-value = 0. 001). The students' performance in solving linear equation word problems is affected significantly by their father's occupation.

Table 12: Pairwise Comparison (Student's Performance to Father's Occupation)

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
BLUE- GOLD	-35.371	24.842	-1.424	0.154	0.927
BLUE- WHITE	-36.126	10.592	-3.411	0.001	0.004
BLUE- N/A	-38.344	15.655	-2.449	0.014	0.086
GOLD- WHITE	-0.755	25.946	-0.029	0.977	1.000
GOLD- N/A	-2.974	28.391	-0.105	0.917	1.000
WHITE- N/A	2.219	17.354	0.128	0.898	1.000

The table shows that only the comparison between fathers performing blue-collar and white-collar jobs had a significant difference in students' performance in solving linear equation word problems.

A significant difference in students' performance is present in both parents' occupations. Thus, the work performed by parents may have a positive effect on students' skills in solving word problems in math. Parents' occupation, especially when it is mathematically related, has a positive impact on a student's performance in math (Lane, 2017) [28].

This finding lends credence to the findings of Akinsanya *et al*. (2014) [2], who concluded that students' academic performance in mathematics may be predicted with a high degree of accuracy based on the occupation of their parents. The findings also support the conclusions reached by Rothman (2004) [50], which state that the essential factor associated with the educational accomplishment of children is not a child's race or ethnicity nor their immigration status, but rather elements related to the family's socioeconomic standing. These characteristics include the educational level of the parents, the amount of poverty in the community, the parental occupation, and the household's income level.

Table 13: Kruskal-Wallis Test (Student's Performance to Family Income)

EFI	N	Mean Rank	Kruskal-Wallis H	df	Asymp. Sig.
Less than ₱5,000	42	81.74	17.635	5	0. 003
₱5,001- ₱10,000	45	112.92			
₱10,001- ₱15,000	38	110.80			
₱15,001- ₱25,000	48	109.96			
₱25,001- ₱50,000	35	134.24			
More than ₱50,000	14	146.54			
Total	222				

The result shows that there is a significant difference in the performance of students in solving linear equation word problems when estimated monthly income is considered *(H (5) = 17.635, p-value = 0. 003).*

Moreover, table 16 shows that students who have a family monthly income of more than ₱50,000 perform better compared to others. Table 17 shows which comparison of students' performance considering estimated monthly family income is significant using the Kruskal-Wallis test pairwise comparison.

Table 14: Pairwise Comparison (Student's Performance to Family Income)

Sample 1- Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Less than ₱5000- ₱25,001- ₱50,000	-52.505	14.696	-3.573	0	0.005
Less than ₱5000- More than ₱50,000	-64.798	19.817	-3.27	0.001	0.016

The table shows that among six classifications of estimated monthly family income, with a total of 15 comparisons between each classification, only two comparisons have a significant difference. These are the comparisons between income less than ₱5000 and ₱25,001- ₱50,000 and less than ₱5000 and more than ₱50,000.

Family income significantly affects students' performance in solving linear equation word problems. Furthermore, if poor families are given an opportunity to improve their way of life to increase their monthly income, their children will also improve in their performance in solving word problems. The ability of parents to provide for the needs of students to easily access or use educational materials is always related to the income of the family.

This data lends credence to the findings of Li and Qiu (2018) [31] and Cheng and Hsu (2016) [8], who concluded that the income of one's family affects the level of mathematical achievement. More than twenty percent of students' mathematical performance was shown to be related to their socioeconomic position, including their families' income (OECD, 2019).

