

Effectiveness of Mathematics Drills on the Speed, Accuracy, and Automaticity of Multiplication Skills of Grade 4 Learners: Basis for Enhancement Program

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Abstract—This study determined the effectiveness of mathematics drills on the speed, accuracy, and automaticity of multiplication skills among Grade 4 learners in selected public elementary schools in Cabiao, Nueva Ecija during School Year 2025–2026. A descriptive quantitative-correlational research design was employed. Data were collected using a researcher-made questionnaire and an adapted Multiplication Basic Facts Test. The data were analyzed using weighted mean and Pearson Product-Moment Correlation Coefficient and were presented in tables with corresponding interpretations. Findings revealed that teachers sometimes utilized mathematics drills in classroom instruction, with mental mathematics drills as the most frequently used strategy. In terms of learners' multiplication skills, results showed a frustration level in speed, poor performance in accuracy, and non-automaticity, indicating difficulty in solving multiplication facts efficiently and correctly. Moreover, a significant relationship was found between the frequency of mathematics drill utilization and learners' multiplication skills in terms of speed, accuracy, and automaticity, with drill charts or tables being the only mathematics drill that showed a significant relationship across the three skills. The study concludes that consistent, combined, and structured use of mathematics drills enhances learners' multiplication fluency and computational performance. The findings support Logan's Instance Theory of Automaticity, which explains that repeated practice strengthens memory retrieval and improves mathematical fluency. Based on the results, a Mathematics Drill Enhancement Program was proposed to strengthen learners' multiplication mastery and improve instructional effectiveness in mathematics education among Grade 4 learners.

Index Terms—Polytechnic University of the Philippines, Cabiao Campus, Bachelor of Elementary Education, mathematics drills, multiplication skills, speed, accuracy, automaticity, Grade 4 learners.

1. The Problem and its Setting

A. Introduction

Multiplication fluency is a critical foundation in mathematics learning, serving as the basis for more complex computations and higher-order problem-solving skills. Mastery of basic

operations, particularly multiplication, is essential for learners to successfully engage with topics such as division, fractions, and algebraic reasoning, and those who fail to achieve fluency often struggle with these areas (DepEd, 2024). Strengthening multiplication skills through structured practice and scaffolded drills therefore remains a central component of effective mathematics instruction (DepEd, 2024).

However, the Filipino students' skill level in mathematics is still a concerning issue today. Learners in the Philippines, especially in the elementary have mounting learning crises in basic mathematics and numeracy. The results of student assessment as indicated by the PISA 2022 rankings showed that the Philippines ranked 77th out of 81 countries globally and scored below the Organisation for Economic Co-operation and Development (OECD) average in mathematics, reading, and science (Ranada, 2023). Out of 24 million enrolled students, 3 million are struggling with functional literacy that also indicates learning gaps in mathematics. In response, the government came up with an intervention mandating free tutorials for reading, mathematics and science through Academic Recovery and Accessible Learning (ARAL) Program under Republic Act 12028 (De Vera, 2025). Furthermore, the majority of grade 4 learners showed difficulty answering items that involved solving multiplication and division (Palma & Cadiz, 2024). They perceived that one of the hindrances is the non-mastery of basic multiplication facts.

This study aims to determine the relationship between the frequency of respondents' teachers' utilization of mathematics drill and respondents' speed, accuracy, and automaticity of multiplication skills. While many studies have explored the general effects of mathematics drills on multiplication performance, this study seeks to focus on identifying which specific skills-speed, accuracy, or automaticity require improvement and which have already been mastered by the majority of learners in the selected schools in Cabiao, Nueva Ecija. By examining these specific variables, the findings will serve as the foundation for developing a Math Drill

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Enhancement Program.

As Bachelor of Elementary Education (BEED) students, this research is a vital part of our academic development and professional preparation. This study seeks to contribute to the field of mathematics pedagogy by developing a Math Drill Enhancement Program, informed by an analysis of the correlation between Grade 4 learners' multiplication mastery and the frequency of math drill utilization. Conducted under the formal authorization of the Polytechnic University of the Philippines–Cabiao Campus, this research adheres to strict ethical standards, prioritizing informed consent and participant confidentiality.

B. Theoretical Framework

The process of acquiring mastery in speed, accuracy, and automaticity in solving multiplication problems requires constant exposure to repeated practice. This study aims to assess how the frequency of utilizing mathematics drills affects the multiplication skills of Grade 4 learners. Thus, its foundation was anchored to Gordon D. Logan's Instance Theory of Automaticity, which stated that automaticity was a transition from algorithmic processing to memory retrieval.

In accordance with Logan's theory, the more a student performs drills, the more they build instances in their memory. Eventually, the brain stops working the problem and starts calling the answer. Every time they encounter a stimulus such as mathematics drills, a new trace of memory is created; therefore, the faster the student pulls the answer from long-term memory. In this theory, speed refers to the time it takes to finish a task or a test as a result of the race between calculation and memory. On the other hand, automaticity refers to the point where the effort in calculation is not necessary and bypassed entirely. It is not solely about being fast but represents a fundamental change in how the task is performed. Moreover, since the memory retrieval of a fixed fact is less prone to error than performing a calculation, accuracy has a higher possibility of naturally increasing as instances grow.

The Instance Theory of Automaticity explains that the more students engage in mathematics drills, the more basic facts will be stored in their memory so that calculation will not be necessary to solve multiplication but through retrieval of memory. As a result, the time required to respond decreases, the retrieval becomes obligatory and needs less conscious effort, and it can lead to higher accuracy with low margin of error.

C. Conceptual Framework

The figure 1 describes the conceptual framework of the study entitled "Effectiveness of Mathematics Drills on the Speed, Accuracy, and Automaticity of Multiplication Skills of Grade 4 Learners: Basis for Enhancement Program." The paradigm applies the IV-DV (Independent Variable – Dependent Variable) framework to illustrate the relationship between the Mathematics Drill Materials, serving as the independent variable, and the Speed, Accuracy, and Automaticity in solving multiplication, which act as the dependent variable. This illustrates the utilization of drill materials as the primary factor intended to influence and enhance the proficiency of learners in

multiplication.

In contrast, the dependent variables focused on the learners' multiplication skills, categorized into three distinct areas: Speed, Accuracy, and Automaticity. Speed refers to how quickly students can solve multiplication problems; Accuracy denotes the correctness of their answers; and Automaticity represents the ability to quickly retrieve answers directly from memory rather than relying on traditional, slower counting strategies.

To determine the effectiveness of the intervention, data on the independent variable, specifically the frequency of mathematics drill utilization, were gathered from the drills conducted by teachers in the selected schools. Simultaneously, the students' performance levels in speed, accuracy, and automaticity were measured and analyzed through a test before the school year ends. This relationship is supported by Gordon D. Logan's Instance Theory of Automaticity. The theory indicates that exposure to repeated practice through regular drills shifts cognitive processing from effortful computation to immediate memory retrieval, thereby simultaneously increasing speed, reducing errors, and establishing automaticity.

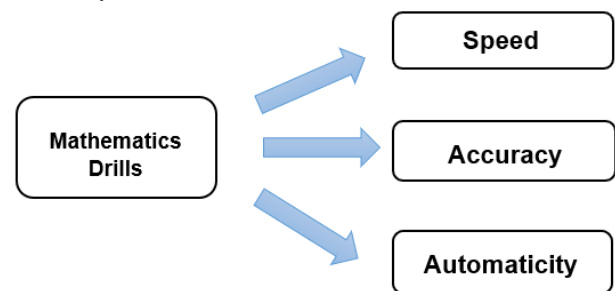


Fig. 1. Conceptual paradigm

D. Statement of the Problem

This study aimed to determine the frequency of utilizing mathematics drills and multiplication skill levels of Grade 4 learners as a basis for designing a math drill enhancement program that addresses both their developmental needs and cognitive processing demands in solving multiplication.

1. How often do teachers utilize commonly used mathematics drills in Grade 4 classrooms?
2. What is the level of multiplication skills of the respondents in terms of:
 1. Speed;
 2. Accuracy; and
 3. Automaticity?
3. Is there a significant relationship between the frequency of mathematics drill utilization and the respondents' speed, accuracy, and automaticity in solving multiplication?
4. What mathematics drill enhancement program may be proposed to improve the multiplication fluency of Grade 4 learners?

E. Hypothesis

There is no significant relationship between the frequency of mathematics drill utilization and the respondents' speed,

accuracy, and automaticity in solving multiplication with 0.05 level of significance.

F. Scope and Limitations of the Study

This study aimed to assess the multiplication skills of Grade 4 learners and determine the relationship between their performance in multiplication and the frequency of teachers' utilization of mathematics drill materials. The research focused on evaluating how consistent the use of drill activities influences learners' automaticity, speed, and accuracy in solving multiplication problems. The findings of the study served as the basis for developing a Mathematics Drill Enhancement Program designed to improve the multiplication proficiency of Grade 4 learners.

The study was delimited to respondents from the Division of Nueva Ecija, specifically within the District of Cabiao. Out of the 21 schools in the district, the research was conducted in three selected elementary schools: Bagong Silang Elementary School, Maligaya Elementary School, and Palasinan Elementary School. The period for data collection and analysis was during the school year 2025-2026.

G. Significance of the Study

This study examined the effect of math drills on speed, accuracy, and automaticity on multiplication skills of Grade 4 learners and aimed to design a mathematics drill enhancement program that strengthens learners' multiplication fluency and teachers practice. The research study will benefit the following:

For learners, improving multiplication skills leads to both short-term and long-term academic benefits. Mastery of multiplication supports success in more advanced topics like division, fractions, and algebra. It is designed to support both students requiring remediation and advanced learners seeking to maintain or exceed their current level of excellence.

