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TERMINAL REPORT

SUCCORING MATH LEARNERS WITH PROJECT E-MWC (ELECTRONIC MATH WINDOW CARD)

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SUMMARY SHEET

Title: Succoring Math Learners with Project e-MWC (Electronic Math Window Card)

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Project Information

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Abstract

This multi-method quantitative sequential study investigated the effectiveness of the electronic mathematics window card (e-MWC) App in enhancing basic math operations mastery among primary graders. A one-group pretest-posttest design was utilized, followed by a correlational survey. Eighty-eight (N=88) Grade 2 and 3 learners from DepEd Mabinay District 3 served as subjects. The app was administered over five standardized sessions, following its development via the MDLC model and comprehensive testing. Baseline pre-test scores revealed a low "Average" mastery level (M=9.50, SD=5.02) across the cohort. Post-test results demonstrated a significant increase in the overall mean score to M=20.10 (SD=3.92). A paired sample t-test confirmed this gain was statistically significant ($t(87) = -16.889$, $p < 0.001$). Furthermore, the app received consistently high ratings from teachers and observers, with overall mean scores interpreted as "Strongly Agree" for Effectiveness (M=4.50), Efficiency (M=4.32), and Satisfaction (M=4.61). The study concludes that the e-MWC App is strongly associated with improved mathematical mastery, establishing it as a valuable, well-received educational technology tool. However, the one-group design precludes definitive causal attribution. Future research should employ a Randomized Controlled Trial to conclusively isolate the app's effect.

Keywords: Electronic Mathematics Window Card (e-MWC) App, Educational Technology, Basic Math Operations, Mathematical Mastery, Elementary Education, Quantitative Sequential Study

Introduction

Imagine entering a world where mastering math becomes fun and engaging. Unfortunately, for many students, this world remains out of reach. Struggles with foundational math skills can lead to demotivation, decreased academic performance, and a belief that they are not "good" at math (Ocadiz, 2017). This is a global concern, but particularly relevant in the Philippines, where TIMSS 2019 results placed Filipino Grade 4 students lowest among 58 participating countries (TIMSS, 2019). The Philippines also ranked near the bottom in the 2022 Programme for International Student Assessment (PISA), placing 77th out of 81 countries in reading, mathematics, and science, with scores significantly below the OECD average (OECD, 2023).

Several factors contribute to this challenge. Learning disabilities can make understanding math concepts difficult (Ocadiz, 2017). Students may also struggle with incomplete mastery of basic number facts and weaknesses in computation skills (Gafoor & Kurukkan, 2015). Traditional methods that rely heavily on rote memorization can disengage students and fail to address individual learning styles (Aksu & Usluyil, 2015). This highlights the need for innovative approaches that cater to diverse learning needs and foster a more positive learning experience.

Fortunately, research suggests that technology can be a powerful tool for improving math learning (Kurt, 2019; Scharaldi, 2020). Interactive mobile apps offer a student-centered approach, allowing for (1) personalized learning experiences where students can progress at their own pace and receive targeted instruction based on their individual strengths and weaknesses (Wang et al., 2020), gamification elements where engaging game mechanics like points, badges, and leaderboards can increase student

motivation and make practicing math enjoyable (Sail et al., 2010), and students can access practice materials and learning activities outside of the classroom, reinforcing skills and promoting independent learning (Scharaldi, 2020).

This project proposes the development of a mobile application called e-MWC (electronic Math Window Card). Drawing inspiration from traditional window cards, e-MWC aims to address the identified challenges by providing students with an engaging and accessible tool to practice and master basic math operations. The app will go beyond traditional methods by offering interactive exercises, gamified elements, and personalized learning pathways based on individual student progress.

By incorporating technology into math education, e-MWC has the potential to revolutionize the learning experience. The app can foster student engagement, cater to individual needs, and ultimately lead to a significant increase in numeracy skills among Filipino students. This aligns with the Philippines' national agenda for education, which emphasizes the use of technology to improve learning outcomes (DepEd, 2018). The development and evaluation of e-MWC can contribute valuable insights into the effectiveness of mobile learning applications for enhancing foundational math skills in the Philippine context.

Review of Literature

Learning mathematics, particularly conceptually challenging topics like rational numbers and algebraic skills, presents a persistent challenge in current educational contexts, often resulting in below-average academic performance. The research reviewed here consistently demonstrates that integrating purposeful technological interventions—including adaptive tutoring systems, virtual manipulatives, and educational

apps—yields statistically significant improvements in student achievement across multiple mathematical domains and grade levels.

A central finding across recent educational technology studies is the positive effect of Adaptive Learning Systems (ALS) and intelligent tutoring on student outcomes. One particularly robust study, a randomized crossover trial, evaluated the Woot Math Adaptive Learning (WMAL) tutor for 4th and 5th graders struggling with rational numbers and fractions. This research reported that after 10 hours of instruction with the adaptive tutor, students achieved statistically higher performance gains than during periods of business-as-usual instruction ($d = 0.39$, $F(1, 589) = 5.73$, $p < 0.05$) (Bush, 2021). This significant difference highlights the efficacy of software designed to incorporate best practices in adaptive sequencing and detailed, procedural feedback.

