International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Competency Levels in Mathematical Word Problem Solving and their Relationship to Academic Performance Among Grade 7 Students

Irish C. Say-a

Department of Education, Division of Davao del Sur, Philippines

Abstract

This study examined Grade 7 students' competency levels in mathematical word problem solving and their relationship to academic performance in a public secondary school in Davao del Sur, Philippines. A descriptive–correlational research design was employed involving forty-two (42) Grade 7 learners. A researcher-developed 40-item test assessed five domains: reading, comprehension, transformation, process, and encoding. Results showed high competency in reading but low competency in comprehension, transformation, process, and encoding, resulting in an overall classification of less competent. Academic performance likewise fell below expected mastery (M = 37.32). Pearson correlation analysis revealed a significant moderate relationship between competency levels and academic performance ($r = .42$, $p = .006$), indicating that higher competency corresponds to better achievement. These findings emphasize the importance of strengthening comprehension and mathematical representation through targeted instructional strategies integrating literacy and structured problem-solving frameworks.

Keywords: Mathematical Word Problems, Student Competency Levels, Academic Performance, Problem-Solving Domains, Grade 7 Learners, Descriptive–Correlational Study.

1. Introduction

Mathematical problem solving is central to developing critical thinking, analytical reasoning, and real-world application skills among learners. However, despite its importance, many students struggle particularly when mathematical tasks are presented in verbal or contextualized form. Word problems require not only computational skill but also reading comprehension, interpretation, logical reasoning, and accurate representation of mathematical relationships.

In many Philippine classrooms, learners demonstrate acceptable performance in routine computational exercises but encounter difficulty when solving word problems. National and local assessments consistently indicate lower performance in contextualized mathematical tasks. These challenges often stem from weak comprehension skills, difficulty translating verbal information into mathematical expressions, and limited strategic problem-solving approaches.

Although previous studies have examined students' mathematical achievement and general problem-solving abilities, most treat word problem solving as a single construct and provide limited analysis of

the specific stages where learners experience difficulty. Few studies have systematically examined students' competencies across distinct domains such as reading, comprehension, transformation, process, and encoding, particularly among Grade 7 learners, nor have they explicitly linked these domain-specific competencies to academic performance. This gap limits teachers' ability to design targeted instructional interventions based on precise learning needs.

Understanding students' competency levels in specific stages of word problem solving is therefore crucial. Rather than treating problem-solving difficulty as a general weakness, analyzing distinct domains—reading, comprehension, transformation, process, and encoding—provides clearer insight into where learners struggle.

This study aims to determine Grade 7 students' competency levels in mathematical word problem solving and examine their relationship with academic performance. By identifying critical areas of difficulty, the research contributes to instructional improvement and targeted intervention planning.

2. Review of Related Literature

The reviewed literature consistently underscores the vital role of Mathematics in scientific advancement and everyday functioning, while simultaneously revealing persistent challenges in students' mathematical competency, particularly in problem solving. Although Mathematics is foundational to logical reasoning, technological progress, and quantitative sciences, many learners perceive it as abstract, difficult, and disengaging. This perception is often attributed to limited instructional strategies and insufficient contextualization of mathematical concepts, which reduce student motivation and active participation in learning (Sugiman & Kusumah, 2010).

Several studies emphasize that successful mathematical learning depends heavily on learners' cognitive processes, including perception, memory, attention, and logical reasoning (Gomez-Pinilla & Hillman, 2013). However, international assessments indicate that many students demonstrate weaknesses in these domains, especially in higher-order thinking and problem-solving skills (Mullis et al., 2012). Such findings suggest that students frequently fail to acquire essential mathematical competencies, signaling a need for instructional interventions that strengthen cognitive engagement and conceptual understanding.

Problem solving is identified as a multifaceted process requiring the integration of mathematical knowledge and cognitive strategies. Tambychik et al. (2010) describe it as a sequential activity beginning with problem identification and concluding with solution verification, while Peng and Reggia (2012) further conceptualize it through hierarchical phases involving comprehension, planning, execution, and confirmation. Difficulties at any stage may impede successful problem resolution, particularly among students who struggle with attention, visual-spatial skills, language processing, and memory (MacFarlane & Woolfson, 2013).

Moreover, effective problem solving relies on interconnected support systems such as verbal reasoning, imagery, symbolic representation, planning, and organizational skills (Tambychik & Meerah, 2010). Disruptions in these systems can result in computational weaknesses, fragmented conceptual understanding, poor knowledge transfer, and difficulty forming meaningful connections among mathematical ideas (Phillips et al., 2010; Wang et al., 2013). McBride-Chang et al. (2011) further highlight the importance of visual-spatial ability in organizing and interpreting mathematical information.

Taken collectively, these studies reveal that students' difficulties in mathematical problem solving stem not only from limited procedural skills but also from broader cognitive and instructional factors.

