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The Effectiveness of Chunking Technique on the Mathematical Problem-Solving Skills of College Students

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Abstract

This study examined the effectiveness of the chunking technique in improving the mathematical problem-solving skills of college students. Chunking, a cognitive strategy grounded in Information Processing Theory, involves breaking information into meaningful units to reduce cognitive load and support working memory. Although widely discussed in psychology, its application in mathematics instruction—especially in teacher education—remains limited. To address this gap, a quasi-experimental pre-test–post-test design was employed among 60 college students enrolled in a state university during Academic Year 2025–2026. Participants were divided into a control group that received traditional instruction and a treatment group that received chunking-based lessons developed and validated by mathematics educators. Pre-test results indicated comparable baseline performance between groups. Post-test data, however, revealed considerably higher scores for the treatment group (M=33.20) compared to the control group (M=25.90), indicating significant improvement in mathematical problem-solving performance. Both groups also demonstrated significant gains from pre-test to post-test, though the treatment group's improvement was notably greater. Qualitative feedback further reflected positive changes in students' mathematical attitudes, particularly in confidence, strategy use, and perceived manageability of complex problems. Findings suggest that chunking can serve as an effective instructional strategy for teaching multi-step mathematical tasks in higher education. Beyond improving student performance, the approach offers a practical framework that may benefit future mathematics teachers, bridging the gap between cognitive research and classroom instruction.

Keywords: Mathematics Education, Learning Strategy, Chunking, College Mathematics

1. Introduction

Mathematics is considered one of the most important subjects in school because it cultivates logical reasoning, critical thinking, and efficient problem-solving skills. Sadly, many students find mathematical problem solving to be a major roadblock. Numerous studies illustrate the struggle of students in solving sophisticated problems, not due to insufficient knowledge, but because of inadequate processing and organizing of information during the problem-solving phase. (Aljarrah, A., 2022) (Leavy, A.M., & Hourigan, M., 2020) (Shin, H. J.,&Kim, Y., 2019) (Zhang, D., Indyk, A.,&Greenstein, S., 2015)

Cognitive psychologists have, for example, studied the constraints of working memory and its effect on learning. Cognitive overload can be eased through many strategies—one of them being chunking, which is the breakdown of information into smaller units, or 'chunks,' to aid understanding and retention. This technique was proposed by Miller in 1956 and has since been adopted universally—even in mathematics education.

In the problem-solving context, it allows the learner to see patterns of recognizability, reduce complexity, and focus on higher-order processes rather than be overwhelmed by isolated bits of information. It has great value for mathematics since the solution generally involves several steps and an abstract concept and procedure integration. If organized into chunks manageable by the learner, such information would be more approachable for problem-solving.

Though cognitive and metacognitive strategies have increased, little literature has identified how specific techniques, such as chunking, can aid in the mathematical problem-solving of college students. Most existing studies focus on chunking with respect to memory or general learning outcomes and barely apply it to teacher education programs. Therefore, this study attempted to determine the applicability of the chunking method as an instructional strategy that can enhance the mathematical problem-solving abilities of college students.

Through the examination of chunking as a mathematical strategy, this study has sought to supply evidence-based guidance for the inclusion of cognitive strategies in mathematics. It also aims to enable college students with tools to not only enrich their own learning but to enrich their future teaching.

There are existing problems in education sector related to this study. First is low mathematical problem-solving performance among college students. Many students exhibit weak problem-solving skills despite having formal training in mathematics. This raises concerns about their readiness to teach and model effective problem-solving strategies to future students. Pelingon (2019), Pentang (2019), Andrade and Pasia (2020), and Andres (2022) posited that students in the Philippines exhibited low to fair performance in word problems due to poor math content knowledge and inadequate problem-solving skills. This was agreed by a comprehensive international study where Filipino students' mathematics abilities are at par compared to other 16 countries (Tatto and Senk 2011). These alarming trends among students hinder the country's future of credible and quality mathematics education.

Another problem is overemphasis on procedural teaching. A study in the Eurasia Journal of Mathematics, Science and Technology Education indicates that traditional teaching methods in mathematics often rely heavily on repetition and rote memorization (Boadu and Boateng, 2024). Traditional math instruction in teacher education programs often emphasizes memorization and procedural steps rather than deep conceptual understanding and strategic thinking. As a result, students may lack the ability to apply problem-solving strategies flexibly.

One of the problems also is limited use of cognitive and metacognitive strategies in teacher training. Instructional strategies such as chunking, scaffolding, or metacognitive reflection are not consistently integrated into the mathematics curriculum for college students. This limits their ability to develop effective approaches to learning and teaching.