Supporting this trend, long-term experimental research conducted over three school years found that students utilizing general educational software as a primary learning tool achieved significantly better results on mathematics knowledge tests compared to those taught using only traditional methods (Gavrilović et al., 2024). Furthermore, this study noted an increase in student satisfaction, suggesting that technology not only improves achievement but also enhances the overall learning experience. These adaptive systems successfully personalize learning trajectories, offering a scaled solution for delivering individualized instruction that teachers often struggle to provide consistently in a traditional classroom setting.

Beyond general adaptive systems, targeted technological tools have proven effective in improving specific mathematical skills across the entire K-12 spectrum. The WMAL intervention's success is partially attributed to its deliberate integration of virtual

manipulatives and a focus on conceptual understanding—a pedagogical best practice often difficult to scale with physical tools (Bush, 2021). By linking dynamic digital manipulatives with immediate feedback, the software helps students build the necessary conceptual foundation before moving on to procedural fluency. The utility of technology extends to more advanced concepts as well. A quasi-experiment utilizing virtual learning objects with students aged 10 to 14 demonstrated a statistically significant improvement in the skills required to solve root exercises ($F(1, 52) = 10.41$, $p = .002$) (Cóndor-Herrera & Ramos-Galarza, 2020). Similarly, a pre-experimental study on the effects of E-Learning and M-Learning (mobile learning) programs showed significant gains in 11th and 12th graders' knowledge of direct proportionality ($t(15) = -7.20$, $p < .001$) and problem-solving ability ($t(15) = -6.75$, $p < .001$), confirming the benefits of flexible, technology-based delivery (Cóndor-Herrera & Ramos-Galarza, 2021). The positive impact of technology is evident even at the earliest stages of education. A comparative analysis of students in Early Childhood Education (ages 57-79 months) using educational apps found significant gains, particularly for students who entered the intervention with lower pre-assessment scores (Mera Cantillo et al., 2025). This underscores the potential of technology to mitigate early disadvantages and promote formal mathematical thinking.

The converging evidence from these diverse studies—ranging from randomized crossover trials on rational numbers to quasi-experiments on root concepts and early childhood apps—establishes a strong consensus: technological interventions are highly effective in supporting and significantly increasing student achievement in mathematics. The described interventions demonstrate that when software is designed using pedagogical best practices—incorporating virtual manipulatives, focusing on conceptual

understanding, and providing personalized, adaptive feedback—it can efficiently scale these practices to support teachers and significantly improve student outcomes, justifying the continued push for incorporating such technological tools into classroom practice.

Objectives

This study aimed to address the issue of low numeracy rates among learners, particularly in basic math operations using the software known as e-MWC App (electronic mathematics window card). Specifically, the study answered the following:

1. What is the mastery level of the mathematics learners on the basic operations before using e-MWC (electronic mathematics window card) App;

2. What is the mastery level of the mathematics learners on the basic operations after using e-MWC (electronic mathematics window card) App;

3. What is the effectiveness, efficiency, and satisfaction level of the e-MWC App; and

4. Is there a significant difference in the mastery level of the mathematics learners on the basic operations before and after using e-MWC App?

Theoretical Framework

This study is grounded in 3 frameworks to analyze the effectiveness of the E-MWC App in enhancing basic math operations mastery among primary-grade learners. The frameworks explain both the technological quality of the intervention and the cognitive mechanisms that account for the observed learning gains.

ISO 9241-11:2018 Usability Standard (as technological foundation) provides the internationally recognized framework for evaluating the app's quality in use. Usability is

defined as: “The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.” This standard serves as the explicit theoretical foundation for Effectiveness, Efficiency, and Satisfaction levels and structurally supports the causal link between the tool's design and the measured outcomes of the study.

Cognitive Load Theory (as cognitive mechanism). The app's measured Efficiency is explained by Cognitive Load Theory (CLT) (Sweller, 1988). CLT theorizes that human working memory has a limited capacity. *Minimizing Extraneous Load.* The E-MWC App's clean interface, focused, single-task presentation, and immediate, precise feedback successfully minimize Extraneous Cognitive Load (mental effort wasted on poor design). And *Maximizing Germane Load.* By eliminating distractions, the design ensures the students’ cognitive resources are directed toward Germane Cognitive Load—the desirable mental effort spent on schema construction and automation. This repetitive, focused practice is the mechanism by which basic mathematical facts are moved from working memory to long-term memory, leading to the rapid achievement of mastery (Paas, Renkl, & Sweller, 2003)

Zone of Proximal Development (ZPD). The overall learning achievement is contextualized by Vygotsky’s Zone of Proximal Development (ZPD). Scaffolding and Mastery Gain, the ZPD defines the difference between what a student can do independently (their actual development—reflected in the low Pre-test mean) and what they can achieve with guidance (their potential development). The E-MWC App acts as the More Knowledgeable Other (MKO) by providing the necessary digital scaffolding (sequential levels, targeted practice). In addition, the Validation of the ZPD. The

significant increase in mastery scores from the pre-test to the post-test and the resulting statistically significant difference serve as empirical evidence that the E-MWC App effectively facilitated learning within the ZPD (Gredler & Shields, 2025)

The E-MWC App is theoretically justified as an effective educational tool because it successfully meets the ISO 9241-11:2018 standards for Effectiveness, Efficiency, and Satisfaction. This user-centered design, in turn, allows the tool to operate as a CLT-compliant device that efficiently manages cognitive resources while providing the crucial ZPD scaffolding needed to transition primary learners from low initial competency to demonstrated mathematical mastery, thereby confirming the statistically significant intervention effect.