Mathematical competency is therefore shaped by the interaction of teaching approaches, cognitive capacities, and conceptual mastery. The literature clearly indicates that strengthening problem-solving instruction and addressing learners' cognitive needs are essential for improving academic performance in Mathematics. This synthesis provides a strong foundation for the present study, which seeks to examine Grade 7 students' competency in mathematical word problem solving and its relationship to academic achievement.

2.1 Mathematical Word Problem Solving

Word problem solving is a complex cognitive task that integrates linguistic processing and mathematical reasoning. Studies indicate that students often fail not because of weak arithmetic skills but due to difficulty interpreting language structures embedded in mathematical problems.

2.2 Reading and Comprehension in Mathematics

Reading comprehension plays a significant role in solving word problems. Learners must extract relevant information, identify relationships, and disregard extraneous details. Weak comprehension skills limit the ability to conceptualize mathematical situations accurately.

2.3 Transformation and Mathematical Representation

Transformation refers to converting verbal statements into mathematical equations or expressions. Research suggests that many students struggle at this stage, particularly when multi-step reasoning is required.

2.4 Process and Encoding

The process stage involves executing mathematical operations accurately, while encoding requires presenting answers in appropriate form. Errors in these stages often reflect misunderstanding rather than computational inability.

Previous research consistently emphasizes that improving comprehension and representation skills significantly enhances mathematical problem-solving performance.

3. Methodology

3.1 Research Design

A descriptive–correlational research design was employed to determine the competency levels of Grade 7 students in mathematical word problem solving and to examine the relationship between competency and academic performance.

3.2 Participants and Sampling

The participants consisted of forty-two (42) Grade 7 students from Felipe-Innocencia Deluao National High School, Tanwalang, Sulop, Davao del Sur, Philippines, during School Year 2020–2021.

Purposive sampling was utilized, as the respondents were selected based on their availability and enrollment in Grade 7 Mathematics during the conduct of the study. This sampling approach was appropriate for examining the specific competencies of learners within the identified educational context.

3.3 Instrumentation and Reliability

A researcher-developed 40-item mathematical word problem test was administered to assess students' competency across five domains:

- Reading
- Comprehension
- Transformation
- Process

- Encoding

Content validation was conducted by Mathematics and English master teachers to ensure clarity, appropriateness of language, and alignment with Grade 7 learning competencies. Their feedback was incorporated to refine item construction and domain representation.

Prior to the actual administration, the instrument underwent pilot testing among learners with similar characteristics. Internal consistency reliability was established, yielding an acceptable reliability coefficient, indicating that the instrument was suitable for measuring students' mathematical word problem-solving competency.

3.4 Scoring Scale and Rubric

Students' competency levels were interpreted using a 5-point Likert scale as follows:

Parameter Limits	Response Category	Competency Level
4.20 – 5.00	Outstanding	Very Competent
3.40 – 4.19	Very Satisfactory	Moderately Competent
2.60 – 3.39	Satisfactory	Fairly Competent
1.80 – 2.59	Fairly Satisfactory	Less Competent
1.00 – 1.79	Did Not Meet Expectations	Not Competent

A rubric was used to evaluate performance in each domain:

Reading

- Reads the problem fluently and accurately
- Reads with minor difficulty
- Reads partially with noticeable difficulty
- Demonstrates significant difficulty in reading
- Unable to read the problem

Comprehension

- Fully comprehends the problem
- Demonstrates partial comprehension
- Shows limited understanding
- Displays minimal understanding
- Unable to demonstrate understanding

Transformation

- Accurately represents the problem using appropriate mathematical models
- Uses at least one correct representation
- Shows unclear or incomplete representation
- Demonstrates incorrect representation
- Unable to represent the problem

Process

- Executes strategies correctly and arrives at accurate solutions
- Applies strategies with minor computational errors
- Performs incomplete procedures
- Uses incorrect strategies

- Unable to perform mathematical processes
- **Encoding**
- Presents complete and accurate final answers with clear interpretation
- Provides understandable answers with minor omissions
- Gives unclear or incomplete responses
- Provides minimal or incorrect answers
- Unable to present final answers

3.5 Data Analysis

Descriptive statistics, including mean, minimum, and maximum values, were computed to determine students' competency levels across the five domains: reading, comprehension, transformation, process, and encoding.

The computed mean scores were interpreted using the predefined 5-point competency scale described in Section 3.4.

To determine the relationship between competency levels and academic performance, Pearson Product–Moment Correlation (r) was employed. The level of significance was set at 0.05. Statistical analyses were performed to determine whether a significant relationship existed between the variables.

4. Results

4.1 Competency Level

Table 3 shows the descriptive analysis of the competency level of the Grade 7 students in mathematical word problem solving based on the categories of reading the language used within a word problem, comprehension, transformation, process, and encoding. The frequency and percent of every category were tabulated, and the result was based on the description of outstanding, very satisfactory, satisfactory, and did not meet expectation.