For teachers, the study serves as a guide for data-based instructional planning. It identifies common learning gaps, helping teachers focus their lessons where students need the most support. Through the Mathematics Drill Enhancement Program, teachers can better track progress and improve the quality of instruction.

For parents and guardians, the research encourages active participation in their children's mathematics learning. Knowing their child's strengths and weaknesses allows them to provide support and practice at home. This cooperation between school and home helps build students' positive attitudes toward mathematics.

For school administrators and policymakers, the findings guide better decisions and resource distribution. The data reveal patterns that can improve curriculum focus and teacher training. With this information, they can align instructional materials and programs to enhance overall mathematics performance.

For future researchers, this study provides a useful foundation for further exploration of mathematics proficiency. Its methodology and findings can be used as a reference for similar or expanded studies. It also contributes evidence to the growing research on improving mathematics education in the Philippines.

H. Definition of Terms

The researchers used operational definition as follows:

Accuracy. A skill that refers to the exactness of the respondents' answers on the Multiplication Basic Facts Test.

Automaticity. A skill that refers to the mastery of multiplication where the effort in calculation to answer the Multiplication Basic Facts Test is not necessary but through retrieval of memory.

Drill Chart or Table. A visual tool that enhances their multiplication skills that use repetitive exercises, often showing numbers, operations, or progress for easy reference.

Mathematics Drills. The materials used in classrooms repeatedly to practice multiplication and to attain mastery in this mathematical operation.

Mathematics Drill Enhancement Program. The expected output educational program designed to improve students' mathematical computation speed, accuracy, and automaticity using planned, timed, and repetitive activities.

Mathematics Games. Interactive activities designed to help Grade 4 learners enhance their multiplication skills that strengthen their skills through play.

Mental Mathematics Drills. Exercises that train students to solve mathematical problems quickly and accurately without using any tools.

Modular Drill Method. A teaching approach where Grade 4 learners complete sequential, self-contained learning units or modules featuring repetitive multiplication exercises to achieve skill mastery before advancing to subsequent modules.

Multiplication Skills. The ability of Grade 4 learners to accurately and fluently perform multiplication operations, which is measured in levels.

Printable Worksheet. A printed learning material that contains multiplication exercises or activities given to Grade 4 learners.

Real Life Application. The use of mathematical concepts and skills in practical, everyday situations to solve real world problems.

Speed. A skill that refers to how fast the respondents finish the Multiplication Basic Facts Test as a result of the competition between calculation and memory.

2. Review of Literature and Studies

This section presents a review of relevant literature and studies gathered by the researchers. This provides a comprehensive background to attain the study's primary goals.

A. Mathematics Drills

Students who participated in timed practice drills significantly improved their mathematical performance. Timed practice drills have been found to enhance learners' response speed and overall mathematical achievement (Sotto and Uchang, 2025). Regular math drills significantly improved students' numeracy proficiency and retention (Manalaysay, 2021). These findings support the view that repeated exposure to multiplication tasks strengthens learners' ability to recall facts efficiently and accurately. Worksheets provide an accessible and structured form of practice that promotes both procedural

fluency and retention of learned skills. The structured format of worksheets allows students to focus on step-by-step problem-solving while minimizing cognitive overload, which facilitates the internalization of arithmetic operations (Dotan & Zviran-Ginat, 2022). Empirical studies consistently demonstrate the benefits of worksheet-based interventions. For instance, worksheet use has been shown to significantly improve computational proficiency and problem-solving skills among learners (Widodo, S. A. et al., 2023). When combined with hands-on materials, worksheets further enhance learner engagement and multiplication fluency (Rejeki, S., 2024; Sari, D. et al., 2022). Alongside worksheets, the utilization of drill charts or multiplication tables serves as a fundamental visual reference.

Playing mathematical games also at least once per week contributed to improved multiplication fluency and reasoning skills (Russo, J. et al., 2021). Teachers are encouraged to implement game-based learning strategies in mathematics instruction that is proven highly effective in enhancing learners' academic performance compared to traditional methods (Cayang, J. & Ursabia, E. 2024). The game-based approach is recommended to use than traditional teaching approach as it increases and enhances the learners' performance based on the comparison test they conducted between two groups of respondents (Camiguing, M. and Paragas, J. 2024). However, some of the observed difficulties experienced by pupils are the instructional materials used and time allotment in learning multiplication (Ilang-Ilang, Taysan Elementary School, 2019). Addressing this problem will add flavor, excitement, challenge and motivation to the pupils in learning the concepts of multiplication. The mere use of games is not enough. The positive effects of digital games in learning may still be varied based on the characteristics of game mechanics, visual, narrative, and research quality (Clark, D. et al. 2016).

Mental multiplication or mental math is an expected learning competency for Grade 4. Thus, teachers are responsible to also do mental math strategies in teaching multiplication including drills (DepEd, n.d.). In mentally recalling multiplication facts, verbal memory which is enhanced by drills is crucial. This suggests that frequent mental math drills may strengthen retrieval in verbal form and reduce load on working memory (Liu, R. et al. 2016). Furthermore, a collaborative learning environment is recommended while utilizing different mental math strategies. It promotes teamwork and peer support in problem-solving tasks (Astodillo, N. 2024). Despite debates about drill methods, many still affirm their effectiveness when used purposefully. When properly implemented, the drill method can increase student motivation and achievement (Wahyuni et al., 2017). Likewise, ordered and systematic drills were shown to improve students' performance in math by 78%, proving that repeated and well-planned practice builds both skill and confidence (Sinaga et al., 2023). This approach was especially beneficial for slow learners, who showed significant improvement in basic counting skills after consistent drill sessions (Qutratuain & Ariyanto, 2023). These findings indicate that drill-based strategies, when structured and goal-oriented, can benefit a wide range of learners.

The effectiveness of drill-based and game-based instruction has also been shown to depend on the quality of instructional design and the meaningful integration of activities within the learning process. When drill activities lack contextual relevance, learners may perceive mathematics as disconnected from real-life situations, which may affect their understanding and long-term retention of multiplication concepts (Mumcu and Hayal, 2018). To bridge this gap, effective mathematics instruction must help students apply mathematical principles to real-world situations. Realistic examples and enjoyable problem-solving activities keep learners engaged, while open communication between teachers and students helps clarify misconceptions and deepen understanding (Velez et al., 2023). Building on this, it was emphasized that enthusiasm plays a key role in mathematics learning. Real world examples and independent problem-solving tasks increase engagement and make mathematics more relevant to everyday life (Hetmanenko, 2024). Applying mathematical principles to familiar and concrete contexts through real world mathematics education based instruction helps students develop a deeper understanding and stronger ability to use mathematical relationships in everyday situations (Samritin et al., 2023). Moreover, modular drill approaches targeting multiplication errors significantly reduced mistakes and improved accuracy, promoting repetitive practice as a core tool in multiplication skill enhancement (Yorulmaz, 2022). These findings underscore the flexibility and effectiveness of different mathematics drills in reinforcing foundational skills in Philippine classrooms.

B. Speed

Structured drills significantly enhance mathematical proficiency, with participants showing marked pre-post gains in multiplication mastery among low-performing Grade 4 learners (Costelo, 2020). Building on this evidence of general mastery, Project DRILLS elevated Grade 4 multiplication speed, with post-test MPS reaching 82.43 from lower baselines. Targeted drills for struggling Grade 4 pupils in the Philippines yielded substantial speed improvements, emphasizing systematic repetition for DepEd competency mastery (StudyMoose, 2021). Furthermore, specific techniques within these frameworks have proven superior to conventional classroom approaches; for instance, Grade 4 experimental group using lattice drills outperformed traditional methods in multiplication speed and automaticity at Cateel Central Elementary School (Moreno & Susada, 2024).

In addition to systematic repetition, the element of time plays a crucial role, as explicit time-drills elevated 71% of students to higher speed levels while maintaining accuracy in solving multiplication problems compared to controls (Lozano, 2019). Consequently, researchers have looked toward physical and digital tools to facilitate this rapid recall. For example, an eight-week flash card drill raised Grade 4 multiplication mean scores from 41.9% to 51.7%, indicating faster retrieval speed in rural Philippine schools (De Vera, 2025).

Beyond the tools themselves, the method of engagement determines how well information is retained. Notably, speed

practice groups answered multiplication facts much faster daily than untimed game groups, committing more to long-term memory via spaced retrieval (Barshay, 2023). Ultimately, when comparing interventions, timed drills excelled in speed development for facts up to 10s, offering evidence transferable to Philippine Grade 4 curricula focused on rapid recall (Coddington et al., 2023).

C. Accuracy

Drill-based practice is grounded in cognitive theories of retrieval, automaticity, and memory reinforcement. According to the testing effect, actively recalling facts strengthens long-term memory and retention more effectively than passive review (Willingham, 2017). Spaced repetition, a practice of reviewing content multiple times over intervals, has been shown to improve accurate recall and fluency in arithmetic operations, including multiplication (Cepeda et al., 2016).

In elementary mathematics, drill-based interventions involve structured practice activities such as flashcards, worksheets, timed tests, and computer-assisted exercises. These activities aim to strengthen automatic retrieval of multiplication facts, thereby reducing cognitive load and enabling learners to perform computations more accurately (Chartered College of Teaching, 2025).

