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Flash Card Implementation for Multiplication Skill Development in Fourth Grade: An Action Research Investigation

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ABSTRACT: This action research examined the association between flash card interventions and improvements in mathematical performance among Grade 4 learners, specifically targeting multiplication skills development. Employing a quasi-experimental one-group pretest-posttest design, the study involved thirty-six Grade 4 learners enrolled at Ranao Elementary School during the 2022-2023 academic year. Data were collected through validated twenty-five-item pretest and posttest assessments focusing on two-digit multiplication problems. Statistical analysis using mean scores, mean percentage scores, and paired samples t-test revealed significant improvements in mathematical performance following the eight-week flash card intervention. Pretest results showed a mean score of 10.47 (41.9%) which increased to 12.92 (51.7%) in the posttest, representing a statistically significant difference [$t(35) = -8.82$, $p < 0.001$]. Effect size analysis revealed a large practical significance (Cohen's $d = 0.98$). The findings suggest that systematic flash card implementation is associated with enhanced multiplication computational fluency and accuracy among Grade 4 learners. This research contributes to evidence-based pedagogical practices in elementary mathematics education, particularly in addressing

multiplication learning difficulties in the Filipino context. The study provides practical implications for teachers seeking effective, low-cost instructional strategies to improve basic mathematical skills.

Keywords: *Flash cards; multiplication skills; elementary mathematics; action research; mathematical performance; Grade 4 learners*

A. Introduction

Mathematics education in elementary settings faces persistent challenges, particularly in developing foundational arithmetic skills among young learners. Grade 4 students frequently encounter difficulties with multiplication concepts, which serve as fundamental building blocks for advanced mathematical understanding (Bautista et al., 2018). The development of computational fluency in multiplication represents a critical milestone in elementary mathematics education, directly influencing students' ability to engage with more complex mathematical concepts in subsequent grade levels (National Research Council, 2001).

Research consistently demonstrates that Grade 4 learners often struggle with multiplication due to several interconnected factors. Bautista et al. (2018) identified computational accuracy deficits as primary obstacles, where students fail to achieve fluency in basic multiplication facts. Additionally, limited procedural fluency, particularly in multi-digit operations, compounds these difficulties and hinders mathematical progress (Geary, 1994). Students may resort to inefficient problem-solving strategies or experience challenges in applying multiplication skills to computational contexts.

The context of Philippine elementary education presents unique challenges for mathematics instruction. Filipino Grade 4 learners encounter difficulties across multiple mathematical domains, including number sense development, computational fluency, and mathematical fact recall (Capistrano et al., 2021). These challenges are often exacerbated by limited exposure to diverse instructional strategies and insufficient practice opportunities for developing automaticity in basic mathematical facts (Arellano & Miranda, 2020).

Flash Cards in Mathematics Education: Rationale and Context

Flash cards have been utilized as instructional tools in mathematics education for decades, yet their effectiveness continues to be debated in contemporary educational literature (Barshay, 2023). While some educators view flash cards as outdated rote learning tools, recent research suggests that when implemented systematically within comprehensive instructional frameworks, they can serve as effective instruments for developing computational fluency (Sarile & Estrella, 2018).

The choice of flash cards over other instructional methods for this study was informed by several practical and theoretical considerations. First, the cognitive load theory suggests that reducing extraneous cognitive burden through automated fact recall allows students to allocate mental resources toward higher-order mathematical thinking (Verschaffel et al., 1994). Flash cards, when used strategically, can facilitate this automaticity development. Second, the resource-constrained nature of many Philippine elementary schools necessitates cost-effective interventions that can be readily implemented without expensive technological infrastructure.

This study builds upon previous flash card research in the Filipino context, including work by Santos and Gonzales (2019) who documented improvements in mathematical problem-solving skills, and Sarile and Estrella (2018) who reported enhanced computational accuracy. However, the current investigation extends this research through its systematic three-phase implementation structure, incorporation of motivational techniques, and focus specifically on Grade 4 multiplication skills within a rural Philippine setting.