Methodology

This study employed a multi-method quantitative sequential design, utilizing a one-group pretest-posttest experimental component followed by a survey, aligning with the methodology proposed by Morse (2003) where initial findings inform subsequent extensions. The core objective was to determine the effect of the electronic mathematics window card (e-MWC) App on the mastery of the four basic math operations among primary graders. Eighty-eight (88) subjects were selected through a stratified sampling procedure from the DepEd Mabinay District 3, with ethical clearance and all required permits, including informed parental consent and learner assent, secured prior to implementation. The e-MWC App, a researcher-developed Android-based tool, was rigorously created following the six-step Multimedia Development Life Cycle (MDLC), including alpha and beta testing, to ensure functionality and real-world usability. Data collection commenced with a pretest to establish baseline mastery, after which subjects

underwent the intervention across five standardized sessions using the app on tablet computers. Immediately following the intervention, a paralleled posttest was administered, and a subsequent survey gathered teacher and observer perceptions regarding the app's effectiveness, efficiency, and satisfaction. Finally, statistical analysis utilized descriptive measures (mean, standard deviation) and an inferential paired sample t-test to assess the significant difference between pretest and posttest scores and, thereby, the effect of the e-MWC App.

Results and Discussion

Table 1. Pre-Test Score and Mastery Level of the Mathematics Learners on the Basic Operations Before Using the e-MWC App.

Grade Level	Pre-Test Score Mean	Percent Equivalent	Mastery Level	Description
Grade 2	9.48	39.52%	Average	Demonstrates a basic understanding of operations, but with inconsistent accuracy. Requires further practice and reinforcement to improve fluency and accuracy.
Grade 3	9.51	39.62%	Average	Demonstrates a basic understanding of operations, but with inconsistent accuracy. Requires further practice and reinforcement to improve fluency and accuracy.

Note: Absolutely no mastery: 0%-4%; Very low: 5%-14%; Low: 15%-34%; Average: 35%-65%; Moving toward mastery: 66%-85%; Closely approximating mastery: 86%-95%; Mastered: 96%-100%

Based on the pre-test results, the Grade 2 and Grade 3 mathematics learners in this study demonstrate a similar initial understanding of basic operations. The table depicts the pre-test mean score for Grade 2 learners was 9.48 out of 24-item test, which is equivalent to 39.52%. Similarly, the Grade 3 learners achieved a pre-test mean score of 9.51 out of the 24-item test, equivalent to 39.62%. According to the provided description, both grade levels are categorized as having an "Average" mastery level.

The "Average" mastery level, as described, indicates that both Grade 2 and Grade 3 learners possess a basic understanding of mathematical operations but struggle with consistent accuracy. This suggests that while they may grasp the fundamental concepts, their ability to apply these concepts correctly and fluently is still developing. The need for further practice and reinforcement is highlighted to improve both their accuracy and speed in performing basic operations. The data indicates that, prior to the intervention, the learners in both Grade 2 and Grade 3 have not yet achieved a high level of mastery in these foundational skills. Considering the Philippine elementary mathematics curriculum, the basic operations for Grade 2 include addition and subtraction with sums and minuends up to 100 without regrouping. By Grade 3, learners are expected to understand the four fundamental operations with whole numbers up to 10,000. The pre-test scores suggest that the learners in this study, even in Grade 3, have not yet reached a strong mastery level in these expected basic operations for their grade level. This suggests that, on average, these students had a basic understanding but lacked consistent accuracy in performing fundamental mathematical tasks, the need for reinforcement.

Table 2. Post-Test Score and Mastery Level of the Mathematics Learners on the Basic Operations After Using the e-MWC App.

Grade Level	Post-Test Score Mean	Percent Equivalent	Mastery Level	Description
Grade 2	22.30	92.93%	Closely Approximating Mastery	Shows strong proficiency in basic operations with minimal errors. Can confidently solve most problems, indicating a near-mastery level.
Grade 3	18.78	78.26%	Moving Toward Mastery	Displays a solid understanding of basic operations, but may make occasional errors or struggle with more complex applications. Progressing steadily towards mastery.

Note: Absolutely no mastery: 0%-4%; Very low: 5%-14%; Low: 15%-34%; Average: 35%-65%; Moving toward mastery: 66%-85%; Closely approximating mastery: 86%-95%; Mastered: 96%-100%

The table presents the post-test and mastery level of the mathematics learners on the basic operations after the e-MWC intervention. Based on the post-test results in Table 2, shows the outcomes after the intervention with the e-MWC app. The post-test mean score for Grade 2 learners was 22.30 out of the 24-item test, which is equivalent to 92.93%. This performance level is described as "Closely Approximating Mastery," indicating strong proficiency in basic operations with minimal errors. The Grade 3 learners achieved a post-test mean score of 18.78 out of the 24-item test, equivalent to 78.26%. Their mastery level is categorized as "Moving Toward Mastery," suggesting a solid understanding of basic operations with occasional errors or struggles with more complex applications.