In qualitative data, thematic analysis was utilized. The data was taken from the 12 respondents, six students, Respondents H1, H2, A1, A2, L1 and L2 and six teachers, Respondents T1, T2, T3, T4, T5 and T6. The first theme occurred in the difficulties encountered by student in solving linear equation word problems is understanding and analyzing the problem. This was stated by Respondent H1, "*For me, my skills were honed by my experiences as a quiz bee player yet in the test I still encounter confusing questions, some of them are hard to understand, but I managed to do it with focus, but it takes time."* and by Respondent H2*, " I do not struggle with math, but with word problems, I take time to understand the problem, though I listed all the given to be my guide to solve the problem, yet I need to analyze the possibilities in the problem.*

This was confirmed by one of the teachers as stated by Respondents T2, "*Even in the top section, I still encounter challenges with them, especially when it comes to understanding the math word problem itself, although they are good at it, of course, we still explain to them straightforwardly. Often for a student, they seem to have difficulty when it comes to problem-solving because in analyzing the problem, they prefer to compute direct computations, unlike problem-solving that needs understanding and analysis."*

According to average and low performing students, understanding the problem so solve it is so challenging. This was stated by Respondent A1, "*I had a hard time with math because I don't like it. It's just complicated when it comes to word problems because there are a lot of things to consider in solving them. To analyze how to solve it is so challenging."* Respondent A2, "*I want to practice because I had a hard time with Math, especially word problems. I have a hard time with math word problems on how to understand to be able to answer them, but if the questions have choices, I find it easy because I can do trial and error."* and Respondent L2, " *I often get confused, especially when I don't get the meaning of the word problems. In word problems, it's hard to understand how to solve them. I still need to understand very well what the problem means. If the question is easy, I can do it, but when the problems are complicated, it is difficult for me to understand, especially when the question is long."* The experiences of students were confirmed by teacher Respondent T3 as she stated, *"When it comes to problem-solving, since the learner is just fond of answering expressions and equations, but when it comes to word problems, they had a hard time because word problems is combined English and math. In my experience, average students encountered challenges in understanding the problem, this part is hard for them, also in problem analysis, it is their weak points, but let's say you gave them a mere linear equation to evaluate, such task is easy for them."*

According to Emanuel *et al*. (2021) [12], in solving word problems, students can somehow read the problems, yet they have difficulty understanding the problem as a whole. As a result, students cannot go further with the process needed to find the answer. Seifi *et al*. (2012) [53] added almost half of the mathematics teachers observed that their students struggled with representing and understanding word problems. Moreover, Phonapichat *et al*. (2013) [43] states that students were unable to figure out the necessary information and steps to be taken because of a lack of skills in understanding keywords in the problem.

The second difficulty encountered by high, average and low performing students is conceptualizing. This was stated by Respondent H2, "*In my experience in solving word problems, when I start a new question, it took me a while because I need to understand how to do it, especially if the concept on the questions is new."* Respondent A1, "*Most of the problems like the number, age, work and many more were taught to us but I forgot most of them. The most difficult part of the test is the problem with the heads and legs of animals. Because I have no idea on the concept to be used, on how to solve it, in the end, because I can't think of anything, I just guessed."* and Respondent L2*, "It is difficult to understand what strategy to be used in various problems, and the formulas needed for solving them. I need someone to teach me to answer word problems. Luckily, the test was multiple choice."*

This difficulty was observed by the teachers. As stated by Respondent T2, "*To the performing students, there are fewer challenges but still, they sometimes had a hard time analyzing what concept they will be using because the linear equation has a wide scope to analyze what the concept is, what specific things to do about the problem."* and Respondent T6, *"Even the average student sometimes forgets what to do in the problems when the actual task is not arranged similarly from the example. The often, most low performing students are incapable to answer word problems because they do not have the idea."*

According to Andam *et al*. (2016) [4], one of the struggles of students in solving word problems is their inability to determine what strategy they will use because they are not familiar with the problem. Shin and Bryant (2015) [54] added that students may have difficulty recognizing the type of problem as they encounter word problems in algebra. As a result, they were not able to find the right strategies to use to solve the problem. Students with math difficulties when solving word problems tend to incorrectly use information that is not important to solving the problem (Jarosz & Jaeger, 2019) [23].