Results revealed:

- High competency in Reading (M = 4.57)
- Low competency in Comprehension (M = 1.79)
- Low competency in Transformation (M = 1.62)
- Low competency in Process (M = 1.52)
- Low competency in Encoding (M = 1.50)

Overall competency was classified as **Less Competent (M = 2.33).**

Table 3. Competency Levels of Grade 7 Students in Mathematical Word Problem Solving. S.Y. 2020 – 2021.

Category	Mean	Description	Interpretation
Reading	4.57	Outstanding	Very Competent. Students demonstrated strong reading proficiency.
Comprehension	1.79	Did not meet the expectation	Not Competent. Students demonstrated limited comprehension of the problem.

Transformation	1.62	Did not meet the expectation	Not Competent. Students showed difficulty in mathematical representation.
Process	1.52	Did not meet the expectation	Not Competent. Students experienced difficulty executing mathematical operations.
Encoding	1.50	Did not meet the expectation	Not Competent. Students had difficulty presenting final answers.
Overall	2.33	Fairly Satisfactory	Less Competent. Students demonstrated below-average competence.

4.2 Academic Performance

Students' academic performance in mathematical word problem solving yielded a mean score of 37.32, which did not meet expected mastery levels as presented in Table 4.

Table 4. Grade 7 Student's Academic Performance Ratings in Mathematical Word Problem Solving. S.Y. 2020 – 2021.

Categories	Rating	Interpretation
Min	12.5	Did not meet the Expectation
Max	72.5	Fairly Satisfactory
Mode	30	Did not meet the Expectation
Mean	37.32	Did not meet the Expectation

4.3 Correlation Analysis

Table 5 shows the test of the significant relationship between the competency level and the students' performance in mathematics.

Pearson correlation revealed a statistically significant moderate positive relationship between competency level and academic performance ($r = .42$, $p = .006$).

Table 5. Relationship between the Competency Level and the Students' Performance in Mathematics.

Variable	r-value	Degree of Relationship	p-value	Decision
Competency	0.42	Moderate Positive	0.006	Reject Ho
Performance				

5. Discussion

The results indicate that students' challenges in mathematical word problem solving are primarily rooted in comprehension and representation rather than computation alone. Although learners demonstrated adequate reading ability, they struggled to translate verbal information into mathematical models and apply appropriate solution strategies.

This finding suggests that successful problem solving depends heavily on learners' capacity to interpret context, identify relationships, and organize information logically. Similar patterns have been observed in previous studies, where difficulties emerged during the problem representation stage rather than during calculation. These outcomes highlight the importance of integrating literacy-based approaches and structured problem-solving frameworks in mathematics instruction to support learners' conceptual understanding and analytical thinking.

This finding is consistent with Verschaffel et al. (2020), who emphasized that representation difficulties significantly hinder learners' success in mathematical word problem solving.

6. Conclusion

This study revealed that while Grade 7 learners possess basic reading skills, they exhibit limited competency in comprehension, transformation, processing, and encoding when solving mathematical word problems. Academic performance was significantly associated with competency level, indicating that strengthening specific problem-solving domains can lead to improved learning outcomes.

These findings emphasize the need for instructional practices that address both linguistic and cognitive demands of mathematics learning.

Ethics Statement

This study was conducted in accordance with ethical research standards. Permission to conduct the research was obtained from school authorities. Participation was voluntary, and informed consent was secured from students and their parents or guardians. Respondents were assured of confidentiality and anonymity, and all data were used solely for academic purposes.

8. References (APA 7th Edition Sample)

1. Abdullah, R. (2015). Preliminary study on semantic knowledge management model for collaborative learning. ARPN Journal of Engineering and Applied Sciences, 10(2), 442–450.
2. Bailey, D. H., Watts, T. W., Littlefield, A. K., & Geary, D. C. (2014). State and trait effects on individual differences in children's mathematical development. Psychological Science, 25(11), 2017–2026.
3. Basch, C. E. (2011). Healthier students are better learners: A missing link in school reforms to close the achievement gap. Journal of School Health, 81(10), 593–598.
4. Bautista, D., & Mulligan, J. (2010). Solutions of addition and subtraction word problems by Filipino public school children. Manuscript submitted for publication.
5. Chew, M. S. F., Shahrill, M., & Li, H. C. (2019). The integration of a problem-solving framework for Brunei high school mathematics curriculum in increasing students' affective competency. Journal on Mathematics Education, 10(2), 215–228.
6. Duke, N. K., Pearson, P. D., Strachan, S. L., & Billman, A. K. (2011). Essential elements of fostering and teaching reading comprehension. In M. L. Kamil et al. (Eds.), What research has to say about reading instruction (4th ed., pp. 286–314). International Reading Association.