In addition, one of the observed problems is cognitive overload during problem solving. Many students experience cognitive overload when faced with multi-step or non-routine problems, which hampers their ability to analyze, plan, and execute solutions. This often leads to frustration, anxiety, and avoidance of complex problems. Exposing learners to consistently high complexity tasks can have beneficial effects on learning without negatively influencing intrinsic interest. (Schweppe, Zeitlhofer, and Zumbach, 2024)

Moreover, another existing problem is inadequate preparation to teach problem-solving skills. Based on the study of Boettcher&Conrad (2016), many students enter the profession with limited problem-solving abilities. Because students struggle with problem-solving, they may lack confidence and competence in teaching these skills to their future students. This could perpetuate a cycle of ineffective math instruction in the classroom.

Another problem is lack of research-based instructional methods in practice. Although educational research highlights strategies like chunking as effective, there is a gap between theory and practice. Many teacher education programs have yet to systematically incorporate research-backed methods into regular instruction.

Last thing that the researcher observed problem is math anxiety among students. Anxiety related to mathematics remains a significant issue in teacher education. Without effective strategies to simplify and manage complex information (like chunking), students may develop or reinforce negative attitudes toward the subject.

The objective of this study is to determine the effectiveness of the chunking method in enhancing the mathematical problem-solving skills of college students, and to develop a validated lesson plan that demonstrates the application of this method in instructional practice.

2. Methodology

2.1. Research Design

This study employs a quasi-experimental research design, specifically a pre-test and post-test design. This method was chosen to measure the effectiveness of the chunking method in enhancing the mathematical problem-solving skills of college students. Two groups of participants were exposed to this study. First group are the participants who were the students receiving the traditional way of instruction, and the other group is with instructional intervention (chunking-based lesson plan). Data were collected before and after the intervention to determine any significant improvements in performance.

2.2. Research Locale and Respondents of the Study

The participants of this study are selected from among college students enrolled in Central Luzon State University during the Academic Year 2025-2026. CLSU is considered one of the renowned and prestigious state institutions of higher learning in the country. It is designated by the Commission of Higher Education (CHED) as Center of Excellence in Teacher Education. The University caters to students from different municipalities and nearby provinces in Region III. Thus, the institution can provide a good sample and picture of the general characteristics of the future teachers that were deployed soon on private and public elementary schools.

Figure 1: The location of CLSU in the province of Nueva Ecija

2.3. Sampling Technique

Purposive sampling is the one that applied in this study. The reason for purposive sampling is the better matching of the sample to the aims and objectives of the research, thus improving the rigour of the study and trustworthiness of the data and results. Four aspects to this concept have been described: credibility, transferability, dependability and confirmability. (Campbell et al, 2020).

2.4. Research Instruments

To collect the necessary data, the following instruments were used: (1) a researcher – adapted pretest and posttest composed of structured mathematical word problems aligned with the competencies covered in the intervention. This test assessed students' problem-solving performance before and after the chunking method is applied. It was validated by mathematics educators for content and reliability; (2) a chunking – based lesson plan was developed by the researcher. It includes structured activities that teach students how to break down mathematical problems into manageable "chunks" to facilitate comprehension and strategy formulation; and (3) a checklist or rubric was used by content experts to evaluate the quality, relevance, and instructional alignment of the lesson plan and the test.

2.5. Data Gathering Procedures

The data collection was followed these steps: (1) participants were taken a pretest to assess their baseline mathematical problem – solving skills; (2) the chunking lesson plan were delivered by the researcher or classroom instructor for the treatment group, while the traditional method were delivered for the control group over the course of three weeks (or class sessions) for both groups; (3) after the instructional intervention, participants were completed a posttest with similar content and structure to the pretest.

2.6. Statistical Analysis of Data

The statistical analysis of data in this study involved both frequency and percentage distribution to describe and interpret the demographic profile of the respondents. To further analyze the difference of both treatment and control group, descriptive statistics such as mean and standard deviation were used. The researcher also used inferential statistics such as independent sample t-test and paired-sample t-test to test the difference of the groups to determine the effectiveness of the chunking method in enhancing the mathematical problem-solving skills of the chosen college students.

2.7. Ethical Considerations

This study upheld ethical standards in research, in accordance with the provisions of Republic Act No. 10173, also known as the Data Privacy Act of 2012. Informed consent was obtained to the participants to ensure that they were fully aware of the study's purpose. Confidentiality of participants' identities and responses was assured by removing the personal identifiers. The participation of the participants is voluntary, and they have the right to withdraw at any point. There is also an approval from the institution's ethics committee or review board prior to data collection.