Creating Equations is the third difficulty encountered by average and low performing students. This was stated by Respondent A1, *"I'm struggling with difficult problems, I'm not sure if I'm correct when I translate the problem into the equation. Although, I could mentally solve the easy item. But in the step-by-step making of equations to solve problems, although I know how to do it, but I'm not that confident."* Respondent A2*, "When translating into variables, I always worry that it might be wrong, I still lack the knowledge to do it, so I am thinking that maybe my effort to solve the problem could be wasted."* and Respondent L1*, "I only answered very few items because I don't really know how to make equations. It only depends on what I understand."* This was confirmed by the statement of Respondent T1, *"Students usually have difficulty in transformation it is their weak point because sometimes they reversely transform the equations."*

Ibrahim and Yaw (2019) [20] stated that students have difficulties in analyzing and transforming word problems into algebraic. This difficulty is only part of the difficulties faced by students in solving word problems. If they were able to transform sentences into mathematical equations, they may be able to identify the correct answer, but still have challenges to face because in solving word problems, students have several difficulties to conquer (Mulungye *et al*., 2016) [36].

Between natural language and mathematical understanding, there is a gap that gives students difficulty when engaging in word problems (Ilany & Margolin, 2010) [21]. This area becomes one of the factors in determining the problem-solving skills of students. According to Vista (2010) [57], students' ability to translate phrases into symbols affects their performance in solving problems in math.

The last theme occurred is comprehension. Only low performing students have experienced this difficulty. This was stated by Respondent L1, *"Almost all the problems are difficult. There are words that I had already forgotten, so I just guessed the answer."* and Respondent L2, *"When the word was too deep in the problem, it was hard for me to understand, and there is still a lot to learn. I'm not sure if I got the words in the problem right when writing a given because I'm not sure."* This was confirmed by the statement of Respondent T1, *"Reading comprehension is always the problem of the low performing students because from the very start they don't fully understand the problem given, so they can't proceed to the next level."* and Respondents T2**,** *"The way low performing students comprehend creates the problem, they don't understand the problem itself, they don't understand what is being asked about the problem."*

This finding is connected to the research that was done by Andam *et al*. (2016) [4], who found that one of the challenges that students have while attempting to solve linear equation word problems is in the understanding stage. It can be challenging for students to work through word problems, particularly those who are still in the beginning stages of their English education (Martiniello, 2008) [34].

For the common errors committed by students in solving linear equation word problems, four themes occurred. Negligence error was the first error committed by both high and average performing students. This was stated by Respondent H1, *"I have committed fewer errors, only the "carry one" in addition. I occasionally neglected to "carry one," so my response is inadequate. Thus, this is where I went awry with the fundamentals."* Respondent A1, *"There are instances where I forgot to write the sign number when computing, so I incorrectly completed the process."* and Respondent A2, *"When I'm in hurry, sometimes I forget to write the other given that's why my answer goes farther from the right one. I messed up the solution."* This error was observed by teachers as stated by Respondent T4, "*These high performers committed mistakes in the basic operations when in a hurry. They made mistakes in easy items."* and Respondent T3, *"Performing students occasionally make mistakes with basic operations. When they are rushed, they get careless. Perhaps they are so certain of their answers that they do not double-check them."*

Students, especially those who are quite successful academically, frequently engage in careless behavior (Clements, 1982) [9]. According to research carried out by Hershkovitz *et al*. (2011) [19], students who have a greater level of mastery with the material also demonstrate a greater level of carelessness. Haghverdi *et al*. (2012) [18] added that some of the mistakes students make are because they write the given in the problem carelessly or don't pay attention to details like numbers, signs, and even exponents. As you try to solve the problem, these mistakes will lead to bigger ones.

