World Journal of Educational Research
ISSN 2375-9771 (Print) ISSN 2333-5998 (Online)
Vol. 13, No. 4, 2026
www.scholink.org/ojs/index.php/wjer

*Original Paper*

# Cognitive Load and BSED Mathematics First Year Students' Performance in Solving Word Problems in Mathematics

Walid Sawwari Muhsin[1]

[1] Zamboanga Peninsula Polytechnic State University, Zamboanga City, Philippines

Received: July 19, 2026 Accepted: August 08, 2026 Online Published: August 28, 2026
doi:10.22158/wjer.v13n4p66 URL: http://dx.doi.org/10.22158/wjer.v13n4p66

***Abstract***

*The study aimed to determine the cognitive load and performance level in solving word problems in mathematics of first year students enrolled in Bachelor of Secondary Education Major in Mathematics in one of the state colleges in Zamboanga City. Additionally, it also intended to identify if significant relationship existed between cognitive load and the performance level of students in solving mathematics word problems. To address the research problem, a descriptive-quantitative correlational design was employed. The results indicated that cognitive load of students was "moderate" while the performance level in solving word problems in mathematics was average. This apparently revealed a very weak negative correlation, interpreted as not significant, between cognitive load and their performance. Presumably, the increase or decrease in cognitive load does not necessarily affect with their performance in solving math problems. In conclusion, cognitive overload might be one of the factors that affects performance level based on the results of the study. Other factors such as students' comprehension, foundational knowledge in algebra, as well as solving parallel problem experience may be considered variables of interest. Practical implications include pedagogical improvements in all branches of mathematics. A similar study should be conducted in a larger sample and include a broader topic in mathematics or even higher mathematics and other variables that will surely benefit curriculum implementors and propose appropriate interventions.*

***Keywords***

*Cognitive Load, Word Problems, BSED-Mathematics, Algebra, Real-life Mathematics, Solving*

## 1. Background of the Study

Mathematics nowadays has been feared by most of the students; it has been perceived as the most difficult discipline, where they automatically lose their interest upon hearing numbers or the word "mathematics" itself. Perceiving it as difficult is one of the factors why students started disliking or fearing mathematics. Some research proved that one of the factors why students dislike mathematics is the influence of adults and peers and how they view it negatively. Mathematics has long been regarded as one of the most imperative disciplines; it helps in building the foundational knowledge for logical reasoning, critical thinking, and problem solving.

Mathematics has numerous branches, which include algebra, trigonometry, geometry, etc., which are usually taught in a direct equation or solving-based manner. But written or problem-based activities are important in order to apply these mathematical concepts to real-world situations. Algebra might involve manipulating numbers and symbols to come up with a solution to an unknown, recognizing and analyzing patterns, looking at relationships, deriving generalizations, and comprehending change (Blanton et al., 2015; Seeley, 2004). Word problems are real life application of mathematical concept where it shows the relationship of these concepts to a physical world. Some of the examples of real-world application are age problem, work problem, number problem, speed problem and mixture problem. These word problems are application of linear equation in real life. Each and every mathematician, whether pure or applied, aspiring or experienced, benefits from the systematic development of algebraic concepts and proficiency in advanced algebra. Thus, the application of the algebraic concepts into real life is imperative as it will enhance their problem solving and critical thinking skill. Hence, determining their cognitive level in solving is pivotal for their own improvement.

However, answering word problems can be difficult for students since it requires not only mathematical skills but also reading comprehension, analysis, and the ability to translate verbal statements into mathematical expressions. For many students, this procedure adds new cognitive demands that may impair their performance. Students' ability to solve word problems may be influenced by many factors in cognitive. Mental effort or cognitive load is one of the factors where the capacity of the cognitive demands is limited and only required to process and learn new information.