Numerous studies have demonstrated that drill-based interventions significantly improve multiplication accuracy among elementary learners. An eight-week flashcard drill intervention for Grade 4 pupils reported substantial gains in multiplication performance, with learners showing a significant increase in correctly solved problems in post-tests (De Vera, 2025). Both traditional and innovative flashcard drills have been shown to increase multiplication mastery in Grade 3 pupils, indicating that repeated recall helps learners internalize correct responses (Canuto-Penrad, 2020). Structured drill interventions using worksheets and daily practice activities have also led to significant improvements in fluent recall of multiplication facts, resulting in improved accuracy from pre-test to post-test measures (Department of Education Multiplication Mastery Project, 2022). Other action research initiatives similarly reported that structured drill programs increase learners' correct response rates, reinforcing that regular, focused practice enhances multiplication accuracy (Toledo et al., 2024).

Timed practice drills have proven effective in increasing both speed and correctness. Grade 8 learners exposed to timed multiplication exercises demonstrated higher post-test scores than those who were not exposed to such interventions, suggesting that timed elements enhance accuracy and can be applied to younger learners (Soto & Uchang, 2025). Computer-assisted drill exercises have been shown to significantly improve multiplication fact fluency, indicating that repetitive, structured practice leads to more accurate responses (Thompson, 2017). Interactive problem drills and educational games also enhance multiplication automaticity and accurate recall among elementary students (Nalusay, Demoral, & Suguís, 2024; Polly et al., 2025). Peer tutoring combined with drill practice further supports correct recall of multiplication

facts (Kromminga & Coddington, 2024).

Although drills improve mastery, the type of drill—traditional versus innovative—may not significantly alter outcomes, suggesting that repetition itself is the key factor in improving accuracy (Canuto-Penrad, 2020). Memory interference may reduce the effectiveness of repeated practice if drills are not carefully structured (Dotan & Zviran-Ginat, 2022). Integrated approaches that combine conceptual understanding with practice, such as the Japanese Multiplication Method and the Lattice Method, can sometimes enhance multiplication accuracy and fluency more effectively than drill-only interventions (Aguilar et al., 2025; Moreno & Susada, 2024). Learner characteristics also influence drill effectiveness, with students possessing stronger baseline skills benefiting more from timed drills, while learners with lower prior knowledge require additional support to achieve accuracy gains (García-Orza et al., 2021; Bay-Williams & SanGiovanni, 2021).

D. Automaticity

Students can solve problems more efficiently when math facts are internalized because their mental resources are freed for complex, higher-order thinking (Skycak, 2025). A primary benefit of achieving automaticity is the significant reduction of cognitive load during mathematical tasks. Students who can recall facts automatically experience less mental strain, which allows them to focus their energy on complex problem-solving (Olson, 2021).

For Grade 4 learners specifically, structured drills help develop this instant recall, thereby reducing the cognitive burden and allowing them to focus on higher-level mathematical challenges (De Vera & De Vera, 2025). Furthermore, engaging in structured practice sessions has been shown to reduce cognitive interference, creating a smoother path for learning multiplication facts (Dotan & Zviran-Ginat, 2022).

However, many students continue to face significant challenges in moving beyond basic counting. A common observation among fourth-grade students is a persistent reliance on counting strategies rather than instant recall. This is particularly evident among low-achieving learners and those with learning disabilities, who often struggle to achieve automaticity. Such reliance on counting can lead to significant difficulties in later mathematical learning. (De Los Santos, 2021). Even with standard instruction, many students still find it difficult to recall single-digit multiplication facts automatically, frequently resorting to counting strategies instead (Baker & Cuevas, 2018). These difficulties are often exacerbated by traditional instructional methods that may fail to reach every student, especially when combined with limited support or time for practice at home (Allen-Lyall, 2018).

To address these challenges, research highlights a variety of effective instructional strategies and interventions. Consistent and structured practice within math center activities has been found to improve both the speed and accuracy of multiplication recall (Arenas & Montales, 2019). Similarly, continuous mathematics drills significantly improve primary learners'

numeracy skills, with daily practice enhancing both mastery and retention (Manalaysay, 2021). Timed practice drills also play a crucial role in improving automaticity across various mathematical operations (Lesaca & Falle, 2021). Beyond traditional drills, innovative methods such as Interactive Taped Math Problems (ITP) have reported significant improvements in automaticity and a reduced reliance on counting (Suguis, 2023). Other methods, such as the lattice method, have also shown superior results in improving speed and accuracy compared to traditional teaching (Moreno & Susada, 2024).

The integration of visual aids and direct instruction further supports this developmental process. For instance, using a visual manipulative number line for skip counting strengthens a student's conceptual understanding and facilitates faster recall (Medina, 2025). For students with learning disabilities, Direct Instruction which utilizes a structured, step-by-step approach with immediate feedback has been shown to improve both working memory and fact recall (Alizadeh et al., 2018). Furthermore, targeted interventions measured by correct digits per minute have proven effective in strengthening the proficiency of students who struggle with learning difficulties (Barton, 2018).

The long-term academic impact of mastering multiplication facts extends to overall achievement and emotional well-being. Automaticity training improves students' general problem-solving skills, particularly when it is combined with activities that promote conceptual understanding (Pratt, 2023). Daily drills paired with concept-based instruction have been positively associated with higher standardized test scores (McGee et al., 2017). This suggests that multiplication fact automaticity is closely linked with a mature number sense and overall mathematics achievement; moreover, interventions that build this automaticity are vital for reducing mathematics anxiety among learners, which hinders their improvement (Walters, 2023).

E. Synthesis of the Reviewed Literature and Studies

Mathematics drills are an essential teaching aid for building multiplication skills from slow and effortful calculation to automatic memory retrieval. Regular exposure to organized activities like flashcards, timed sheets, and computer software can improve the "testing effect" and apply the principle of spaced repetition to commit basic facts to memory. Although traditional approaches are still effective, new approaches such as interactive games and computer software can further improve engagement, provided they are meaningfully incorporated into the curriculum to prevent shallow learning.

Speed and accuracy can be greatly improved through systematic and timed practice, which decreases the mental burden on the learner. Research has shown that explicit time-drills not only increase the speed of response but also result in greater accuracy, since memory-based retrieval is less likely to be incorrect than actual counting. Grade 4 students have been shown in specific studies to demonstrate great pre-post gains in fluency skills through organized interventions like Project DRILLS or lattice methods, which help struggling students achieve basic competency levels.

In conclusion, mathematics drills are essential tools that help change the process of multiplication from a slow calculation procedure to a quick memory recall process, directly improving student speed and accuracy. By achieving automaticity, students in Grade 4 are able to decrease their mental burden and concentrate on more complex mathematical concepts and higher-order problem-solving. Consequently, the consistent use of structured drills serves as a vital foundation for improving overall numeracy and academic achievement in elementary mathematics.

3. Methodology

This section presents the methodology used in the study, including the respondents, the population, the research instrument, the validation process for the instrument, the data-gathering process, and the statistical treatment.

A. Method of Research

The researchers used a quantitative research design to evaluate the multiplication skills of grade four learners, which served as the basis for developing a mathematics enhancement program. This approach enabled the systematic collection and analysis of numerical data to objectively describe learners' levels of proficiency and identify areas requiring improvement.

The 100-item multiplication basic facts test, adapted from the study of Toledo et al. (2024) with a modified allotted time, served as the primary instrument to measure the dependent variables: speed, accuracy, and automaticity of learners. In addition, a researcher-made survey questionnaire was utilized to determine the independent variable, specifically the frequency of teachers' utilization of mathematics drills in the classroom. Together, these instruments provided the necessary data to analyze the relationship between drill frequency and student multiplication proficiency. The gathered information also helped the researchers gain insights into their learning difficulties and strengths in multiplication.

A descriptive research design was purposefully adapted to systematically describe the learners' level of multiplication skills and to determine potential factors influencing their performance. The use of descriptive statistics specifically frequency counts, percentages, and mean scores, facilitated a clear and concise presentation of the data.

The survey data were analyzed in terms of descriptive statistics by means of frequency counts, means, and percentages. These findings provided an empirical basis for the formulation of a mathematics enhancement program designed to strengthen the multiplication skills of grade four learners and improve their overall achievement in mathematics.

B. Population, Sample Size, and Sampling Technique

The respondents of this study were learners from Bagong Silang Elementary School, Maligaya Elementary School, and Palasinan Elementary School. Simple random sampling, specifically the lottery method, was used to determine the schools that participated in the study to ensure the selection was unbiased and that every school had a truly equal chance of being selected.

The total population of learners was 179. The researchers used Cochran's Formula for sample size computation to determine the appropriate number of respondents from the total population. This formula is commonly used when the population is large or when the exact population size varies.

$$n = \frac{n_0}{1 + \frac{(n_0-1)}{N}}$$

Where:

n_0 - initial sample size from Cochran's Formula

N - total number of population

n - corrected sample size

The Calculator

Precision Level:

Confidence Level:

Estimated Proportion:

Small Population: ☒

Population Size:

The appropriate sample size given the population size and specified combination of precision, confidence and variability is 123.

The appropriate sample size, given the population size and specified combination of precision, confidence, and variability, was 123. To find the sample size for each school, the researcher computed the average percentage by dividing the total sample size by the total population. The result was 68.71%.

$$GA = \frac{\text{sample size}}{\text{total number of population}}$$

$$GA = \frac{123}{179}$$

$GA = 0.6871$ or 68.71%

Table 1 presents the total population and sample size of the respondents. The table is divided into three columns; the first column contained the names of the selected schools in the Region III District IV of Cabiao Nueva Ecija. The second column listed the total number of Grade four pupils in each school, with a total population of 179 and the last column displayed the sample size with a total of 123 based on the result of Cochran's Formula.