The post-test results reveal a substantial improvement in the mastery levels of basic operations for both Grade 2 and Grade 3 learners after the intervention with the e-MWC app. For Grade 2, the increase from a pre-test mean score of 9.48 (39.52%, "Average" mastery) to a post-test mean score of 22.30 (92.93%, "Closely Approximating Mastery") is remarkable. This significant gain suggests that the e-MWC app was highly effective in enhancing the Grade 2 learners' proficiency in basic mathematical operations. The description of their post-test performance indicates that they can now solve most problems confidently with minimal errors, signifying a near-mastery level. This aligns with research suggesting that math apps can lead to significant learning gains in basic math skills. Moreover, the Grade 3 learners also demonstrated positive progress. Their post-test mean score of 18.78 (78.26%, "Moving Toward Mastery") shows an improvement from the pre-test mean score of 9.51 (39.62%, "Average" mastery). While they have not reached the same level of near-mastery as the Grade 2 learners, their performance

indicates a solid understanding of basic operations. The description suggests they are progressing steadily towards mastery but may still require some support with more complex applications or may make occasional errors. This level of improvement also supports the potential effectiveness of educational apps in improving math skills.

Further, this post-intervention data provides a clear picture of the learners' improved abilities after using the e-MWWC app. Comparing the pre-test and post-test results directly addresses the third research question regarding the effectiveness level of the e-MWC App. The data strongly suggests that the app was effective in improving the mastery of basic operations for both grade levels, with a particularly pronounced impact on the Grade 2 learners.

Table 3.1 Effectiveness level of the e-MWC App as perceived by the teachers/observers.

INDICATOR	MEAN	DESCRIPTION	Effectiveness Level
Effectiveness			
1. The student was able to complete the math tasks using the app.	4.36	Strongly Agree	Very High
2. The app helped the student practice and improve basic math operations.	4.68	Strongly Agree	Very High
3. The student showed increased understanding of addition, subtraction, multiplication, or division after using the app.	4.41	Strongly Agree	Very High
4.The app content matched the student's grade level and learning needs.	4.55	Strongly Agree	Very High
Overall Mean	**4.50**	Strongly Agree	Very High

Note: Very Low: 1.00 – 1.80; Low: 1.81-2.60; Moderate: 2.61-3.40; High: 3.41-4.20; Very High: 4.21-5.00

The quantitative results strongly affirm the high effectiveness of the math application in supporting student learning. The overall mean score for the Effectiveness

indicator was 4.50, which is interpreted as "Strongly Agree" on the 5-point Likert scale, indicating a unanimous positive assessment. The most compelling evidence of the app's success is its role in skill development, evidenced by the highest mean score of 4.68 for helping students "practice and improve basic math operations." This suggests the app is an outstanding tool for foundational skill mastery. Furthermore, this practice appears to translate into actual comprehension, as indicated by the high mean of 4.41 for students showing "increased understanding" of mathematical concepts. This validates the pedagogical soundness of the app's content and structure. Crucially, the content itself was deemed highly appropriate, scoring a mean of 4.55 for matching the students' grade level and learning needs, a factor that likely contributes to the high engagement and subsequent learning gains. Finally, the ability to complete tasks using the app scored a mean of 4.36, confirming strong usability and minimal technical friction. The consistently high ratings across all indicators establish the math application as a highly successful and appropriate educational intervention that effectively boosts both the practice and understanding of basic math skills.

Table 3.2. Efficiency level of the e-MWC App as perceived by the teachers/observers.

INDICATOR	MEAN	DESCRIPTION	Efficiency Level
Efficiency			
5. The student navigated the app without much assistance.	3.95	Agree	High
6. The student completed math tasks in a reasonable amount of time.	4.18	Agree	High
7. The instructions or prompts in the app were easy for the student to follow.	4.41	Strongly Agree	Very High
8. The app responded quickly and worked smoothly during use.	4.73	Strongly Agree	Very High
Overall Mean	**4.32**	**Strongly Agree**	Very High

Note: Very Low: 1.00 – 1.80; Low: 1.81-2.60; Moderate: 2.61-3.40; High: 3.41-4.20; Very High: 4.21-5.00

The analysis of the Efficiency indicator reveals that the math application is highly efficient, achieving an Overall Mean score of 4.32, which corresponds to a descriptive rating of "Strongly Agree" on the 5-point Likert scale. The results show exceptional technical performance, with the highest mean score of 4.73 confirming that the "app responded quickly and worked smoothly during use." This high rating is complemented by a score of 4.41 for the clarity of instructions, indicating that the "instructions or prompts in the app were easy for the student to follow." Lower, but still very positive, scores were recorded for task completion time (4.18, "Agree") and the ability to navigate independently (3.95, "Agree"). These scores collectively establish that the app possesses strong technical reliability and an accessible design. The discussion confirms that the app's high level of efficiency significantly supports its previously observed high effectiveness. The near-perfect score for technical smoothness (4.73) suggests that the application is free from disruptive lags or glitches, which is crucial for maintaining student focus and flow during learning tasks. This technical stability, combined with the clear instructions (4.41), ensures students spend their time focused on learning math rather than troubleshooting the platform. The slightly lower score for independent navigation (3.95) suggests the app is usable, but initial guidance or occasional teacher support might be beneficial for some students to fully maximize efficiency. Nevertheless, the fact that students were able to complete tasks in a reasonable amount of time (4.18) further reinforces that the application is a time-effective and user-friendly tool, making it highly suitable for integration into the learning environment.