According to Cognitive load theory (CLT) (Sweller, 1988), learning will be more effective when unnecessary cognitive demands are reduced and when the cognitive load and the working memory only focuses on the necessary and essential information, a higher tendency of solving the problem correctly. Thus, when student experience a higher cognitive load, they may find it hard to retain information and worst cannot comprehend the problem.

In mathematics education, understanding the cognitive load being experienced by student while solving or doing tasks is imperative for teachers as it will provide a valuable insight of how students process, learn, understand and solve complex problems. Leppink's (2013) cognitive load scale is a reliable way to measure the mental effort exerted by the students while doing task or solving problems. This scale consists of intrinsic load, extraneous load and germane load that is fully aligned to the Cognitive load theory (CLT) of Sweller (1988). Through this measurement, teachers and researchers can fully determine whether the cognitive load used and imposed while solving problems exceeds the capacity of working memory of the students as it may affect their performance.

Math major students are expected to perform well in solving mathematics problem and as a future math teachers, they should have a prior knowledge and enough skills in mathematics fundamental concepts. However, students with enough fundamental concept still problematic in solving, some of the causes are misinterpretation of the problem and stress while trying to understand the problem.

In connection to the observation of the researchers on the significance of cognitive level, stress and performance in solving word problems. The intention of this study is to identify the cognitive level and performance of freshmen students in solving word problems in mathematics enrolled in Bachelor of Secondary Education Major in Mathematics in one of the state colleges in Zamboanga City of Academic Year 2025-2026.

*1.2 Statement of the Problem*

This study aimed to determine the students' cognitive level in solving word problems in mathematics, specifically in real-life application of algebra of Bachelor of Secondary Education major in mathematics students in one of the state colleges in Zamboanga City. Specifically, it sought to answer the following research questions:

1. What is the level of cognitive load of BSED Mathematics first year students in solving word problems in Mathematics?
2. What is the performance level of students in solving word problems in Mathematics?
3. Is there a significant relationship between the cognitive load and performance of students in solving word problems in mathematics?
4. Is there a significant difference in the performance and cognitive load when they are grouped according to their sex?

## 2. METHOD

*2.1 Research Design*

This study employs descriptive-correlational quantitative research design as it aims to determine the relationship between cognitive load and students' performance in solving worded problems in mathematics, and to identify significant differences among variables. The objective of this study is to examine how cognitive load affects students' performance in solving worded calculus problems by analyzing both the degree of relationship and potential significant differences among subgroups such that when they are grouped according to their gender. According to Creswell (2014), a descriptive-correlational quantitative design involves collecting numerical data to describe characteristics, identify patterns, and examine relationships between variables without manipulating them.

This design is appropriate as it allows the researcher to gather data then quantitatively describe existing conditions of the cognitive load and performance of students in solving worded problems in mathematics, then explore the relationships, and compare differences across groups such as levels of cognitive load or academic performance categories.

This would help address the problem of the study and achieve its objective to understand how cognitive load influences mathematics problem-solving performance, by allowing researcher to gather, quantify and describe the data then carefully utilize the appropriate statistical analysis to determine the associations between variables.

*2.2 Population and Sampling*

The respondents of this study are the enrolled BSED first year students major in Mathematics of Zamboanga State College of Marine Sciences and Technology of Academic Year 2025-2026. They were chosen because they are directly involved in solving worded math problems as part of their major, which is the main focus of the study.

**Table 1. Summary of the Demographic Profile of the Participants of the Study**

| **Demographic Profile** | | **Frequencies *(%)*** *(N = 37)* |
|---|---|---|
| | Male | **15** *(41%)* |
| **Gender** | Female | **22** (*59%)*) |

The table one (1) presents the demographic profile of the respondents. The population of this study consists of 37 students who are officially enrolled in Bachelor of Secondary Education Major in Mathematics. Purposive non-probability sampling was used in this study to select the respondents base on a specific criterion, that is, a first-year student who are officially enrolled in Bachelor of secondary education majoring mathematics in the Academic Year 2025-2026. Total enumeration will be utilized in this study which means all students enrolled in the said course will be the respondents which consist of 15 males and 22 females.