Out of 79 pupils at Bagong Silang Elementary School, 54 respondents were selected. In Maligaya Elementary School, out of 25 pupils, 17 respondents were selected. In Palasinan Elementary School, out of 75 pupils, 52 respondents were selected.

The researchers obtained the list of Grade 4 pupils in each school, which was used to establish the sample population. Respondents were then selected using systematic sampling. The distribution of numbers was verified to ensure proper representation. The questionnaires and tests, which served as the primary data collection instruments, were administered to the selected respondents. To maintain consistency, the total sample of 123 pupils was proportionally distributed across the three schools.

C. Description of Respondents

This study focuses on public elementary schools within the Department of Education (DepEd) Schools Division of Nueva Ecija, specifically targeting the district of Cabiao. The respondents consist of Grade 4 learners randomly selected from three schools: Bagong Silang Elementary School, Maligaya Elementary School, and Palasinan Elementary School. To ensure the representativeness of the sample and eliminate selection bias and discrimination, schools were chosen through random sampling rather than based on the students' mathematical proficiency. This approach ensures that learners of all ability levels are represented, allowing the results to provide insights for both low-performing students and those achieving advanced mastery.

Table 2
Demographic profile of the respondents

Frequencies		
Age		Counts
9 years old	46	37.4 %
10 years old	61	49.6 %
11 years old	12	9.8 %
12 years old	4	3.2 %
Grades		
90 to 100	26	21.1 %
85 to 89	40	32.5 %
80 to 84	41	33.3 %
75 to 79	15	12.2 %
75 below	1	0.8 %

As shown in the table, the largest proportion of respondents are 10 years old, comprising 49.6 % of the total population. This is followed by 9 years old at 37.4%, while 11 years old account for 9.8% and 12 years old represent 3.2%. The result indicates that most of the respondents are within the normal and expected age range for Grade 4 learners. This suggests that the respondents possess relatively similar levels of maturity and educational experiences, which may contribute to the consistency and reliability of the responses gathered in the study.

Based on the data presented, in terms of grades, the majority of respondents fall within the 80 to 84 range represent 33.3%, followed by 85 to 89 with 32.5% and 90 to 100 with 21.1%. Only a small proportion obtained grades below 75 represent

Table 1
Total number of population and sample size of the respondents

Name of School	Total Number of Population	Sample Size
Bagong Silang Elementary School	79	54
Maligaya Elementary School	25	17
Palasinan Elementary School	75	52
Total	179	123

0.8%. These results suggest that most of the respondents exhibit satisfactory to excellent academic performance.

The respondents evaluated the frequency of their teachers' utilization of mathematics drills and how this correlates with their own multiplication skills. Demographic information, including the respondents' age and mathematics grades were gathered to better understand the structure of the sample.

These respondents are considered reliable sources of data to determine the significant correlation between the frequent use of mathematics drills and the learners' speed, accuracy, and automaticity in multiplication. The result of the study will help low-performing students improve and help advanced students maintain and go beyond their excellence.

D. Research Instrument

An adapted-modified researcher-made instrument was used for the descriptive phase of the study. The researchers carefully created the instrument to align with the research topic and objectives. It was organized to ensure that each item generated reliable and relevant data from the participants.

The questionnaire had three main sections. The first section gathered the respondents' demographic information, including name (optional), age, and mathematics grade. While these demographic variables were not included in the Statement of the Problem (SOP), they were collected to provide descriptive data of the respondents to ensure they meet the specific criteria of the study.

The second section explored how often teachers use mathematics drill materials. It utilized a five-point Likert scale, originally developed by Rensis Likert (1932) with these options: (5) Always, (4) Often, (3) Sometimes, (2) Rarely, and (1) Never.

The primary tool used in the third section is the Multiplication Basic Facts Test, adapted to assess the learners' speed, accuracy, and automaticity in basic multiplication facts. The instrument consists of 100 items covering fundamental multiplication operations.

The structure and administration of this instrument were adapted from the study of Toledo, et al. (2024), ensuring that the assessment aligns with established pedagogical standards for elementary mathematics intervention. To measure the students' level of speed, accuracy, and automaticity, the scoring and interpretation had three different bases: the Instructional Status benchmarks established by Wright, J. (n.d.) for Math Computation Curriculum-Based Measurement were used for speed; the accuracy measurement was based on the performance scale utilized in the study of Toledo et al. 2024, and the the 3-second per item rule automaticity benchmarks for multiplication recall defined by Russo, J. 2021 were applied in measuring automaticity. Consequently, the adapted 100-item assessment was administered to the respondents with a strict five-minute (5) time limit. While Toledo et al. (2024) utilized a 3-minute duration, this study adjusted the timeframe to mathematically match the 3-second per item benchmark. Allowing 3 seconds per item across a 100-item test equates to a total testing time of 300 seconds ($100 \times 3 \text{ seconds} = 300 \text{ seconds}$), which precisely converts to five (5) minutes (300

$\text{seconds} \div 60 \text{ seconds} = 5 \text{ minutes}$). This exact alignment ensures a standardized, objective, and reliable measure of the participants' mathematical speed, accuracy, and automaticity.

Overall, the instrument aimed to collect detailed data on both the learners' mathematical abilities and the instructional practices of teachers. The results from the questionnaire helped form the proposed Mathematics Drill Enhancement Program.

E. Validation of the Instrument

Validity is a fundamental requirement for any research instrument. It is essential for ensuring that the tool produces accurate data and maintains the overall quality of the study (Urrutia et al., 2020). Furthermore, clear and credible evidence of an instrument's validity is required for peers and the broader community to trust and correctly interpret the research findings (Research Methods Review, 2025). With this, the researchers conduct a validity test with their instrument.

The instrument underwent systematic validation under the supervision of the thesis adviser, with further evaluation conducted by two other experts specializing in research tool assessment.

The research instrument was also submitted to the University Research Ethics Committee (UREC) for evaluation to ensure adherence to ethical standards concerning participants' rights and safety, informed consent, and data confidentiality. Following a thorough review and confirmation that all ethical conditions were met, the UREC provided ethical clearance, permitting the researchers to proceed with the data gathering phase.

A grammarian also assessed the instrument for grammar and clarity of the statements. Some statements were revised during this stage to improve language accuracy.

F. Data-Gathering Procedures

The researchers first secured approval for the research instrument and the conduct of the study by presenting an authorization letter and the research proposal to their thesis adviser for review and endorsement.

A pilot test was conducted among a small group of Grade 4 learners from a school not included in the main study. The results of the pilot test were analyzed using jamovi to determine reliability using Cronbach's Alpha. Based on these findings, the instrument was revised and improved to ensure reliability and validity.

The researchers submitted the manuscript of Chapters 1 to 3, along with the research instrument and validation certificates to the Schools Division Superintendent of the DepEd Division Office in the municipality of Santa Rosa, Nueva Ecija. Upon securing the official approval from the Schools Division Office, the researchers forwarded the approved letters and instruments to the school principals of Bagong Silang Elementary School, Maligaya Elementary School, and Palasinan Elementary School, to request permission to conduct the study.

After obtaining approval from the concerned school heads, the researchers coordinated with each school's principal and Grade 4 coordinator to schedule the conduct of the study. Consent forms and information sheets describing the purpose,

Table 3
Frequency of math drills utilization

Scale	Weighted Mean (WM)	Interpretation (I)	Description
5	4.20 – 5.00	Always	The drill is practiced daily (5 times a week).
4	3.40 – 4.19	Often	The drill is practiced 3 to 4 times a week.
3	2.60 – 3.39	Sometimes	The drill is practiced 1 to 2 times a week.
2	1.80 – 2.59	Rarely	The drill is practiced once or twice a month.
1	1.00 – 1.79	Never	The drill is not used at all in the classroom.

Table 4
Speed

Items Per Minute (IPM)	Total Items Attempted (5 mins)	Weighted Mean (WM)	Instructional Status
20+	100	2.34 – 3.00	Mastery level
10 – 19	50 – 99	1.67 – 2.33	Instructional level
Below 10	Below 50	1.00 – 1.66	Frustration level

Table 6
Automaticity

Automatic Correct Responses	Weighted Mean (WM)	Verbal Interpretation (VI)
90 – 100	2.34 – 3.00	Automatic (Mastered)
75 – 89	1.67 – 2.33	Semi-Automatic (Fluency Building)
Below 75	1.00 – 1.66	Non-Automatic (Strategic Counting)

procedures, risks, and benefits of participation were distributed to all teacher-respondents.

The data collection involved the distribution of the questionnaire, which was administered personally by the researchers during non-teaching hours. Respondents were allotted approximately 15–20 minutes to complete the survey.

To guarantee compliance with ethical protocols during data collection, the researchers strictly adhered to the guidelines established by the University Research Ethics Committee (UREC). This involved upholding respondent confidentiality, securing informed consent, and ensuring student protection for the entire duration of the study. Completed questionnaires and test papers were collected and kept securely, with access limited only to the research team. Small tokens of appreciation, such as ballpens, was given to participants as permitted by the school administration. All gathered data were tallied, tabulated, and analyzed using appropriate statistical tools. After the completion of the study, the researchers provided a summary of findings to the participating schools as part of their commitment to transparency and academic collaboration.