The second theme occurred is misinterpretation which was experienced by all students from high to low. This was stated by Respondent H1, *"In the test, I made a mistake with the uniform motion problem because I just misunderstood the statement, due to time pressure."* Respondent A1, *"Some sentences are difficult to understand because of the interconnected ideas that need to be analyzed together. So, I make a lot of mistakes because it is confusing to understand the problems."* and Respondent L2, *"Almost every one of the questions is challenging. My reasoning is flawed due to the fact that I do not have a complete understanding of the problem that needs to be solved. My English skills are quite poor."* This error was confirmed by the statement of Respondent T2, *"In my experience in teaching the star sections, students often commit mistakes in comprehension even the high performers, much more the low performers, because the way they comprehend the problem is erratic, sometimes their interpretation is not related to what is being asked in the problem."*

According to Jha (2012) [24], the first skill that students should have could be reading and the second is understanding. Students can only start solving word problems when they can write what is important in the problem and understand the problem itself. Adu *et al*. (2015) [1] added that one of the most common mistakes students make when handling word problems with linear equations is that they don't fully understand the problem. Newman's (1997) error hierarchal level or the well-known NEA shows that comprehension is the second of five steps. Students often make this mistake because it involves language skills that are more important for solving problems than skills like math (Fuchs *et al*., 2014) [15].

Creating equation error is the third theme occurred which was experienced by average and low performing students. This was stated by Respondent A2, *"When I tried to translate the problem into variables, I ran into a lot of trouble. Because it's the most difficult, this is where I consistently make errors. My understanding of this topic is really restricted. Unless the question is ridiculously straightforward."* and Respondent L2, *"I was able to answer very few items because I understood very little. Besides, it's really hard to make an equation. Most of my answers are wrong because I don't know much about solving them. But I want to learn, but I think it's too hard."* This error was confirmed by the statements of Respondent T4, *"Poor students have trouble articulating a problem and ask many questions. First, comprehension is the major issue when dealing with children. Translation won't help. Most can't make equations. They're also clueless."* and Respondent T6, *"Average students lack transformation skills. They have different processes when the question you give in the assessment is different from the examples."*

This conclusion is consistent with the findings of Norasiah (2002) [40] and Rahim (1997) [47], who found that low-achieving students struggled to convert mathematical problems into equations and needed help grasping the specialized vocabulary of the subject. Students need help with converting words into mathematical equations.

The last theme occurred is computational error which was experienced by average and low performing students. This was stated by Respondent A1, *"Sometimes I don't know whether to use a negative or positive sign, so the effect is wrong. I know how to add and remove whole numbers, but it seems harder to solve word problems."* Respondent A2, *"I don't always understand when I've made a mistake with sign numbers. Yet I memorized the integer song. I also get lost sometimes, especially when I have to work with fractions."* Respondent L1, *"I know how to add. But it's easy for me to mix up the signs, especially when the negative sign shows up more than once when adding or removing. I don't know very much."* and Respondent L2, *"Since I was in high school, math has been hard for me. That's where I get lost about simple integer operations."* This error was confirmed by the statements of Respondent T5, "*From what I've seen, many students get math wrong when they try to understand the idea of numbers. Students who aren't very good at math find it hard to understand how to add and subtract numbers with different signs."* and Respondent T6, "*In solving problems, the concept of integers is the most frequent source of error. The addition and subtraction of unlike signs in integers causes confusion among pupils of average and low ability."*

The difficulty with performing operations involving fractions and integers was likely the cause of the computational error that was found in this study. According to Nelson and Powell's (2017) research, students who struggle with mathematics have poor calculating skills in comparison to average students. Sometimes, students make mistakes when doing easy operations with integers. This could be because they are in a rush or because of other things. (Hershkovitz *et al*., 2011) [19] say that careless work can lead to mistakes in figures, especially when students are sure they know how to do the work. Moreover, a student's performance in later grades of mathematics is directly tied to their ability to compute (Geary, 2011) [16].