*2.3 Research Locale*

This study will be conducted at Zamboanga State College of Marine Sciences and Technology, located at fort pilar, Zamboanga City. This institution started as the Southern Mindanao Branch of the Philippines institute of fisheries technology in 1956. The institution is offering a lot of courses that will cater students' interest and produce a globally competitive graduate.

The college is currently being managed by the college president, Vice-Presidents and Deans of different colleges which includes College of Business Management (CBM), College of Marine Engineering (CME), College of Fisheries and Allied Sciences (CFAS), College of Liberal Arts (CLA) and most importantly the College of Teacher Education (CTE) which is the main focus of this study.

The Zamboanga State College of Marine Sciences and Technology (ZSCMST) is now known as the center of excellence in fisheries and continue its journey of becoming a university.

*2.4 Instrument*

Being quantitative in nature, the main tool that was used in this research study is a test questionnaire. The questionnaire is a set of mathematical problems composed of different real-world problems under algebra specifically in linear equation which carefully prepared to answer by group of students who are enrolled in BSED mathematics first year. The said instrument was used in gathering an empirical data that is needed in the study. The data was used to determine the performance level in problem solving and their level of cognitive loads in answering. The instrument is divided into two parts, the first part is the demographic profile of the students, the second part is the 5-item Test Questionnaire covering different real-world problems in algebra that includes Age problem, Work problem, Number problem, Speed problem and mixture problem. Each of the word problem is followed by a cognitive load scale of Leppink et al., (2013) to measure their cognitive load right after the solving process.'

*2.5 Validity and Reliability*

The researchers consulted the expertise of the panel of experts by supplying and giving them a copy of the questionnaire to be reviewed in order to ensure and establish validity and reliability of the instrument. The research instruments were evaluated by three validators to ensure the appropriateness of the instrument. The experts carefully examined the two parts of the questionnaire for accuracy, precision, and clarity. One professor is a PhD candidate in Mathematics Education, and the other two is a PhD Completed Academic Requirements (CAR) also in Mathematics Education. The questionnaires were given out by the researchers shortly after it has been validated. After data gathering, the researcher used Inter-rater reliability to test the reliability of the questionnaire. The researcher requested from the panel of experts to rate the 37 questionnaires answered by the respondents using a rubric, the rubric gives a score of four (4) points to the answer if it follows correct solution and arrived at a correct answer. Three (3) points for getting a correct answer but there is slight error in the solution. Two (2) points only if partially correct method or solution but incorrect final answer and one (1) point for attempting to solve but shows misconception and 0 point for no attempt or irrelevant work. Cohen's Kappa was used to determine the agreement level and to test reliability. The results show 0.85 kappa value which means almost perfect agreement.

*2.6 Data Gathering and Analysis*

The data collection started by asking permission from the office of the vice president for the approval, followed by the college dean and program adviser and then the research teacher for letting construction and signing.

The research instrument was presented to the group of panels on the presentation for approval and validation of the questionnaire. Upon approval and validation, the researchers will retrieve the letter and proceed in conducting the survey.

The researchers started the data collection by administering the informed consent to the participants. Then, a 5-item questionnaire was given to the respondents.

After conducting the survey, the researcher organized and process the collected data using tools, analysis and interpretation.

For problem statement number 1, the descriptive mean is used to determine the average level of cognitive load experienced by BSED first year students. This tool is appropriate because the data that will be collected is in the form of Likert scale.

For problem statement number 2, the Descriptive Percentage is suitable to describe the performance level of the students.

For problem statement number 3, in order to determine the relationship between cognitive load and performance, a correlational statistic will be utilized specifically Pearson r, which will determine the strength and the direction of the relationship.

For problem statement number 4, in order to determine if there is significant difference in the cognitive load and performance of BSED first year student when they are grouped according to their sex, t-test will be used to compare the mean scores of the groups.