Table 3.3. Satisfaction level of the e-MWC App as perceived by the teachers/observers.

INDICATOR	MEAN	DESCRIPTION	INTERPRETATION
Satisfaction			
9. The student appeared engaged or motivated while using the app.	4.50	Strongly Agree	Very High
10. The animations and visuals helped the student understand math concepts.	4.55	Strongly Agree	Very High
11. The student enjoyed using the app for learning math.	4.68	Strongly Agree	Very High
12. The overall experience with the app was positive for the student.	4.73	Strongly Agree	Very High
Overall Mean	**4.61**	**Very High**	**Very High**

Note: Very Low: 1.00 – 1.80; Low: 1.81-2.60; Moderate: 2.61-3.40; High: 3.41-4.20; Very High: 4.21-5.00

The data indicate that student Satisfaction with the math application is extremely high, evidenced by an Overall Mean of 4.61, which is interpreted as "Strongly Agree." The analysis of the Satisfaction indicator reveals that the math application is exceptionally well-received by students, achieving the highest overall mean score across all three dimensions of evaluation. The Overall Mean is 4.61, corresponding to a definitive "Strongly Agree" rating on the 5-point Likert scale.

The high satisfaction scores provide crucial validation that the app is successful in creating a positive and motivating learning environment. The highest mean score of 4.73 for the "overall experience was positive" suggests a comprehensive endorsement, indicating that all aspects of the app—effectiveness, efficiency, and engagement—culminated in an outstanding user experience. This is further reinforced by the finding that students "enjoyed using the app" (4.68), which is a key predictor of sustained usage and continued learning. The strong mean of 4.50 for engagement/motivation confirms that the app successfully captured student attention. This motivation is strongly linked to the instructional design, as the score of 4.55 shows the animations and visuals were not just

entertaining, but actively helped the student understand math concepts. This is highly significant because it confirms that the app's aesthetic and interactive elements are pedagogically sound, serving a functional purpose in learning rather than just being decorative. The combination of high enjoyment and high perceived learning utility suggests the app has successfully achieved "edutainment," making the learning process intrinsically rewarding and reinforcing the earlier findings on high effectiveness.

Table 3.4. The Overall Summary and Integrated Discussion of the Math Application Evaluation.

Evaluation Dimension	Overall Mean	Description	Interpretation
A. Effectiveness	4.50	Strongly Agree	Very High Educational Impact
B. Efficiency	4.32	Strongly Agree	High Usability and Performance
C. Satisfaction	4.61	Strongly Agree	Extremely Positive User Experience

Note: Very Low: 1.00 – 1.80; Low: 1.81-2.60; Moderate: 2.61-3.40; High: 3.41-4.20; Very High: 4.21-5.00

The comprehensive evaluation of the math application across the three dimensions of Effectiveness, Efficiency, and Satisfaction reveals a highly successful educational technology tool. With consistently high ratings across all categories, the app demonstrates a powerful synergy between learning outcomes, technical performance, and user experience. The overall mean of 4.50 for Effectiveness confirms the app's primary educational value. The data strongly suggests the application is successful in its core mission: students are not only able to complete tasks but are actively improving their basic math operations (4.68) and showing increased understanding (4.41). This high performance is fundamentally supported by the app's appropriate content matching (4.55), ensuring the material is well-targeted to student needs.

The high scores for Efficiency (overall mean: 4.32) provide the necessary context for the learning success. The near-perfect technical reliability (smooth and quick response: 4.73) and the clarity of the instructions (4.41) ensure that the student's cognitive energy is focused on the math, not on overcoming technical hurdles. The app's design minimizes friction, leading to a productive and streamlined learning experience, which is why students were able to complete tasks in a reasonable amount of time (4.18). The truly exceptional scores in Satisfaction (Overall Mean: 4.61) serve as the critical validation of the app's overall design. The fact that the overall experience was positive (4.73) and students "enjoyed using the app" (4.68) demonstrates that the application has successfully integrated learning with engagement. The high positive correlation between the helpfulness of animations/visuals (4.55) and the high level of motivation (4.50) indicates that the app's aesthetic and interactive features are serving a pedagogical purpose, making the learning process intrinsically rewarding. Hence, the math application excels on all fronts. Its high effectiveness (students learn) is powered by high efficiency (the app works well and is easy to use), which culminates in extremely high satisfaction (students enjoy the experience). This virtuous cycle—where technical excellence and engaging design drive positive learning outcomes—makes the application a highly recommended and robust educational technology solution.

Table 4. Significant Difference on the Mastery Level of the Mathematics Learners on the Basic Operations Before and After Using e-MWC App.

	Mean Score	N	Std. Deviation	Std. Error Mean	t-value	p-value
Pre-Test	9.5000	88	5.02179	0.53532	-16.889	0.000
Post-Test	20.1023	88	3.91883	0.41775		

Significant p-value < 0.05

The table presents the paired t-test that revealed a significant difference in the mathematics learners' mastery of basic operations before and after using the e-MWC App. The mean mastery level before using the app (Pretest) was 9.50, with a standard deviation of 5.02179. After using the app (Posttest), the mean mastery level significantly increased to 20.1023, and the standard deviation decreased to 3.91883. The paired t-test produced a t-value of -16.889 and a p-value of 0.000.