For the strategies used by students in solving linear equation word problems, six themes occurred. Experimentation is the common strategy which was used by all students from high to low. This was stated by Respondent H2, *"I find it easier when I use trial and error, I think it is the fastest way to analyze."* Respondent H1, "*When I couldn't figure something out, the only thing I did was trial and error."* Respondent A2, *"I also use trial and error when I don't know what to do to solve a problem but I also analyze each possibility."* and Respondent L2, *"During the exam, I just read the questions and then used trial and error on the choices, depending on what I understood. When it's too hard, I just make guesses."* Performing students use guess and check or trial and error to pursue the correct answer. Sadly, poor-performing students use guessing and checking on what they understand, but it is nearly guessing. This was stated by Respondent T4, *"When it comes to individual tasks like exams, those low-performing students make guesses, especially the problematic ones; when it comes to choices, they don't seem to be reading anymore, and they're just making guesses."* On the other hand, performing students used experimentation to get the correct answer. This was stated by Respondent T2, *"Because sometimes what children do is trial and error, sometimes when we check their solution, their answer is correct, but the solution they made and the process is different from the linear equation, but they answered it correctly, meaning they know how to analyze, they have their way of solving, but we also teach them that they also need to follow the steps, because sometimes, luckily, the process is correct when using trial and error.*

Students that perform exceptionally well in school have a number of additional skills that are reserved for solving arithmetic word problems. They are able to remember everything readily and swiftly in accordance with the requirements of the assignment. Students who already possess a certain level of expertise have a better chance of finding success by adhering to a conventional process such as experimentation or trial and error (Samuelsson, 2008) [51].

Using algebraic equations is the next strategy used by high and average performing students in solving linear equation word problems. This was stated by Respondent H1, *"I am more fluent in algebraic equations when I use them. I can translate problems into algebraic equations because I'm used to doing it."* and Respondent A2, *"I read it repeatedly, and then I translate it into equations, and then I solve what the word problem is looking for. When the question is easy, my answer is often correct."* This was supported by the statement of Respondent T5, *"To the smart ones, they really have guts. They are the ones who can create an equation from the problem. Sometimes they use other solutions which is also correct."*

This is shown to be the case in the research carried out by Adu *et al*. (2015) [1], who concluded that some students were able to conduct the transformation when solving word problems involving linear equations, and that these skills can be learnt. According to the findings of Scheuermann *et al*. (2009) [52], even students who struggle with mathematics can increase their ability to apply algebraic equations to the solution of word problems.

Only high performing students used mental calculation in solving linear equation word problems. This was stated by Respondent H2, *"In a classroom setting, before the pandemic, sometimes I did mental math on easy problems; it's like multiplication."* and Respondent H1, *"In the quiz bee before, mental math was often the strategy to speed up.*

But in class, I really need a solution, so I'm used to solving problems using algebraic equations." This was also affirmed by Respondent T5, *"High performing students are really good. Sometimes they use logical guesses or mental math based on what they choose, which is easier for them according to what they do."*

Jordan *et al*. (2010) [25] define a mental calculation as the act of performing mathematical computations only in one's head, without the aid of any external tools such as paper and a writing implement. Children who practice mental computation increase their higher-order thinking, reasoning, and critical thinking skills, as well as their ability to make sense of mathematical concepts and mathematical processes. Students will benefit not only in the classroom but also in their personal lives and careers as a result of this. According to Pourdavood *et al*. (2020) [44], students who are able to grasp the approach of mental mathematics will find that the strategy is effective in a variety of settings.

In addition, high performing students also used organized notes in solving linear equation word problems. This was stated by Respondent H1, *"Writing notes helps me a lot in answering questions so that I don't get confused in creating equations so that I can also speed up."* and Respondent H2, *"Sometimes I really need to take notes so that I don't have to read long problems again."*

Powell and Fuchs (2018) [45] suggested a method that can be used by students as a tool to assist them in the process of solving word problems. Problems are defined in terms of a single operation, or keywords are linked to a particular operation. Students are given the opportunity to write and link commonly used terms such as more, altogether, share, and twice through the use of this approach. They now have a clue about what to do next in the process of constructing equations as a result of doing this. The Florida Department of Education (2010) [14] also mentioned about assisting kids in analyzing what the problem is all about by having them make an organized list of their thoughts. Because students cannot solve a problem without first listing or even writing down the given data, it makes sense to employ this method.