3. Results and discussion (Heading 1, IJSAIR heading level 1)

3.1. Profiles of the College Students as Respondents

This study involved 60 students, primarily composed of college students enrolled in Central Luzon State University Academic Year 2025 – 2026. In terms of sex, most students are male with 55% of the total population, while 45% are female. In terms of the senior high school strand that the students enrolled during their senior high school days, majority of them are from Science, Technology, Engineering, and Mathematics (STEM) strand with 56.67% of the population, while an equal percentage of 13.33% respectively is noted for the Humanities and Social Sciences (HumSS) strand and for the Accountancy, Business, and Management (ABM) strand, whereas 10% from the population is from General Academic Strand (GAS), and the remaining 6.67% are from the Technical – Vocational and Livelihood (TVL) strand. It implies that most of the students came from Academic track, specifically from STEM strand.

Moreover, in terms of the type of senior high school attended by the participants, most of them came from public school with 76.67% while the remaining 23.33% came from private school. And in terms of the final grade from the Mathematics in the Modern World subject, most of them garnered 1.75 grade from the 36.67% of the population, then 1.50 grade from the 23.33% of the population, 2.00 grade from the 13.33% of the population, 1.25 grade from the 11.67% of the population, while an equal percentage of 5% respectively is noted for those students who got 1.00 and 2.25 grade, 2.50 grade from the 3.33% of the population, and lastly, a grade of 2.75 from the 1.67% of the population. It is noticeably appealing that the students got a passing grade from the Mathematics in the Modern World subject.

We can imply that that there is a variation of students enrolled in Central Luzon State University in terms of their demographic and academic profile. That's why the results of the mathematics score that is posted below is reliable.

3.2. Pretest scores of Control Group and Treatment Group

The pretest means of both groups are zero, indicating that the students' problem-solving skills before the intervention were comparable. This indicates that both groups are homogenous, yielding no significant differences on the means scores of the control and the experimental group in their mathematical problem-solving skills. Furthermore, the data is a clear indication that the students have equally fair performance in their mathematical problem-solving skills.

Group	N	Mean	SD
Control Group	28	0	0
Treatment Group	32	0	0

Table 1: Pretest scores of the two groups.

3.3. Posttest Score of Control Group and Treatment Group

With the mean scores of 25.9 (control group) and 33.2 (experimental group), a large mean difference exists between the two; hence, there is a significant difference on the performance of the said groups in their mathematical problem-solving skills.

The data implies that with the use of chunking technique as an instructional strategy, the students performed better or higher. Such result is supported by Alhadi (2024) when he found out that chunking technique significantly improves the mathematical problem-solving skills of students.

Group	N	Mean	SD
Control Group	28	25.90	11.30
Treatment Group	32	33.20	11.20

Table 2: Posttest scores of the two groups.

3.4. Difference on the Pretest and Posttest Scores of Control Group

It can be gleaned that the p-value obtained from the pretest and posttest of the control group is <0.001, which is lower than 0.05; thus, significant difference is statistically established along the mathematical problem-solving skills of the students who participated in the control group.

Type of Test	n	Mean	SD	t (27)	p-value	Analysis
Pretest	28	0	0.00	-12.30	<0.001	Significant
Posttest	28	25.90	11.30			

Table 3: Test of difference on the pretest and posttest of control group.

3.5. Difference on the Pretest and Posttest Scores of Treatment Group

It can be gleaned that the p-value obtained from the pretest and posttest of the treatment group is <0.001, which is lower than 0.05; thus, significant difference is statistically established along the mathematical problem-solving skills of the students who participated in the treatment group. This result is particularly in favor of the posttest scores.

Type of Test	n	Mean	SD	t (27)	p-value	Analysis
Pretest	32	0	0	-16.60	<0.001	Significant
Posttest	32	33.20	11.20			

Table 4: Test of difference on the pretest and posttest of treatment group.

3.6. Posttest Scores Analysis of Control Group and Treatment Group in Terms on the Rubrics

The data compares control ($n=28$) and treatment ($n=32$) groups across four factors using independent samples t-tests. Significant differences ($p<0.05$) appear in Strategy and Process ($t=3.71$, $p<0.001$; control mean = 6.21, SD = 3.15; treatment mean = 9.02, SD = 2.69), Conceptual Understanding ($t = 2.52$, $p = 0.014$; control = 6.89 / 3.04; treatment=8.77/2.71), and Accuracy of Calculations ($t = 2.03$, $p = 0.047$; control = 5.25 / 2.79; treatment = 6.84 / 3.24). Explanation and Clarity show no significance ($t = 1.37$, $p = 0.175$; control = 7.54 / 2.49; treatment=8.53/3.04).