The substantial increase in the mean mastery level from 9.50 to 20.1023, coupled with the statistically significant p-value of 0.000, strongly suggests that the observed improvement was not due to chance. Hence, there is a significant difference on the mastery level of the mathematics learners before and after the intervention. The negative t-value (-16.889) indicates that the direction of the difference was an increase in the post test mean compared to the pre test mean. This confirms that the e-MWC App had a significant positive impact on the learners' mastery of basic mathematical operations. The decrease in the standard deviation also signifies improved consistency among learners after using the app. Therefore, the findings clearly demonstrate the effectiveness of the e-MWC App as a valuable tool for enhancing mathematical proficiency, and its integration into educational practices could potentially improve student learning outcomes.

In connection, three studies explored the use of mobile applications to enhance numeracy skills across different educational levels. Miller (2018) investigated kindergarten students using iPad apps in a play-based environment, observing increased engagement and collaboration, though mathematical achievement gains were minimal. In contrast, Insorio (2020) and Malabayabas et al. (2024) focused on Grade 11 students, demonstrating significant improvements in numeracy and academic performance through

targeted mobile applications, "Numeracy Enhancement Tool" and "Math-GALING," respectively. Additionally, a 2016 study at Sto. Domingo Integrated School investigated the "window card technique" with Grade 8 students, finding a remarkable improvement in the experimental group's performance on integer applications compared to the control group. This study, similar to the others, highlights the impact of instructional strategies on mathematical performance, demonstrating that innovative methods, like the window card technique, can effectively address below-average student performance. These studies collectively suggest that mobile apps can be effective tools for numeracy development, but their success hinges on factors like app design, student age, and educational context.

Conclusion

The study concludes that the application of the e-MWC App is highly associated with a statistically significant improvement in the primary learners' mastery of the four basic mathematical operations. The paired sample t-test confirmed a significant difference between the pre-test mean score (9.50) and the post-test mean score (20.10), indicating a substantial and non-random gain in learner proficiency ($t(87) = -16.889$, $p < 0.001$). This empirical finding is powerfully reinforced by the survey results, which demonstrated a consensus among teachers and observers that the app possesses Very High Effectiveness (M=4.50), Efficiency (M=4.32), and Satisfaction (M=4.61). The application successfully integrates technical reliability and engaging design, creating a positive and effective learning experience that directly contributes to increased mathematical performance and confidence.

However, the interpretation must be qualified by the study's one-group pretest-posttest design. While the results strongly support the app's instructional value, the lack

of a control group prevents definitive causal attribution, leaving the observed gains potentially influenced by extraneous variables like the novelty effect or maturation.

Therefore, the e-MWC App is highly recommended as an engaging and valuable supplementary tool for basic math instruction. For future research, it is imperative to employ a Randomized Controlled Trial (RCT) design with a control group to conclusively isolate and confirm the app's unique and causal impact on learner mastery.

Recommendations

1. DepEd Mabinay is strongly encouraged to adopt and integrate the e-MWC App into the curriculum for Grade 2 and Grade 3 learners as a supplementary tool for practicing basic math operations.

2. Teachers should utilize the app specifically for reinforcement and achieving automaticity in basic operations, especially primary grade learners. They may incorporate the app into learning centers, homework assignments, or remedial sessions to foster a positive and motivated environment for mathematics learning. While the app showed high efficiency, the slightly lower score for independent navigation suggests teachers should provide initial guidance or a brief tutorial to students to ensure all learners can maximize the app's use with minimal friction.

3. For app developers, they may consider future revisions to explore ways to better support learners in complex applications, possibly by introducing multi-step problems or context-based word problems that require chaining basic operations.

4. The Local Government Unit (LGU) may consider allocating funds for the expanded and sustained deployment of the e-MWC App across all primary schools within the Mabinay District. They may also prioritize stable internet connectivity and device

procurement (tablets or computers) in the participating schools to ensure the smooth and equitable use of the app. LGU may also fund teacher training programs focused on the pedagogical integration of the e-MWC App. This ensures that teachers are proficient not only in the technical operation of the app but also in leveraging its features (scaffolding, feedback) to maximize student learning, aligning with best practices in educational technology.

5. For future researchers, it is imperative that future research employs a Randomized Controlled Trial (RCT) design with a dedicated control group. This methodology is necessary to conclusively isolate the causal effect of the e-MWC App on student mastery and rule out the influence of confounding variables (e.g., novelty effect, maturation) inherent in the current one-group design.

6. Research may also be conducted to compare the e-MWC App's effectiveness against traditional instructional methods or against other existing commercial math applications to firmly establish its relative advantage in the educational technology landscape.

7. Future studies may focus on the tracking the performance of learners over a longer period (e.g., three to six months post-intervention) to determine the retention of the acquired math mastery and confirm the long-term educational value of the app.

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Appendix A. **Statistical formula & analysis**

Paired t-test

Formula:

$$t = \frac{\bar{d} - 0}{s_d/\sqrt{n}}$$

Where:

$\bar{d}$ is the mean of the differences between paired observations
0 is the hypothesized mean difference (null hypothesis)
s_d is the standard deviation of the differences
n is the number of pairs

The mean or average formula

Formula:

$$\bar{x} = \frac{\Sigma x_i}{n}$$

Where:

$\bar{x}$ is the mean,
Σx_i is the sum of all values, and
n is the number of values.