On the other hand, average performing students used reading repetition analysis in solving linear equation word problems. This was stated by Respondent A1, *"I read the problem over and over when it is difficult to understand, then I create the equation. Sometimes I don't realize I've solved the problem already."* and Respondent A2, *"Sometimes I find it difficult to understand the problem of what the important given are, so I keep on reading."*

Reading the same passage multiple times, as Logan (1997) [32] found, improved word recognition. It was explained to me that even if a student encounters a word for the first time that they have never encountered it before, it is possible for them to comprehend the meaning of the word as they become more familiar with it through subsequent reading. Reading and understanding are intertwined processes that build off of one another. Reading is necessary for comprehension, but simply being able to read is not a sufficient condition for understanding. Basaran (2013) [5] demonstrates that additional study has shown that there is a direct association between fluent reading and comprehension.

Lastly, low performing students used imitation to solve linear equation word problems. They need to have a model of examples, or somebody would lead them so that they can continue and follow the steps needed to solve problems. This was stated by Respondent L1, *"I still need a guide so that I can solve math problems. I can't start without an example. That is why I need to have notes on examples to follow"* and Respondent L2, *"I ask my knowledgeable classmates and sometimes my mother how to answer my assignments. So far, I can follow easy problems."* This was affirmed by Respondent T6, "*For those who are low performing students, the task that should be given to them should be almost the same as the one you gave in the example because they are easily confused. Sometimes you just replace the given quantity because they can't do it without a guide."* and Respondent T4, *"Mostly, based on my experience, the strategies that the students use are peer tutoring, especially in discussion and activities. I always do groupings, but for low performing students, they will ask how to solve the problem, because they are incapable sometimes when they don't have guides. So, I partnered them with the good ones."*

According to Robertson and Kahney (1996) [49], in order for beginning students to solve problems that are unfamiliar to them, the method that they employ most frequently is one of imitation. Students benefit greatly from imitation because it enables them to arrive at a solution that has a good chance of being correct without requiring that the student fully comprehend the reason for that answer, and because it lays the groundwork for further education. Students can evaluate how well they are understanding the topic of the word problems they are working on by comparing their own work to the examples provided (Reeves & Weisberg, 1994) [48].

Conclusions

The following conclusions were made based on the evidence provided:

Students in grade 8 have a poor track record of success when completing word problems in linear equations. The math performance of students in the eighth grade in dealing with linear equation word problems is influenced by various factors, including age, sex, educational attainment of parents, occupation of parents, and monthly income. Linear equation word problems successfully categorized students as high, average, and low performers. Both students have differences and share difficulties, common errors, and strategies in solving linear equation word problems.

Understanding and analyzing the problem and conceptualizing the problem were encountered by both high, average and low-performing students. High-performing students experience fewer difficulties compared to others. Low-performing students have the most frequently encountered difficulties. The difficulties faced by 8th-grade students in solving linear equation word problems were broader than language.

Misinterpretation was the common error high, average, and low-performing students committed. High-performing students had the least committed errors. Both high and average-performing students committed negligence errors. Creating equations and computational error are both committed by average and low-performing students.

Experimentation was the common strategy high, average, and low-performing students used. High-performing students have several strategies for solving word problems compared to average and low-performing students.

Engagement in different mathematical word problems was an essential experience to develop a student's solving ability. The ability of students to deal with word problems can be developed through constant practice. Furthermore, the results of this study add to the body of literature regarding the performance, difficulties, common errors, and strategies of students in solving linear equation word problems in algebra.

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