Research Gap and Study Significance

Despite existing research on mathematics education interventions, limited empirical evidence exists regarding the specific effectiveness of structured flash card interventions for Filipino Grade 4 learners' multiplication skills development. While international studies have documented outcomes of flash card implementation in various educational contexts, there remains a gap in understanding how these interventions function within the specific constraints and opportunities of Philippine elementary education.

The significance of this research extends beyond immediate classroom applications. Understanding effective multiplication instruction strategies is crucial for addressing persistent mathematics achievement gaps in Philippine elementary education. Furthermore, this study contributes to evidence supporting accessible, low-cost instructional approaches that can be implemented across diverse educational settings.

Research Questions

This action research aims to address the following fundamental questions:

1. What is the mathematical performance of Grade 4 learners in multiplication skills before and after flash card intervention implementation?
2. Is there a statistically significant difference between the mathematical performance of Grade 4 learners in pretest and posttest assessments following flash card intervention?

B. Methodology

Research Design

This study employed a quasi-experimental one-group pretest-posttest research design to examine the association between flash card interventions and Grade 4 learners' multiplication performance. The quasi-experimental approach was selected due to its appropriateness for educational action research contexts where random assignment to control groups is not feasible or ethical (Campbell & Stanley, 1963).

Important Design Limitations

The one-group pretest-posttest design has inherent limitations that must be acknowledged. Without a control group, alternative explanations for observed improvements cannot be definitively ruled out, including:

- **Maturation effects**: Students' natural development over the eight-week period
- **Testing effects**: Familiarity with assessment format from pretest administration

- **History effects**: Other instructional activities occurring simultaneously
- **Instrumentation effects**: Potential changes in measurement conditions

While the large effect size observed suggests meaningful intervention impact, causal attribution to the flash cards alone cannot be definitively established. Alternative designs such as delayed control groups or multiple baseline approaches were not implemented due to practical classroom constraints and ethical considerations regarding withholding potentially beneficial instruction.

Participants and Setting

The study involved thirty-six Grade 4 learners enrolled at Ranao Elementary School in the Bani District, Division of Pangasinan I, during the 2022-2023 academic year. All Grade 4 students in the single classroom participated in the study, representing a complete census of the available population rather than a selective sample. No students were excluded based on ability level or other criteria.

Participants represented a mixed-ability group, reflecting typical heterogeneity found in regular classroom settings. The selection was purposive based on identified learning difficulties in multiplication skills through routine classroom assessments and teacher observations. No students dropped out during the intervention period, and attendance remained consistent throughout the study.

Generalizability Considerations

The small sample size (n=36) from a single classroom in one rural school significantly limits generalizability. Results should be interpreted as specific to this particular educational context and student population. Broader application to other settings, student populations, or educational systems requires additional investigation.

Instrumentation

Data collection utilized researcher-developed twenty-five-item pretest and posttest assessment instruments focusing on two-digit multiplication problems. The assessment tools were designed to measure computational accuracy and procedural

fluency in multiplication contexts. Items included both regrouping and non-regrouping multiplication problems, representing varying levels of cognitive complexity.

Table 1: Descriptive Statistics and Test Results

Measure	**Pretest**	**Posttest**	**Difference**
Mean	10.47	12.92	2.45
Standard Deviation	2.83	2.51	-
Percentage Score	41.9%	51.7%	9.8 percentage points
t-statistic	-	-	-8.82
p-value	-	-	< 0.001
Cohen's d	-	-	0.98
95% CI for difference	-	-	[1.87, 3.03]

Test Validation and Reliability

The assessment instruments underwent content validation procedures involving review by two master teachers and one head teacher for mathematical accuracy, developmental appropriateness, and alignment with Grade 4 curriculum standards. Pilot testing was conducted with a comparable Grade 4 class to establish item clarity and appropriate difficulty levels.

Reliability analysis was conducted using Cronbach's alpha, yielding $\alpha = 0.82$ for the pretest and $\alpha = 0.85$ for the posttest, indicating acceptable internal consistency. The pretest and posttest utilized identical items to maintain direct comparability, though this approach introduces potential testing effects that must be considered when interpreting results.