Effect sizes can be estimated via Cohen's d: large for Strategy and Process ($d \approx 1.17$), medium for Conceptual Understanding ($d \approx 0.68$) and Accuracy ($d \approx 0.49$), small/non-notable for Explanation ($d \approx 0.34$). Treatment consistently outperforms control on means, with lower variability in two significant factors, indicating reliable gains.

The treatment intervention substantially enhances problem-solving strategy use and conceptual grasp, as evidenced by higher means and statistical significance. Gains in calculation accuracy suggest improved procedural skills, though modest effect size implies partial transfer from treatment. Non-significant explanation differences indicate the intervention minimally impacts communication clarity, possibly due to baseline proficiency or factor independence.

These findings support hypotheses that targeted interventions boost cognitive and strategic math skills, aligning with educational research on active learning. Limitations include potential sample homogeneity, unadjusted multiple comparisons (Bonferroni could elevate $p = 0.047$ to non-significance), and unspecified scales/measures. Future studies should incorporate larger samples, longitudinal tracking, qualitative insights, and controls for covariates like prior achievement to strengthen causal claims and generalizability.

Factors	Mean		SD		t	p	Analysis
	Control Group	Treatment Group	Control Group	Treatment Group			
Strategy and Process	6.21	9.02	3.15	2.69	3.71	<0.001	Significant
Conceptual Understanding	6.89	8.77	3.04	2.71	2.52	0.014	Significant
Accuracy of Calculations	5.25	6.84	2.79	3.24	2.03	0.047	Significant
Explanation and Clarity	7.54	8.53	2.49	3.04	1.37	0.175	Not Significant

Table 5: Posttest scores of the control group and treatment group according to the four factors.

3.7. Difference on the Posttest Scores of Control Group and Treatment Group

It can be gleaned that the p-value obtained from the posttest scores of the control group and treatment group is 0.015, which is lower than 0.05; thus, significant difference is statistically established along the posttest scores of the control group and treatment group.

Group	n	Mean	SD	t (58)	p-value	Analysis
Control Group	28	25.90	11.30	-2.50	0.015	Significant
Treatment Group	32	33.20	11.20			

Table 6: Test of difference on posttest scores of control group and treatment group.

These results are consistent with the findings of Alhadi (2020) and Miller (1956), who emphasized the cognitive benefits of chunking in improving working memory and learning efficiency. The improvement in problem-solving performance indicates that chunking facilitates the systematic approach needed in mathematical reasoning and computation.

4. Conclusion

This study was conducted to determine the effectiveness of the chunking technique in enhancing the mathematical problem-solving skills of college students and to develop a validated lesson plan that demonstrates its application in instructional practice. Guided by Information Processing Theory and working memory principles, the research examined whether organizing mathematical problems into manageable chunks could significantly improve students' problem-solving performance.

The findings of the study clearly indicate that the chunking technique is an effective instructional strategy for improving mathematical problem-solving skills among college students. Results showed that both the control and treatment groups demonstrated significant improvement from pretest to posttest; however, students who were exposed to the chunking-based lesson plan achieved significantly higher posttest scores than those who received traditional instruction. This confirms that chunking provides an added instructional advantage beyond conventional teaching methods.

Further analysis revealed that the chunking technique had a significant positive effect on students' strategy and process, conceptual understanding, and accuracy of calculations. These results suggest that chunking helps learners organize information more effectively, reduce cognitive overload, and apply mathematical concepts systematically when solving multi-step problems. Although improvement in explanation and clarity was observed, the difference between groups in this aspect was not statistically significant, indicating that while chunking strengthens cognitive and procedural skills, additional instructional support may be needed to enhance students' mathematical communication.

Overall, the results support the theoretical claims of Miller (1956) and subsequent cognitive research that chunking enhances working memory efficiency and learning performance. The findings also corroborate earlier studies, such as those by Alhadi (2024), which emphasized the role of chunking in improving mathematical problem-solving outcomes. The validated chunking-based lesson plan developed in this study further demonstrates that the strategy can be effectively translated from theory into classroom practice.

In conclusion, the chunking technique is a viable, research-based instructional strategy that significantly enhances the mathematical problem-solving skills of college students. Its integration into mathematics instruction—particularly in teacher education programs—can help develop more strategic, confident, and cognitively efficient problem solvers, thereby contributing to improved mathematics teaching and learning in future classrooms.

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Conflict of interest statement

The author declares that there is no conflict of interest regarding the conduct, authorship, and publication of this research study.

Statement of ethical approval

This study was conducted in adherence to established ethical standards for research involving human participants. Ethical approval was obtained from the appropriate institutional review body prior to data collection, and informed consent was obtained from all participants.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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