## 3. RESULTS AND DISCUSSION

The purpose of this study is to determine the cognitive load and BSED Mathematics first year students' performance in solving mathematics word problem. These problems are real life application of linear algebra algebra such that age problem

work problem, number problem, Speed-Distance-Time Problem and Mixture Problem.

***What is the level of cognitive load of BSED Mathematics first year students in Solving word problems in Mathematics?***

**Table 2. Cognitive Load in Solving Word Problems**

| Cognitive Load | Mean responses | Descriptive equivalent |
|---|---|---|
| Intrinsic Load | **4.0198** | High Cognitive Load |
| Extraneous Load | **2.465** | Low Cognitive Load |
| Germane Load | **4.472** | High Cognitive Load |
| Overall Mean | **3.652** | Moderate Cognitive Load |

Legends:

(1.00-2.00) Very Low Cognitive Load

(2.01-3.00) Low Cognitive Load

(3.01- 4.00) Moderate Cognitive Load

(4.01- 5.00) High Cognitive Load

(5.01-6.00) Very High Cognitive Load

Table two (2) presents the level of Cognitive load in solving word problems of the respondents. Weighted mean was used as a statistical tool in order to determine the level of Cognitive load based from the responses of the participants.

According to Sweller (1988), cognitive load consists of intrinsic, extraneous, and germane elements. The first part of the cognitive scale is the intrinsic load where it shows that the mean score of the respondents is 4.0198 with a descriptive equivalent of High Cognitive Load, which indicates that cognitive load of the respondents is High in terms of complexity and difficulty of the task or the problem given. This suggests that complexity of the problem and material highly affecting the cognitive load of students. This is high because it involves high effort in interpreting and understanding the problem. Sweller (1988) stated that intrinsic load refers to the inherent complexity of the material or the task. The complexity is contingent on the intrinsic nature of the learning matter and the foundational knowledge of the learners. Learner’s prior knowledge is significant because the size of meaningful information chunks that a learner can handle without overloading their working memory WM capacity is really dependent upon it (Van Gog & Rummel, 2010).

The second part of the cognitive scale is the Extraneous load where it shows that the mean score of the respondents is 2.465 with a descriptive equivalent of Low Cognitive Load, which indicates that cognitive load of the respondents is low in terms observable appearance of the problem such that poor instructional design (Sweller, 1988). Extraneous cognitive load largely varies according to the intended purpose of the instruction. For instance, when the goal of instruction is to construct problem solving schemas, extraneous load occurs if the materials present text and visuals that learners struggle to combine meaningfully (Chong, 2005).

The third and last part of the cognitive scale is the Germane load where it shows that the mean score of the respondents is 4.472 with a descriptive equivalent of High Cognitive Load, which says that cognitive load of the respondents is quite high in terms of the mental effort devoted to meaningful learning and schema development. This suggests that the germane load is high indicates that respondents are effectively using their mental effort to understand problems.

The table shows that the level of cognitive load that consists of intrinsic, extraneous and germane has an overall mean score of 3.652 with a descriptive equivalent of Moderate Cognitive Load which says that the cognitive load of the respondents is in moderate when solving word problems in mathematic. It means that the word problems in mathematics specifically in the real-

life application of linear algebra required a a moderate and reasonable mental effort to process and solve problems. It also suggests that the problems are challenging but not overwhelming.