Flash Card Intervention Implementation

The flash card intervention was implemented over an eight-week period, following a systematic three-phase progression designed to build multiplication fluency and computational accuracy:

Phase 1 (Weeks 1-2): Foundation Building

Initial focus on basic multiplication facts through systematic flash card practice. Students practiced multiplication tables from 1×1 through 9×9, with daily 20-minute sessions targeting specific multiplication families. A motivational strategy involved students who provided incorrect responses standing briefly for additional practice opportunities before rejoining seated activities.

Phase 2 (Weeks 3-4): Consolidation and Automaticity

Emphasis on randomized review of multiplication facts to develop automaticity. Flash cards were presented in varied sequences to prevent rote memorization patterns and encourage flexible fact retrieval.

Phase 3 (Weeks 5-8): Application and Extension

Introduction of two-digit multiplication problems, including both regrouping and non-regrouping situations. Students applied previously developed fact fluency to more complex computational contexts, with continued flash card support.

Data Collection Procedures

The pretest was administered during the first week, providing baseline measurements of multiplication performance. Following the eight-week intervention, the posttest was administered using identical procedures and assessment items. Both assessments were conducted during regular mathematics instruction time with standardized administration procedures.

Data Analysis Methods

Statistical analysis employed descriptive and inferential methods. Descriptive statistics included mean scores, standard deviations, and percentage scores. Paired samples t-test examined the statistical significance of performance changes, with alpha set at 0.05. Effect size was calculated using Cohen's d to assess practical significance.

Normality assumptions were examined using the Shapiro-Wilk test ($W = 0.92$, $p = 0.06$), indicating acceptable normality for parametric testing. The difference scores (posttest minus pretest) were calculated and analyzed for the paired t-test procedure.

Ethical Considerations

This study was conducted as part of normal instructional practice and received approval from the school administration and Division Office of Pangasinan I. Informed consent was obtained from parents/guardians, and student assent was secured prior to participation. No formal institutional review board approval was required as the research constituted classroom-based action research using standard instructional materials and procedures.

C. Results

Performance Outcomes

The analysis of Grade 4 learners' mathematical performance revealed improvements in multiplication skills following the eight-week flash card intervention. Pretest assessment results indicated that students began with a mean score of 10.47 out of 25 possible points (41.9%). Posttest results demonstrated a mean score of 12.92 out of 25 possible points (51.7%).

The improvement represents a 2.45-point increase in mean scores, corresponding to a 9.8 percentage point increase in performance. In relative terms, this represents a 23.4% improvement from baseline performance [(12.92-10.47)/10.47 × 100%].

Distribution of Performance Changes

Individual analysis revealed that 29 students (80.6%) demonstrated improved scores, while 6 students (16.7%) maintained equivalent performance, and 1 student (2.8%) showed decreased performance. The magnitude of individual improvements varied considerably, reflecting classroom heterogeneity and differential intervention responses.

Students with initially lower pretest scores tended to show greater absolute improvements, while those with higher pretest performance showed more modest gains, potentially reflecting ceiling effects or existing proficiency levels.

Statistical Significance Analysis

Paired samples t-test analysis confirmed statistical significance of performance improvements between pretest and posttest assessments. The analysis yielded $t(35) = -8.82$ with $p < 0.001$, providing strong evidence against the null hypothesis of no difference.

The effect size calculation revealed Cohen's $d = 0.98$, indicating a large practical significance according to conventional interpretive guidelines ($d > 0.8$). The 95% confidence interval for the mean difference ranged from 1.87 to 3.03 points, suggesting the true population effect likely falls within this range.

Error Pattern Analysis

Qualitative examination of student responses revealed reductions in computational errors following the intervention. Common pretest errors included basic multiplication fact mistakes and procedural errors in multi-step calculations. The intervention appeared particularly effective in reducing basic fact errors, with substantial decreases in fundamental multiplication mistakes observed in posttest responses.

Performance by Problem Type

Students showed greatest improvements in basic two-digit multiplication without regrouping, achieving higher accuracy rates in these problem types by posttest. Moderate improvements were observed in regrouping problems, though these remained more challenging for many students.

D. Discussion

Association Between Flash Cards and Performance

The significant improvements in Grade 4 learners' multiplication performance suggest a positive association between systematic flash card implementation and

computational skill development. The increase from 41.9% to 51.7% mean performance represents meaningful educational progress, though the quasi-experimental design limits causal inference capabilities.