G. Statistical Treatment of Data

The researchers utilized statistical tools such as Weighted Mean and Pearson R Correlated to calculate the raw information collected. This ensured an accurate and meaningful interpretation and analysis of the findings, which formed the basis for final conclusions.

1) Weighted Mean

The weighted mean was utilized to calculate the average overall responses for the instrument's second part and third part, which measured the frequency of respondents' teachers' utilization of mathematics drills and the respondents level of multiplication skills. It was computed by adding up all the values of the variable fx and dividing the result by the total number of samples denoted by n .

Where:

$$\bar{x} = \frac{\sum fx}{n}$$

$\bar{x}$ = weighted mean

$\sum fx$ = sum of the product of frequency and weight

n = total sample size

Likert Scale:

The Likert Scale was used to analyze and interpret the responses from the second part of the questionnaire. The responses were utilized to assess the frequency of respondents' teachers' utilization of mathematics drills.

The Five-Point Likert Scale:

Multiplication Skills:

(Adapted from the Instructional Status benchmarks established by Wright, J. (n.d.) for Math Computation Curriculum-Based Measurement) See table 4.

(Based on the performance scale utilized in the study of Toledo et al. 2024) See table 5.

Table 5

Accuracy

Score (Out of 100)	Weighted Mean (WM)	Descriptive Scale
90 and above	4.20 – 5.00	Excellent
85 – 89	3.40 – 4.19	Very Good
80 – 84	2.60 – 3.39	Good
75 – 79	1.80 – 2.59	Fair
74 and below	1.00 – 1.79	Poor

(Based on the 3-second per item rule automaticity benchmarks for multiplication recall defined by Ross, J. 2021) See table 6.

2) Pearson Correlation Coefficient

The Pearson product-moment correlation coefficient is the commonly used statistical tool in research for measuring the linear relationship between two variables. In this study, this was applied to determine if there is a significant correlation between the frequency of respondents' teachers' utilization of mathematics drill materials and the respondents' speed, accuracy, and automaticity in solving multiplication.

The formula is as follows:

$$r = \frac{n \sum xy - (\sum x)(\sum y)}{\sqrt{[n \sum x^2 - (\sum x)^2][n \sum y^2 - (\sum y)^2]}}$$

Where:

r = pearson correlation coefficient

n = sample size
 $\sum x$ = sum of all x values
 $\sum y$ = sum of all y values
 $\sum xy$ = sum of the products of paired values
 $\sum x^2$ = sum of the squared x values
 $\sum y^2$ = sum of the squared y values

H. Decision Rule

Ha. P-values is less than or equal to 0.05 level of significance, rejected the null hypothesis.

Ho. P-value is greater than or equal to 0.05 level of significance, retained the null hypothesis.

I. Conclusion

Ha. There is a significant relationship if the P-value is less than or equal to 0.05 level of significance, reject the null hypothesis.

Ho. There is no significant relationship if the P-value is greater than or equal to 0.05 level of significance, accept the null hypothesis.

4. Results and Discussion

This section includes a thorough presentation and discussion of the data analysis and findings from 123 respondents of all the students from the 4 selected elementary school. The survey data were provided in tabular form with supporting interpretations, implications, and theoretical bases.

A. Respondents' Frequency of Utilizing Mathematics Drills

Table 7 presents the level of utilization of mathematics drills in instruction as perceived by the respondents. The results reveal an overall weighted mean of 2.86, interpreted as "Sometimes," indicating a moderate level of utilization of drill-based strategies in mathematics instruction. This suggests that while these strategies are present in classroom instruction, their use is not consistently sustained across teaching practices.

Among the indicators, mental mathematics drills obtained the highest weighted mean of 3.50, interpreted as "Often," indicating frequent use of oral computation and rapid-response activities to enhance learners' computational fluency. This is followed by printable worksheets with a weighted mean of 3.33, interpreted as "Sometimes," suggesting that teachers occasionally utilize structured written exercises to reinforce mathematical skills and concepts. Next, drill charts or tables recorded a weighted mean of 3.10, interpreted as "Sometimes," reflecting moderate use of visual aids in instruction. Real-life application integration obtained a weighted mean of 2.94, also interpreted as "Sometimes," indicating moderate contextualization of mathematical concepts in real-world

situations. In contrast, modular drill methods obtained a weighted mean of 2.38, interpreted as "Rarely," indicating limited use of flexible and independent instructional approaches. Lastly, mathematics games recorded the lowest weighted mean of 1.90, interpreted as "Rarely," suggesting minimal use of game-based instructional strategies in mathematics instruction.

Overall, the findings indicate that mathematics instruction remains moderately reliant on traditional drill-based approaches, particularly mental computation and worksheets, while interactive and learner-centered strategies are less frequently implemented. The overall weighted mean of 2.86 suggests that although drill strategies support procedural fluency, their predominant use without sufficient integration of contextualized and engaging learning experiences may limit the development of higher-order thinking skills and learner engagement. This finding is supported by Capuno et al. (2019), who reported that Filipino mathematics teachers commonly utilize drill-and-practice strategies to improve computational skills; however, overreliance on such methods may result in only moderate

levels of student engagement and conceptual understanding. This is further aligned with the Department of Education (2016), which emphasizes the importance of balancing procedural fluency with conceptual understanding and real-life application through varied and learner-centered instructional strategies.

Furthermore, Logan's Instance Theory explains that repeated exposure to similar mathematical tasks strengthens memory retrieval, making responses faster and more efficient over time. Research suggests that retrieval-based activities such as flashcards and repeated recall exercises significantly improve multiplication fluency among elementary learners than simple review activities, highlighting the value of structured drill exercises in mathematics instruction (Ophuis-Cox et al., 2023).

B. Respondents' Level of Multiplication Skills

Table 8 presents the level of multiplication skills among the respondents across three key dimensions: speed, accuracy, and automaticity. The data reveals that speed obtained the highest weighted mean of 1.15, interpreted as "Frustration," which indicates a significant struggle to complete multiplication tasks within the allotted time. This is closely followed by accuracy, with a weighted mean of 1.06, interpreted as "Poor," suggesting that students frequently provide incorrect answers. Furthermore, automaticity recorded the lowest weighted mean of 1.03, interpreted as "Non-Automatic," reflecting a heavy reliance on slow mental strategies rather than instant recall.

Table 7
Weighted mean of the respondents' frequency of utilizing mathematics drills

Mathematics Drills	Weighted Mean (WM)	Verbal Interpretation (VI)
Printable Worksheets (e.g., Timed "Mad Minute," multiplication grids, or activity sheets)	3.33	Sometimes
Mental Math Drills (e.g., Oral recitation, "Number Talks," or flashcard recall)	3.50	Often
Math Games (e.g., bingo, digital multiplication games)	1.90	Rarely
Real-Life Applications (e.g., Solving multiplication via store scenarios or classroom objects)	2.94	Sometimes
Drill Charts or Tables (e.g., Using multiplication posters, pocket charts, or table recitation)	3.10	Sometimes
Modular Drill Method (e.g., Self-paced drill packets provided in learning modules)	2.38	Rarely
Overall	2.86	Sometimes

Legend: 5.00-4.20 – Always; 4.19-3.40 – Often; 3.39-2.60 – Sometimes; 2.59-1.80 – Rarely; 1.79-1.00 – Never

Table 8
Weighted mean of the respondents' level of multiplication skills

Descriptives		
Level of Multiplication Skills	Weighted Mean (WM)	Verbal Interpretation (VI)
Speed	1.15	Frustration
Accuracy	1.06	Poor
Automaticity	1.03	Non-automatic

Legend: 1.15 – Frustration; 1.06 – Poor; 1.03 Non-automatic

The findings align with Logan's Instance Theory, which suggests that the lack of stored memory "instances" forces students to rely on slow, error-prone computation (Logan, G. D., 1988). Thus, the frustration in speed and deficiency in accuracy are consequences of failing to transition from effortful computation to direct memory retrieval. In contrast, the interventions targeting multiplication fact fluency can significantly improve students' performance and automatic recall of multiplication facts (Kromminga and Coddington, 2024). Moreover, retrieval practice enhances multiplication fluency and supports long-term retention of multiplication facts, suggesting that structured interventions may help address the low multiplication skill levels observed among the respondents (Ophuis-Cox et al., 2023).

C. Significant Relationship Between the Frequency of Math Drill Utilization and the Respondents' Speed, Accuracy, and Automaticity in Solving Multiplication

Table 9

Pearson R correlation on the frequency of printable worksheet utilization and the respondents' speed, accuracy, and automaticity in solving multiplication

Printable Worksheet			
Multiplication Skills	P-Value	Decision	Conclusion
Speed	0.018	Do not Retain Ho	Significant
Accuracy	0.849	Retain Ho	Not Significant
Automaticity	0.731	Retain Ho	Not Significant

Legend: If p-value is ≤ 0.05 , do not retain Ho; If p-value is > 0.05 retain Ho

Table 9 presents the correlation analysis between the frequency of utilizing printable worksheets and the learners' multiplication skills. The findings show that for the variable of speed, the p-value is 0.018, which is less than the alpha of 0.05. Thus, the null hypothesis for speed was rejected, leading to the conclusion that the frequency of utilizing printable worksheets has a statistically significant correlation with the learners' computational speed. This suggests that as teachers provide more frequent paper-based drills, students are likely to solve multiplication problems with increased quickness due to repetitive exposure. In contrast, findings for accuracy and automaticity show p-values of 0.849 and 0.731, respectively. Both of which are greater than the alpha of 0.05. Thus, the null hypothesis was retained, leading to the conclusion that the utilization of printable worksheets has no statistically significant correlation with learners' accuracy and automaticity. This implies that while these drills improve the pace of work, they do not necessarily ensure the correctness of answers or the development of effortless memory retrieval among the respondents.