Standard deviation formula (for sample)

Formula:

$$s = \sqrt{\frac{\sum(X - \bar{x})^2}{n - 1}}$$

Where:

s is the sample standard deviation
X each individual value in the sample
$\bar{x}$ is the sample mean
n is the number of data points in the sample

Appendix B. **Sample questionnaire/survey form**

Research Questionnaire

Dear Respondents,

This questionnaire is designed to gather data for a study titled "**Succoring Math Learners with Project e-MWC (Electronic - Math Window Card)**". We kindly ask that you provide honest and thoughtful responses. Please be assured that all information you provide will remain strictly confidential.

Thank you for your cooperation and participation.

Profile of the Respondents

NAME (optional): _____
GENDER: ( ) Male ( ) Female
AGE: _____
Department: _____
Position: _____
Respondent Type: ☐ Teacher ☐ Parent ☐ Observer.

This survey aims to evaluate the usability of the *e-MWC App (Electronic Math Window Card)*, a learning tool designed to help elementary students master basic math operations. The questions are based on the **ISO 9241-11:2018** usability framework, focusing on **effectiveness**, **efficiency**, and **satisfaction** as observed during the student's interaction with the app.

Instructions: Please rate the following statements based on your observation of the student while using the e-MWC App. Use the scale below:

1 – Strongly Disagree
2 – Disagree
3 – Neutral
4 – Agree
5 – Strongly Agree

Please, indicate your level of agreement by writing (✓) inside the box.

A. Effectiveness (Does the student achieve learning goals using the app?)

	1	2	3	4	5
1. The student was able to complete the math tasks using the app.					
2. The app helped the student practice and improve basic math operations.					
3. The student showed increased understanding of addition, subtraction, multiplication, or division after using the app.					
4. The app content matched the student's grade level and learning needs.					

B. Efficiency (How easily and quickly does the student use the app?)

5. The student navigated the app without much assistance.

6. The student completed math tasks in a reasonable amount of time.

7. The instructions or prompts in the app were easy for the student to follow.

8. The app responded quickly and worked smoothly during use.

1	2	3	4	5

C. Satisfaction (Was the student comfortable, engaged, and happy using the app?)

9. The student appeared engaged or motivated while using the app.

10. The animations and visuals helped the student understand math concepts.

11. The student enjoyed using the app for learning math.

12. The overall experience with the app was positive for the student.

1	2	3	4	5

Open-Ended Questions (Optional):

13. What do you think are the strengths of the e-MWC App?

_____
_____
_____

14. What improvements would you suggest for the app?

_____
_____
_____

15. Any observations or reactions from the student while using the app?

_____
_____
_____

Thank You for participating

Appendix C. **Terminal Audited Financial Report**

Appendix D. **List of Personnel Involved**

Project Title: **Succoring Math Learners with Project e-MWC (Electronic Math Window Card)**

Project Leader/Sex: **Lister M. Cabonilas/Male**

Implementing Agency: Negros Oriental State University – Research Development and Extension Office

Researchers:

Lister M. Cabonilas/Male

Office: **NORSU Mabinay Campus – College of Teacher Education**

Highest Educational Attainment: **Doctor of Philosophy in Educational Management**

Co-Reseacher:

Clyde D. Dael/Male

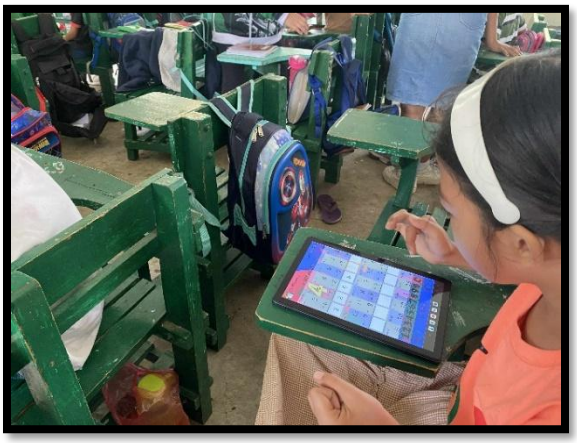
Office: **NORSU Mabinay Campus – College of Technology**

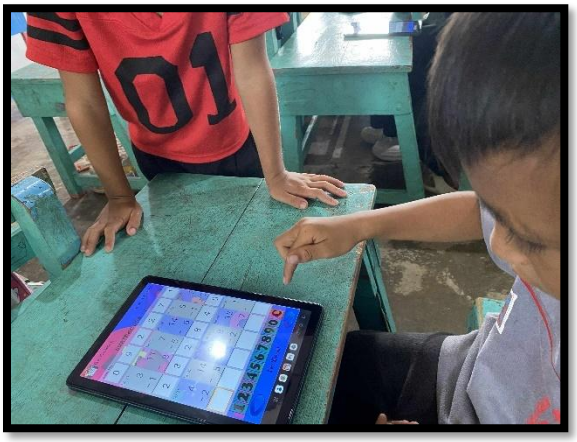
Highest Educational Attainment: **Master of Science in Information Technology**