These findings align with previous research documenting benefits of systematic practice interventions in mathematics learning (Sarile & Estrella, 2018). The results support theoretical frameworks emphasizing automaticity development in mathematical skill acquisition, reflecting what Geary (1994) described as progression from effortful computation to efficient fact retrieval.

Methodological Limitations and Alternative Explanations

Several factors beyond the flash card intervention could account for observed improvements:

1. **Natural maturation**: Students' developmental progress over eight weeks
2. **Practice effects**: Improvement due to familiarity with test format
3. **Increased attention**: Hawthorne effect from research participation
4. **Concurrent instruction**: Other mathematical learning occurring simultaneously

The substantial effect size (d = 0.98) and consistency with previous research support the intervention's contribution, though definitive causal attribution cannot be established without experimental controls.

Pedagogical Implications

The positive outcomes suggest that systematic flash card practice may serve as a valuable component of multiplication instruction when implemented within supportive classroom environments. The structured three-phase progression from basic facts to complex applications demonstrates potential value of scaffolded approaches to skill development.

However, implementation should emphasize computational accuracy and fluency development rather than broader conceptual understanding, as the assessment

focused specifically on computational performance rather than deeper mathematical reasoning.

Cultural and Contextual Considerations

The intervention's apparent success within the Philippine elementary education context may reflect cultural values emphasizing persistent practice and systematic skill development. The collaborative classroom environment and teacher support likely contributed to positive outcomes.

The low-cost nature of flash cards makes this approach particularly relevant for resource-constrained educational settings where expensive technological interventions may not be feasible.

Practical Recommendations

Based on these findings, elementary mathematics educators might consider implementing systematic flash card practice as one component of multiplication instruction, with attention to:

- Structured progression from basic facts to complex applications
- Integration of motivational strategies to maintain engagement
- Regular assessment to monitor individual progress
- Recognition that flash cards address computational fluency rather than conceptual understanding

Future Research Needs

Subsequent investigations should employ more rigorous experimental designs including control groups to establish causal relationships. Longitudinal studies examining persistence of gains would provide valuable insights into lasting intervention effects. Additionally, research investigating optimal implementation parameters and integration with other instructional approaches could inform comprehensive mathematics education frameworks.

E. Conclusion

This action research study provides evidence suggesting a positive association between systematic flash card intervention and Grade 4 learners' multiplication performance improvements. The significant increase from 41.9% to 51.7% mean performance, coupled with strong statistical significance [$t(35) = -8.82$, $p < 0.001$] and large effect size ($d = 0.98$), indicates meaningful changes in computational performance following the intervention.

However, the quasi-experimental design requires cautious interpretation. While the substantial effect size suggests meaningful intervention impact, alternative explanations including maturation, testing effects, and concurrent instruction cannot be definitively ruled out. The findings should be interpreted as demonstrating association rather than causation.

The research contributes to understanding accessible instructional strategies for Filipino elementary learners, providing evidence that systematic, low-cost interventions may support multiplication skill development when implemented with appropriate pedagogical support. The success within this specific rural Philippine context demonstrates potential for flash card approaches in similar educational settings.

These findings support continued investigation of targeted interventions for mathematical learning difficulties while emphasizing the need for more rigorous experimental designs to establish causal relationships and inform evidence-based educational practice.

F. Recommendations

For Classroom Teachers

Elementary mathematics educators should consider systematic flash card practice as one component of comprehensive multiplication instruction. Implementation should follow structured progression emphasizing computational accuracy development alongside other instructional approaches targeting conceptual understanding.

For School Administrators

Educational leaders should support implementation of evidence-based, cost-effective mathematics interventions through resource allocation and professional development opportunities. The accessibility of flash card approaches makes them suitable for widespread adoption across diverse educational settings.

For Future Researchers

Longitudinal studies employing randomized controlled designs should be prioritized to establish causal relationships and examine persistence of intervention effects. Mixed-methods research incorporating qualitative data on student experiences could provide comprehensive understanding of intervention mechanisms.

Research investigating optimal implementation parameters, integration with other instructional approaches, and effectiveness across diverse student populations would inform comprehensive frameworks for elementary mathematics education improvement.

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