This outcome partially supports Gordon Logan's Instance Theory of Automaticity, which indicates that repeated, localized exposure to a specific visual stimulus configuration strengthens corresponding physical execution and motor actions over time. When classroom instructors distribute

printable worksheet sets on a regular basis, young learners build a spatial and character-based familiarity with standard numeric matrices and arithmetic text formats. This visual habituation enables them to recognize specific equation layouts rapidly and execute numeric characters with minimized physical hesitation, reducing overall task completion time. However, because conventional written worksheets do not implement individual problem restrictions, students are permitted to maintain high execution speeds while continuously leaning on effortful procedural shortcuts. Grade 4 learners frequently complete written activities quickly by skip-counting by rote intervals or mapping temporary tallies along the margins of the printed sheets. Consequently, the strategy fails to trigger a structural cognitive transition from slow algorithmic calculation to direct fact retrieval. This explanation accounts for why traditional written worksheets remain statistically unrelated to long-term factual accuracy or cognitive automaticity among elementary school respondents.

Similarly, conventional written practice sheets improve writing speeds through task habituation, but do not provide the dynamic retrieval prompts required to push an elementary student past conscious counting into true mathematical automaticity (Kromminga and Coddington, 2024). To supplement this framework, Sotto and Uchang (2025) argued that paper packets successfully lower basic reaction times through sheer muscle memory and visual familiarity, but do not inherently refine baseline factual precision. Furthermore, Lozano (2019) demonstrated that traditional worksheets often lack the individualized, immediate corrective interventions needed to rectify persistent execution errors, which prevents simple paper repetition from improving accuracy scores. Structural limitations, such as passive written drills, do not force immediate memory retrieval because students face no pressure to stop using primitive calculation habits, allowing them to remain at a procedural level while completing tasks quickly (Barshay, 2023).

In addition, while repetitive worksheets help struggling elementary students achieve short-term processing speed goals within local learning curricula, they rarely alter a child's long-term retrieval proficiency without adaptive modifications (StudyMoose, 2021). This concept is reinforced by the findings of the Department of Education Multiplication Mastery Project (2022), which discovered that static worksheet repetitions enhance local task familiarity and assignment completion rates without significantly raising objective performance scores on independent accuracy tests. As established by García-Orza et al. (2021), while physical practice sheets minimize student hand-writing delays and processing latency, their structural benefits are strictly limited to mechanical execution speeds, leaving conceptual accuracy and automaticity unaffected.

Table 10 shows the relationship between the frequency of

utilizing mental math drills and the respondents' multiplication performance. Findings show that the p-values for speed (0.107), accuracy (0.109), and automaticity (0.110) are all greater than the alpha level of 0.05. Consequently, the null hypothesis was retained for all three variables, leading to the conclusion that the frequency of utilizing mental math drills has no statistically significant correlation with the multiplication skills of the learners. This demonstrates that although mental math drills such as oral recitations and flashcards are identified as the most frequently utilized instructional strategy by teachers ($x = 3.50$), they do not currently influence the learners' ability to solve multiplication facts with statistically higher levels of speed, precision, or automatic recall. The findings objectively imply that the current implementation of these drills may lack the instructional intensity or personalized focus required to transition students from strategic counting to mastery.

Table 10

Pearson R correlation on the frequency of mental mathematics drill utilization and the respondents' speed, accuracy, and automaticity in solving multiplication

Mental Mathematics Drill			
Multiplication Skills	P-Value	Decision	Conclusion
Speed	0.107	Retain Ho	Not Significant
Accuracy	0.109	Retain Ho	Not Significant
Automaticity	0.110	Retain Ho	Not Significant

Legend: If p-value is ≤ 0.05 , do not retain Ho; If p-value is > 0.05 retain Ho

According to Gordon Logan's Instance Theory of Automaticity, true mathematical fluency relies on a direct, immediate transition from multi-step computational procedures to direct memory retrieval. When teachers introduce mental mathematics exercises in a standard verbal format, the task places an immediate and heavy cognitive load on a child's short-term memory system. For Grade 4 learners who are currently situated at a computational frustration level, calculating abstract figures completely in their heads causes severe processing saturation and memory interference. Without visual prompts, concrete number lines, or physical anchors to help process the math facts, struggling students face severe cognitive overload, forcing them to guess answers blindly or disengage from oral sessions entirely. Therefore, simply increasing the classroom frequency of an abstract verbal drill does not lead to measurable gains in objective speed, performance accuracy, or direct memory recall.

This finding is highly consistent with the insights of Dotan and Zviran-Ginat (2022), whose cognitive research proved that unstructured oral and mental retrieval activities for multiplication facts often produce zero fluency improvements due to high levels of working memory interference and math anxiety. The abstract, non-contextual math drills are frequently perceived by young learners as a stressful and disconnected exercise, which undermines long-term memory formation and retrievable performance gains (Mumcu and Hayal, 2018). Similarly, over-relying on high-frequency rote repetition without establishing strong underlying conceptual foundations produces fragile mental links that collapse under performance testing (Lehtinen et al., 2017).

Additionally, research into early numeracy learning

highlights why unassisted mental drills are ineffective for struggling groups. When fourth-grade students lack strong concrete representations of arithmetic concepts, unguided oral drilling simply forces them to rely more heavily on covert finger-counting or mental tallying (De Los Santos, 2021). This continuous reliance on primitive counting keeps them locked at a non-fluent processing level. Furthermore, Allen-Lyall (2018) confirmed that routine verbal math drills fail to benefit elementary students who do not receive supplemental, scaffolded home reinforcement, as abstract oral exercises do not offer enough structural support to build permanent memory traces on their own. This is further validated by interactive media studies from Nalusay et al. (2024), which concluded that abstract oral questions lack the engaging feedback loops and visual cues found in modern interactive tools, rendering traditional mental math drills statistically ineffective for improving fluency metrics. As demonstrated by Alizadeh et al. (2018), young learners particularly those experiencing learning adjustments or working memory limitations require highly explicit, visually supported, step-by-step guidance rather than rapid verbal questioning to successfully build arithmetic automaticity.

Table 11

Pearson R correlation on the frequency of mathematics games utilization and the respondents' speed, accuracy, and automaticity in solving multiplication

Mathematics Game			
Multiplication Skills	P-Value	Decision	Conclusion
Speed	< .001	Do Not Retain Ho	Significant
Accuracy	0.078	Retain Ho	Not Significant
Automaticity	0.059	Retain Ho	Not Significant

Legend: If p-value is ≤ 0.05 , do not retain Ho; If p-value is > 0.05 retain Ho

Table 11 presents the correlation between the frequency of utilizing mathematics game and the respondents' multiplication performance. The data reveals that speed has a p-value of < 0.001 , which indicates a highly significant relationship. Thus, the null hypothesis for speed was rejected, leading to the conclusion that the frequency of utilizing mathematics game has a statistically significant correlation with the learners' performance. This suggests that as teachers provide more engaging mathematics games, students tend to improve their computational speed due to increased engagement and repeated exposure to multiplication tasks. Findings for accuracy and automaticity show p-values of 0.078 and 0.731 are greater than the alpha of 0.05. Thus, the null hypothesis was retained, leading to the conclusion that the utilization of mathematics game has no statistically significant correlation with learners' accuracy and automaticity. Multiplication fluency games encouraged active participation and frequent practice, which contributed to faster retrieval of multiplication facts (Polly, et al., 2025). Game-based training provides substantial benefits for arithmetic fluency development, supporting the use of mathematics games for improving computational speed (Jay and Moore, 2019). Furthermore, automaticity requires more than game exposure it needs guided instruction and repeated timed practice beyond games alone. This suggests that mathematics games play an important role in improving multiplication speed among learners, but additional structured

interventions may be needed to significantly enhance accuracy and automaticity (ERIC, 2019).

Table 12

Pearson R correlation on the frequency of real-life application utilization and the respondents' speed, accuracy, and automaticity in solving multiplication

Real-Life Application			
Multiplication Skills	P-Value	Decision	Conclusion
Speed	0.067	Retain Ho	Not Significant
Accuracy	0.088	Retain Ho	Not Significant
Automaticity	0.081	Retain Ho	Not Significant

Legend: If p-value is ≤ 0.05 , do not retain Ho; If p-value is > 0.05 retain Ho

Table 12 shows the relationship between the frequency of utilizing real life application and the learners' multiplication skills. The data shows that the p-value for speed (0.067), accuracy (0.088), and automaticity (0.081) are all greater than the alpha level of 0.05. Consequently, the null hypothesis was retained for all three variables, leading to the conclusion that the frequency of utilizing real life application has no statistically significant correlation with the multiplication skills of the learners.

Math fact automaticity acts as a crucial predictor of performance on general mathematics tests, but it operates independently from real-life application frequency meaning automaticity develops through direct drill practice, not through real-life application utilization (Baker & Cuevas, 2018). According to Gordon Logan's Instance Theory of Automaticity, the development of computational fluency relies on a cognitive shift from deliberate, multi-step calculation algorithms to direct, single-step memory retrieval. When word problems or contextual real-life scenarios are introduced to elementary students, the mathematical task is wrapped in a narrative framework.