7. Gomez-Pinilla, F., & Hillman, C. (2013). The influence of exercise on cognitive abilities. Comprehensive Physiology, 3(1), 403–428.
8. Kendeou, P., Van Den Broek, P., Helder, A., & Karlsson, J. (2014). A cognitive view of reading comprehension: Implications for reading difficulties. Learning Disabilities Research & Practice, 29(1), 10–16.
9. Leighton, J. P., & Gierl, M. J. (2011). The learning sciences in educational assessment: The role of cognitive models. Cambridge University Press.
10. Leikin, R. (2019). Developing mathematical talent in schoolchildren: Who, what, and how. In S. I. Pfeiffer (Ed.), The psychology of high performance: Translating human potential into domain-specific talent (pp. 173–192). Springer.
11. MacFarlane, K., & Woolfson, L. M. (2013). Teacher attitudes and behavior toward the inclusion of children with social, emotional and behavioral difficulties in mainstream schools: An application of the theory of planned behavior. Teaching and Teacher Education, 29, 46–52.
12. Mamolo, L. (2019). Analysis of senior high school students' competency in general Mathematics. Universal Journal of Educational Research, 7(9), 1938–1944.
13. McBride-Chang, C., Zhou, Y., Cho, J. R., Aram, D., Levin, I., & Tolchinsky, L. (2011). Visual spatial skill: A consequence of learning to read? Journal of Experimental Child Psychology, 109(2), 256–262.
14. Mullis, I. V. S., Martin, M. O., Foy, P., & Arora, A. (2012). TIMSS 2011 international results in mathematics. TIMSS & PIRLS International Study Center, Boston College.
15. Newman, M. A. (1997). An analysis of sixth-grade pupils' errors on written mathematical tasks. Victorian Institute for Educational Research.
16. Niss, M., & Højgaard, T. (2019). Mathematical competencies revisited. Educational Studies in Mathematics, 102(1), 9–28.
17. Norris, P., & Epstein, S. (2011). An experiential thinking style: Its facets and relations with objective and subjective criterion measures. Journal of Personality, 79(5), 1043–1080.
18. Ozturk, T., & Guven, B. (2016). Evaluating students' beliefs in problem solving process: A case study. Eurasia Journal of Mathematics, Science and Technology Education, 12(3), 411–429.
19. Peng, Y., & Reggia, J. A. (2012). Abductive inference models for diagnostic problem-solving. Springer Science & Business Media.
20. Phillips, L. M., Norris, S. P., & Macnab, J. S. (2010). Visualization in mathematics, reading and science education (Vol. 5). Springer Science & Business Media.
21. Sabu, S. (2010). In-service training programmes and teaching competence of teachers. Edutracks, 9(9).
22. Sengul, S., & Katranci, Y. (2015). Meta-cognitive aspects of solving indefinite integral problems. Procedia – Social and Behavioral Sciences, 197, 123–130.
23. Sugiman, D., & Kusumah, Y. S. (2010). Dampak pendidikan matematika realistik terhadap peningkatan kemampuan pemecahan masalah siswa SMP. IndoMS Journal on Mathematics Education, 1(1), 41–51.
24. Sukanya, M., & Biruntha, S. (2012, August). Techniques on text mining. In 2012 IEEE International Conference on Advanced Communication Control and Computing Technologies (ICACCCT) (pp. 269–271). IEEE.

25. Tambychik, T., & Meerah, T. S. M., (2010). Students' difficulties in mathematics problem-solving: What do they say?. International Conference on Mathematics Education Research 2010 (ICMER 2010). Procedia – Social and Behavioral Sciences, 8, 142–151.
26. Tambychik, T., & Meerah, T. S. M. (2010). Mathematics Skills Difficulties: A Mixture of Intrecacies. International Conference on Learner Diversity 2010. Procedia – Social and Behavioral Sciences, 7(C), 171–180.
27. Ulya, H., & Kartono, A. R. (2014). The effect of cooperative learning model on students' mathematics problem-solving ability. International Journal of Education and Research, 2(5), 577–582.
28. Verschaffel, L., Schukajlow, S., Star, J., & Van Dooren, W. (2020). Word problems in mathematics education: a survey. ZDM, 52(1), 1–16.
29. Wang, M. T., Eccles, J. S., & Kenny, S. (2013). Not lack of ability but more choice: Individual and gender differences in choice of careers in science, technology, engineering, and mathematics. Psychological Science, 24(5), 770–775.
30. Wittmann, E. C. (2021). Teaching units as the integrating core of mathematics education. In Connecting Mathematics and Mathematics Education (pp. 25–36). Springer.
31. Zakaria, E., Chin, L. C., & Daud, M. Y. (2010). The effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. Journal of Social Sciences, 6(2), 272–277