**What is the performance level of students in solving word problems in Mathematics?**

**Table 3. Performance Level in Solving Word Problems**

| Word Problems | Mean score | Descriptive equivalent |
|---|---|---|
| Age Problem | **2.027** | Average Mastery |
| Work Problem | **1.622** | Low Mastery |
| Number Problem | **2.378** | Average Mastery |
| Speed-Distance-Time Problem | **1.541** | Low Mastery |
| Mixture Problem | **1.378** | Low Mastery |

| | | |
|---|---|---|
| Overall Mean | **1.789** | Average Mastery |

Legends: (0.00 - 0.80) Absolutely no mastery

(0.81 - 1.60) Low Mastery

(1.61 - 2.40) Average Mastery

(2.41 - 3.20) High Mastery

(3.21 - 4.00) Mastered

Table three (3) presents the level of performance in solving word problems, or the real-life application of linear algebra of the first-year students major in mathematics. Performance in mathematics can be examined and appraise through students' test scores and the quality of their problem-solving process (Polya, 1957). Weighted mean and percentage were used as a statistical tool in order to determine level of performance based from the responses of the respondents in solving the problem.

The solutions of the respondents were checked and evaluated using a rubric. The rubric gives a score of four (4) points to the answer if it follows correct solution and arrived at a correct answer. Three (3) points for getting a correct answer but there is slight error in the solution. Two (2) points only if partially correct method or solution but incorrect final answer and one (1) point for attempting to solve but shows misconception and 0 point for no attempt or irrelevant work.

The first word problem is an age problem where eleven (11) students got it correctly. One (1) student got a correct answer but there is slight error in the solution. Five (5) students got a partially correct method or solution but incorrect final answer. Eighteen (18) students attempted to solve but shows misconception and two (2) students didn't attempt to answer or showed irrelevant work. The mean score of the respondents is 2.027 with descriptive equivalent as Average Mastery which suggest that in age problem, the performance level of the respondents is moderate or average.

The second word problem is a work problem where six (6) students got it correctly. Also, six (6) students got a partially correct method or solution but incorrect final answer. Twenty-four (24) students attempted to solve but shows misconception and one (1) student didn't attempt to answer or showed irrelevant work. The mean score of the respondents is 1.622 with a descriptive equivalent as Low Mastery which suggest that in work problem, the performance level of the respondents is low.

The third word problem is a number problem where seventeen (17) students got it correctly. Two (2) students got a partially correct method or solution but incorrect final answer. Sixteen (16) students attempted to solve but shows misconception and two (2) students didn't attempt to answer or showed irrelevant work. The mean score of the respondents is 2.378 with descriptive equivalent as Average Mastery which suggest that in number problem, the performance level of the respondents is moderate or average.

The fourth word problem is a Speed-Distance-Time problem where four (4) students got it correctly. Eight (8) students got a partially correct method or solution but incorrect final answer and twenty-five (25) students attempted to solve but shows misconception. The mean score of the respondents is 1.541 with descriptive equivalent as Low Mastery which suggest that in Speed-Distance-Time problem, the performance level of the respondents is low.

The fifth and last word problem is a mixture problem where four (4) students got it correctly. Another Four (4) students got a partially correct method or solution but incorrect final answer. Twenty-seven (27) students attempted to solve but shows misconception and two (2) students didn't attempt to answer or showed irrelevant work. The mean score of the respondents is 1.378 with descriptive equivalent as Low Mastery which suggest that in mixture problem, the performance level of the respondents is low.

The table shows that the level of performance in solving word problems in mathematics specifically in the real-life application of linear algebra has an overall mean score of 1.789 with a descriptive equivalent of average mastery indicating that the performance level of the respondents is just but needs a lot of improvement. Word problems are real-life application of different concepts in mathematics that will help see the relevance of mathematics in a day-to-day life it is also based on Mathematical tasks that require translation of verbal information into mathematical expressions (Verschaffel et al., 2020)

***Is there a significant relationship between the cognitive load and performance of Students in solving word problems in mathematics?***

**Table 4. Correlation: Cognitive Load and Performance of Students in Solving Word Problem**

| **Variables** | **r-Value** | **P-Value** | **Interpretation** |
|---|---|---|---|
| Cognitive Load Performance | **-0.082** | 0.631 | Not significant |

Table 4 presents the correlation between the respondents' level of cognitive load and their performance in solving word problems in mathematics. A closer look at this table, it reveals that their cognitive load has a very weak negative correlation to their performance in solving word problems in mathematics (r= **-0.082**, p= 0.632), which is not significant at alpha .05. This accepts the null hypothesis which says that there is no significant relationship between the cognitive load and the performance of the respondents when solving word problems in mathematics. This suggests that that the cognitive load does not correlate with the students' performance in solving word problems. This also means that the the increase or decrease in cognitive load does not necessarily affect or does not correlate with their performance in solving the problem.