For Grade 4 learners who are currently situated at a computational frustration level, these contextual applications introduce heavy linguistic and semantic processing demands. Instead of focusing their working memory entirely on direct fact recall, the students must first decode the text, identify the relevant numbers, and determine the correct arithmetic operation to apply. The results of the non-significant outcome of the study highly consistent with the empirical insights of Powell et al. (2021), who observed that contextualized word problem interventions often yield negligible improvements in direct arithmetic fact fluency because word problems primarily exercise problem-solving schemas rather than direct cognitive fact retrieval pathways.

Furthermore, Fuchs et al. (2020) demonstrated that while real-life word problem structures are highly effective at building conceptual understanding and mathematical reasoning, they do not provide the high-frequency, isolated operational repetitions needed to establish the long-term memory traces that drive automatic recall.

Additionally, contemporary research in math pedagogy highlights the structural gap between reasoning tasks and structural fluency practice. As argued by Kling and Bay-Williams (2021), real-life applications are essential for mathematical meaning-making but are structurally inefficient when deployed as a primary tool for developing speed and

automaticity, which instead demand highly targeted, low-stakes retrieval drills. Moreover, as demonstrated by Swanson et al. (2018), young learners with developing mathematical skills face severe short-term memory bottlenecks when managing situational contexts and computational mechanics simultaneously, which validates why real-life application frequency fails to exhibit a statistically significant correlation with the speed, accuracy, and automaticity scores of the respondents.

Table 13

Pearson R correlation on the frequency of drill charts or tables utilization and the respondents' speed, accuracy, and automaticity in solving multiplication

Drill Charts/Tables			
Multiplication Skills	P-Value	Decision	Conclusion
Speed	0.015	Do Not Retain Ho	Significant
Accuracy	0.029	Do Not Retain Ho	Significant
Automaticity	0.023	Do Not Retain Ho	Significant

Legend: If p-value is ≤ 0.05 , do not retain Ho; If p-value is > 0.05 retain Ho

Table 13 presents the data on the correlation analysis using the frequency of Drill Chart/Table and Multiplication skills of the respondents. The findings show the significant variable namely: speed ($p=0.015$), accuracy ($p=0.029$), and automaticity ($p=0.023$). The findings suggest that the null hypothesis be rejected among all three factors. This means that the more frequently the students get involved in multiplication activities, the better their problem-solving skills are.

The repeated exposure to multiplication fact practice significantly improved learners' fluency and mastery of basic multiplication facts (Berrett and Carter, 2018). Furthermore, Powell et al. (2022) found that distributed and consistent practice strengthens fact retention and retrieval, which contributes to better performance in multiplication tasks. Therefore, the significant relationship between the utilization of Drill Chart/Table and learners' multiplication skills suggests that regular drill activities can effectively enhance students' automaticity that leads to decreasing the time to respond and higher accuracy of answers in multiplication.

Table 14

Pearson R correlation on the frequency of modular drill method utilization and the respondents' speed, accuracy, and automaticity in solving multiplication

Modular Drill Method			
Multiplication Skills	P-Value	Decision	Conclusion
Speed	$< .001$	Do Not Retain Ho	Significant
Accuracy	0.891	Retain Ho	Not Significant
Automaticity	0.857	Retain Ho	Not Significant

Legend: If p-value is ≤ 0.05 , do not retain Ho; If p-value is > 0.05 retain Ho

Table 14 presents the significant correlation between the frequency of Utilizing Modular Drill Method and Multiplication skills of the respondents. As shown in the table speed has a p-value of 0.001, lower than the level of significance. Therefore, the null hypothesis for speed was rejected. This finding proves that Modular Drill Method has significant relationship with the speed of the respondents in terms of multiplication. Nevertheless, the value of accuracy, which is 0.091 and automaticity 0.857 are higher than the value of level of significance which is 0.05. Thus, the null hypotheses

for these variables were accepted, implying that there is no statistically significant correlation between the Modular Drill Method and learners' accuracy and automaticity. Therefore, the effectiveness of the Modular Drill Method on multiplication depends on the respondents' speed. Furthermore, the students who regularly practiced multiplication facts demonstrated faster responses and greater fluency over time (Allen-Lyall, 2018). These findings suggest that the Modular Drill Method is particularly effective in enhancing learners' speed in multiplication activities.

Table 15

Pearson R correlation on the frequency of combined mathematics drill utilization and the respondents' speed, accuracy, and automaticity in solving multiplication

Multiplication Skills	Mathematics Drills		
	P-Value	Decision	Conclusion
Speed	< .001	Do Not Retain Ho	Significant
Accuracy	0.046	Do Not Retain Ho	Significant
Automaticity	0.029	Do Not Retain Ho	Significant

Legend: If p-value is ≤ 0.05 , do not retain H_0 ; If p-value is > 0.05 retain H_0

Table 15 shows the significant relationship between the frequency of utilizing mathematics drills and the learners' multiplication skills. The data reveals that speed has a p-value of $< .001$, which indicates a highly significant relationship. Similarly, accuracy (0.046) and automaticity (0.029) both resulted in p-values below the 0.05 level of significance. Consequently, the statistical decision for all three variables is to reject the null hypothesis. Thus, there is a significant relationship between the utilization of mathematics drills and the multiplication skills of the learners in terms of speed, accuracy, and automaticity.

The findings imply that consistent mathematics drills are an effective instructional tool for enhancing overall proficiency. Unlike other methods that may only impact a single area, these drills successfully contribute to how quickly learners solve problems, the precision of their answers, and their ability to recall facts automatically. This supports Logan's Instance Theory, which states that repeated exposure and practice strengthen memory traces, allowing learners to retrieve multiplication facts more efficiently and accurately.

Similarly, the retrieval practice significantly improved multiplication fact fluency among elementary learners, indicating that consistent mathematics drills contribute to better recall and overall multiplication performance (Ophuis-Cox *et al.*, 2023).

In addition, the multiplication interventions involving repeated practice produced positive effects on students' multiplication fact fluency (Kromminga and Coddling, 2024). These findings support the present study's conclusion that mathematics drills play an important role in improving multiplication speed, accuracy, and automaticity among Grade 4 learners.

D. Proposed Mathematics Enhancement Drill Program

Table 16 represents the timeline and a comprehensive plan for the implementation of the M.A.A.S.T.E.R. (Multiplication Accuracy Automaticity, and Speed Through Enhanced

Routine) Mathematics Drill Program, in accordance with the newly approved trimester system for public education institutions, beginning Academic Year 2026–2027 (Presidential Communications Office, 2026).

This program consists of six phases, each with a two-week duration and corresponding minute allocations, except for Phase 1 and 5, which spans only one week. The implementation will be administered to the Grade 4 learners primarily by their classroom mathematics teacher, with the official approval of the school principal.

The results of this study suggest that combining various mathematics drills enhances the multiplication skills of Grade 4 learners more effectively than relying on a single or limited drill type. While combining different mathematics drill types is highly recommended to improve multiplication fluency, doing so all at once is difficult due to limited class time. To handle this time constraint, the drills in this study were carefully scheduled in rotation across different phases, ensuring they were still used 4 or 5 times a week to maintain a high and consistent frequency.

Phase 1, Pre-Implementation Proper, is dedicated to preparing the schedule, content, and materials, as well as securing administrative approval for the program. The enhancement program officially commences in Phase 2 (Foundation & Encoding), which targets accuracy and automaticity prior to accelerating the learners' cognitive pacing and speed. This phase will be conducted through the utilization of Drill Charts or Tables, which demonstrated a significant relationship across speed, accuracy, and automaticity. Consequently, Drill Charts or Tables will serve as the primary, fixed mathematics drill across all phases of the program, supplemented by Home Modular Drill Packets for additional support. During this phase, learners begin receiving a printed 100-item test sheet every Friday.

Furthermore, Phase 3 focuses on Fluency Acceleration through the combined routine of Drill Charts/Tables, Mathematics Games, and Timed Printable Worksheets targeting speed, as these specific drills demonstrated a significant relationship with speed development based on the empirical findings of this study.

Phase 4 introduces Contextualization and Absolute Mastery of the three core multiplication skills. This phase is supported by Mental Mathematics Drills and Real-Life Application Drills; though these drills showed no significant relationship individually based on the statistical findings, they serve as vital supporting mechanisms when paired with the Drill Charts/Tables to collectively achieve speed, accuracy, and automaticity.

Moreover, Phase 5 is designated for Post-Implementation and Evaluation to assess the learners' progress, growth, and the overall effectiveness of the program. This phase identifies developments in their multiplication skills via a post-test consisting of an adapted, 100-item basic multiplication facts test administered under a strict 5-minute time limit.