***Is there a significant difference in the performance and cognitive load when they are grouped according to their sex?***

**Table 5. Difference: Cognitive Load and Performance of Students in Solving Word Problem when Grouped According to Sex**

| Test Variable | Group Variable | Mean | SD | t obs | df | P-value | Interpretation |
|---|---|---|---|---|---|---|---|
| Performance | Male | 47.33 | 22.90 | 0 .584 | 35 | 0.563 | Not significant |
| | Female | 42.95 | 22.02 | | | | |
| Cognitive Load | Male | 58.68 | 15.04 | -0.847 | 35 | 0.403 | Not significant |
| | Female | 62.36 | 11.41 | | | | |

Table 5 presents the significant differences in the level of cognitive load and performance between male and female first year BSED mathematics students where T-test was used as a statistical treatment. For performance, since the t-obs is equal to 0.584 and the p-value equals 0.563 which is greater than alpha 0.05 with degrees of freedom of 35, therefore not significant. It says that there is no significant difference in the level performance when the data is grouped according to their sex. For cognitive load, since the t-obs is equal to -0.847 and the p-value equals 0.403 which is greater than alpha 0.05 with degrees of freedom of 35, therefore not significant. It also says that there is no significant difference in the cognitive load when the data is grouped according to their sex. The findings show that there are no significant differences in the level of cognitive load and performance when they are grouped according to their sex or between male and female first year student of BSED mathematics.

Gender-related differences have also been observed in relation to mathematical problem-solving. While earlier research shows that males often surpass females in complicated reasoning tasks, contemporary studies reveals that these differences have become insignificant. Hyde and Linn (2006) claimed that minor gender gaps in mathematics achievement, and subsequent integrated analysis by Lindberg et al. (2010) and Else-Quest et al. (2010)

## 4. Conclusions

Based on the findings of the study, the following conclusions were formulated. Word problems in linear equation requires critical thinking, comprehension and basic foundation in mathematics operation to be able to come up with correct solution and right answer. This study found out that the cognitive load of the first-year students while solving word problem is moderate which means that the respondents have an average cognitive load. This means that the mental effort and demands of the students were manageable but still finds it challenging. The researcher also found out that the performance level of the first-year BSED mathematics students in solving word problems is also average mastery which requires more practice, critical thinking and comprehension in solving word problems.

The study also found out that there is no significant relationship between the cognitive load and the performance of the respondents when solving word problems in mathematics. This means that the cognitive load does not correlate with the students' performance in solving word problems. This also means that the increase or decrease in cognitive load does not necessarily affect or does not correlate with their performance in solving the problem. Also, there is no significant difference in the performance level and cognitive load when the respondents are grouped according to their sex. Which means that the performance level and cognitive load of freshmen male and female student have no significant difference or they are on the same level.

This study recommends, teachers should design and present problems in mathematics in a way that reduces cognitive load of the students. In order to achieve this, teachers should simply the teaching and instruction, providing more example and adjust the complexity of the problem slowly and gradually. Students should practice more on solving problems, especially word problem in algebraic expressions to improve critical thinking, comprehension and master the concept needed in solving word problems. This study implies that administrators and teachers alike should plan out an appropriate interventions or curricular modifications. Such that integrating lessons and activities that will help improve students' cognitive strategies. A similar study should be conducted in a larger sample and include a broader topic in mathematics or even higher mathematics not just on linear equation. Include also other variables that will surely benefit curriculum implementers and propose appropriate interventions

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