Table 16

M.A.A.S.T.E.R. (Multiplication accuracy, automaticity, and speed through enhanced routine) mathematics drill program

Phase and Objective	Mathematics Drill Modality	Target Multiplication Skill Focus	Mon-Thurs Class Schedule (8-10 Mins)	Friday Assessment Strategy (100 Items/5 Mins)	Key Implementing Personnel	Monitoring and Progress Evaluation
Phase 1: Pre-Implementation Proper	No drills implemented yet (Diagnostic Baseline Phase)	Baseline Profiling of Speed, Accuracy, and Automaticity	Minutes 1–10: Distribution, orientation, and administration of diagnostic tools to establish initial learner performance brackets	100-item Pre-test 5-minute condition Categorize students based on the performance scale of speed, accuracy, and automaticity for multiplication	Classroom Mathematics Teacher Grade 4 Learners School Principal (for administrative clearance)	Establishes the statistical baseline data Identifies prevailing errors and strategic counting habits before the M.A.A.S.T.E.R. routine officially launches
Trimester Week 1 (Opening Block)						
Objective: To establish a statistical baseline and profile initial learner speed, accuracy, and automaticity						
Phase 2: Foundation Building	Combined Routine: Anchor Drill Charts/Tables paired with high-support Choral Response and Modular Packets (Home Assignment)	Accuracy Automaticity	Minutes 1–4 (Anchor): Choral Recitation and rapid pointer-drills using wall-mounted Drill Charts/Tables to visually activate correct facts Minutes 5–10 (Stack): Direct flashcard modeling or focused pocket-chart scanning where accuracy is prioritized over rapid guessing	Weekly Basic Facts Progress Test: Students are given a printed copy of the 100-item test sheet	Classroom Mathematics Teacher Grade 4 Learners	Monitors if students are making fewer mistakes in their multiplication answers. Ensures that students can remember the correct mathematics facts before forcing them to answer faster
Trimester Weeks 2–3 (Instructional Block)						
Objective: To prioritize student accuracy and correct memory recall of basic facts over rapid guessing						
Phase 3: Fluency Acceleration	Combined Routine: Anchor Drill Charts/Tables paired with high-engagement Mathematics Games and Timed Printable Worksheets.	Speed Shortening Response Times	Minutes 1–3 (Anchor): Quick-fire visual scanning of Drill Charts to prime the brain Minutes 4–10 (Stack): Alternating days between competitive Multiplication Games (e.g., Math Bingo) and rapid individual Printable Worksheets ("Mad Minutes" grids)	Weekly Basic Facts Progress Test: Students are given a printed copy of the 100-item test sheet	Classroom Mathematics Teacher Grade 4 Learners	Assesses the reduction of student percentages trapped within the "Frustration Level" of speed Tracks the balancing point where speed increases without destroying accuracy
Trimester Weeks 4–5 (Instructional Block)						
Objective: To shorten multiplication response times and reduce the percentage of students at the frustration level						
Phase 4: Contextualization & Mastery	Combined Routine: Anchor Drill Charts/Tables paired with Mental Math Drills and Real-Life Context Applications	Conceptual transfer, absolute automaticity, and long-term retention	Minutes 1–3 (Anchor): Blind/Mental tracking of multiplication tables without looking at posters Minutes 4–10 (Stack): High-intensity oral Mental Math Drills followed immediately by rapid application to brief real-world word scenarios (e.g., fast purchasing totals)	Weekly Basic Facts Progress Test: Students are given a printed copy of the 100-item test sheet Final formative checkpoint before the official post-test	Classroom Mathematics Teacher Grade 4 Learners	Validates student transition from the low level to absolute mastery, via the 3-second-per-item rule. Measure all three core skills simultaneously
Trimester Weeks 6–7 (Instructional Block)						
Objective: To achieve absolute automaticity and enable long-term conceptual retention in real-world scenarios						

Continuation of Table 16

Phase and Objective	Mathematics Drill Modality	Target Multiplication Skill Focus	Mon-Thurs Class Schedule (8-10 Mins)	Friday Assessment Strategy (100 Items/5 Mins)	Key Implementing Personnel	Monitoring and Progress Evaluation
Phase 5: Post-Implementation & Evaluation Trimester Weeks 8 (Instructional Block) Objective: To mathematically compute overall program growth and effectiveness by comparing pre-test and post-test	No drills (Evaluation and Data Computation Phase)	Final Growth Measurement across Speed, Accuracy, and Automaticity	Minutes 1–10: Gathering student feedback, organizing final research tracking portfolios, and clearing regular math lesson routines	100-item Post-test administered under identical baseline conditions to mathematically compute the program's overall effectiveness	Classroom Mathematics Teacher Grade 4 Learners Research Evaluator/Statistician	Runs the final statistical calculations (Pre-test vs. Post-test performance). Documents the definitive shift in speed, accuracy, and automaticity to prove the program met its objectives
Phase 6: Sustainability & Reporting Trimester Weeks 11–12 (Enrichment Block) Objective: To share the successful routine framework with administration and fellow teachers for future institutional use	Program Reporting and Dissemination	Institutionalization of the M.A.A.S.T.E.R. Routine	Not applicable (Executed during collaborative teacher sessions/LAC sessions)	Presentation of the final computed data charts to the school administration	Classroom Mathematics Teacher Grade 4 Learners School Head/Principal	Focuses on sharing the successful combined-drill framework with fellow Grade 4 teachers, ensuring the 8–10 minute routine can be adopted across sections in future terms

Following a two-week interval dedicated to class examinations and regular classroom routines, the final phase-Phase 6: Sustainability and Reporting will resume. During this phase, educators will gather to share pedagogical strategies and disseminate the empirical results of the M.A.A.S.T.E.R. program.

Logan's (1998) Instance Theory of Automaticity supports the premise that constant exposure to mathematics drills improves information retention. This cognitive reinforcement leads to fewer calculation errors and promotes the rapid recall of answers with minimal conscious retrieval effort.

Additionally, combining traditional and innovative mathematics drills is highly effective in producing multiplication performance gains (Bell, 2024). This instructional methodology, which integrates highly structured, error-reducing flashcard repetition alongside specialized, game-based timed activities, drives immediate and substantial progress in multiplication fluency (Canuto-Penrad, 2020).

5. Summary of Findings, Conclusions, and Recommendations

This section shows a summary of the findings, conclusions, and recommendations as an outgrowth of this research study based on the data analyzed in the previous chapter. This study aimed to determine the effectiveness of mathematics drills on the speed, accuracy, and automaticity of multiplication skills of Grade 4 Learners in selected public elementary schools in

Cabiao, Nueva Ecija, during the School Year 2025-2026.

A. Summary of Findings

1) The Respondents' Perceived Frequency of Mathematics Drills Utilization

1. The teachers utilization of commonly used mathematics drills in Grade 4 classroom has an overall weighted mean of 2.86.

2) The Respondents' Level of Multiplication Skills

1. In terms of Speed, the overall weighted mean is 1.15.
2. In terms of Accuracy, the overall weighted mean is 1.06.
3. In terms of Automaticity, the overall weighted mean is 1.03.

3) The significant relationship between the frequency of mathematics drill utilization and the respondents' speed, accuracy, and automaticity in solving multiplication

1. The significant relationship between the frequency of math drill utilization and the respondents' speed in solving multiplication had an overall P-value of $< .001$. The P-value of speed ($< .001$) was less than the 0.05 level of significance.
2. The significant relationship between the frequency of math drill utilization and the respondents' accuracy in solving multiplication had an overall P-value of 0.046. The P-value of accuracy (0.046) was less than the 0.05 level of significance.

3. The significant relationship between the frequency of math drill utilization and the respondents' automaticity in solving multiplication had an overall P-value of 0.029. The P-value of automaticity (0.029) was less than the 0.05 level of significance.

4) Proposed Mathematics Drill Enhancement Program

1. In the proposed M.A.A.S.T.E.R. (Multiplication Accuracy, Automaticity, and Speed Through Enhanced Routine) Mathematics Drill Program, Drill Charts or Tables will be the primary and fixed mathematics drill for all the phases of this program with a P-value of 0.015 for speed, 0.029 for accuracy, and 0.023 for automaticity.

B. Conclusions

1) The Respondents' Perceived Frequency of Mathematics Drills Utilization

1. The teachers sometimes utilized mathematics drills in Grade 4 classrooms.

2) The Respondents' Level of Multiplication Skills

1. In terms of multiplication speed, respondents demonstrated the level of frustration, with the data showing that most learners currently struggle to solve basic multiplication facts within the required time limits.
2. In terms of accuracy, this indicates that the respondents have poor mastery of multiplication, as they frequently commits error in their responses, requiring improvement in their computation skills.
3. In terms of automaticity, this implies that the respondents are non-automatic, as their responses require deliberate thinking rather than automatic recall.

3) The significant relationship between the frequency of mathematics drill utilization and the respondents' speed, accuracy, and automaticity in solving multiplication

1. There was a significant relationship between the frequency of mathematics drill utilization and the respondents' multiplication skills in terms of Speed.
2. There was a significant relationship between the frequency of mathematics drill utilization and the respondents' multiplication skills in terms of Accuracy.
3. There was a significant relationship between the frequency of mathematics drill utilization and the respondents' multiplication skills in terms of Automaticity.

4) Proposed Mathematics Drill Enhancement Program

1. The M.A.A.S.T.E.R. Mathematics Drill Program is proposed as an effective intervention to significantly improve the multiplication fluency of Grade 4 learners. Drill Charts or Tables will be the primary and fixed mathematics drill for all the phases of this program as it showed significant relationship across speed, accuracy, and automaticity.

C. Recommendations

1) For Teachers

1. Teachers should incorporate frequent mathematical drills to enhance students' multiplication fluency, specifically regarding their calculation speed.
2. Teachers should integrate a variety of activities and strategies when implementing mathematics drills to improve students' accuracy and automaticity in multiplication.
3. Teachers should implement the proposed M.A.A.S.T.E.R. Mathematics Drill Program. This program is a combination of a diverse array of drill modalities rather than relying on a single, limited set of materials.

2) For Future Researchers

1. Future researchers should employ pre-test and post-test methodologies with varying time allotments to more effectively measure speed, accuracy, and automaticity.
2. Future researchers should investigate additional variables influencing multiplication skills, such as student study habits and the availability of supplementary academic support.

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