Appendix E. **List of Equipment**

Unit	Description	Quantity	Uni Cost	Amount
Unit	Tablet/Mobile Tablets, TechLife Pad Neo (4+64) TLPAD002, 4GB+64gb, Seamless LTE Connectivity, 10.1" High Definition Display	10	6,750.00	67,500.00

Appendix F. **Photos (for documentation purposes)**





COMMUNICATION LETTERS

Republic of the Philippines
Department of Education
REGION VII – CENTRAL VISAYAS
Schools Division of Negros Oriental

DepED NEG.OR RELEASED NO: 024-1951 DATE: 05 AUG 2024 BY: RECORDS SECTION

1st Indorsement
August 1, 2024

Respectfully returned to **Mr. Lister M. Cabonilas LPT, MAED**, Assistant Director SAS/Lead Researcher of NORSU Mabinay Campus, the herein request to conduct a study titled "Succoring Math Learners with Project e-MWC (Electronic Math Window Card)."

Please be informed that this office **interposes no objection** to this request provided that the no disruption of classes policy is observed as stipulated in DepEd Order No. 9, series of 2005 titled "Instituting measures to increase engaged time-on-task and ensuring compliance therewith." It is also emphasized that this study is conducted solely for educational purposes and that the contributions of participating elementary schools in the four (4) districts of Mabinay are recognized.

NERI C. OJASTRO EdD, CESO V
Schools Division Superintendent
8/2/2024

Address: Kagawasan Avenue, Capitol Area, Daro, Dumaguete City
Telephone Nos.: (035) 225-2838 / 225-2376 / 422-7644
DepEd TAYO SDO Negros Oriental negros.oriental@deped.gov.ph
www.depednegor.net

RA 9299 Republic of the Philippines June 25, 2004
NEGROS ORIENTAL STATE UNIVERSITY
NOPS (1907) NOTS (1927) EVSAT (1968) CVPC (1983)
Kagawasan Avenue, Dumaguete City, Negros Oriental, Philippines 6200
18Q19869 BAGONG PILIPINAS

Mabinay Campus

VISION STATEMENT

A globally recognized state university.

MISSION STATEMENT

Negros Oriental State University delivers global excellence through advanced instruction, impactful research, and modern infrastructure shaping effective leaders to serve the Philippine society and the world.

QUALITY POLICY

Negros Oriental State University commits to delivering quality instruction, research, extension and production. We ensure compliance with all statutory and regulatory requirements and continuously work to improve our management system to meet our quality objectives.

Approved BOR No. [illegible] Embodied in ISO 9001:2015 [illegible]

ISO 9001:2015 Internationalization [illegible]

ISO 9001:2015 Registration [illegible]

Remote Surveillance Certification [illegible]

February 25, 2025

DR. MARILOU N. LOBOS
Public Schools District Supervisor
DepEd-Mabinay District III
Mabinay, Negros Oriental

Mam:

Greetings of great life!

I hope this message finds you in good spirits. As part of our university's continuous research development efforts, We are writing to respectfully ask for your permission to carry out a key research project entitled **"Succoring Math Learners with Project e-MWC (Electronic Math Window Card)."**

In light of the ongoing difficulties in teaching mathematics, especially to students in Grades 1-3, it is imperative to investigate innovative strategies for improving mathematical knowledge and proficiency. The objective of this study is to fill this gap by creating and assessing Project e-MWC as a potential solution.

The study will focus on the grades 1-3 pupils and mathematics teachers. I am seeking permission to carry out this study in the selected schools under your district. By conducting this research, we aim to contribute to the growing body of knowledge in mathematics education and provide valuable insights into effective teaching and learning strategies.

I assure you that all data collected will be handled with the utmost confidentiality and used exclusively for research purposes. Your positive response to this request would be immensely valuable.

Attached is the indorsement from the Schools Division Superintendent for your reference. Thank you for considering this request. We enthusiastically await your favorable response.

Very Truly Yours,

LISTER M. CABONILAS, MAED-Math
Researcher

CLYDE D. DAEL, MSIT
Researcher

Noted:

NOVA A. GORCIEGA, MAED
Asst. Dir., Research Development and Extension

Approved:

MARILOU N. LOBOS, ED.D.
Public Schools District Supervisor

Document ID	[illegible]			Page 3 of 4
Issue Date	[illegible]	Issue Status	2	
Reviewed & Authorized by	[illegible]	Approved by		

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Kagawasan Avenue, Dumaguete City, Negros Oriental, Philippines 6200
Phone: (63) (35) 522-6050 Fax: 225-4751 Email: norsuprez@norsu.edu.ph www.norsu.edu.ph
18Q19869
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Approved BOR No. 150 s. 2009 Embodied in ISO 9001:2015 [illegible]

ISO 9001:2015 Internationalization [illegible]

ISO 9001:2015 Registration [illegible]

Remote Surveillance Certification [illegible]

February 25, 2025

MRS. NADINE E. BALDOZA
School Principal
New Namangka Elementary School
Namangka, Mabinay, Negros Oriental

Mam:

Greetings of great life!

I hope this message finds you in good spirits. As part of our university's continuous research development efforts, We are writing to respectfully ask for your permission to carry out a key research project entitled **"Succoring Math Learners with Project e-MWC (Electronic Math Window Card)."**

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CLYDE D. DAEL, MSIT
Researcher

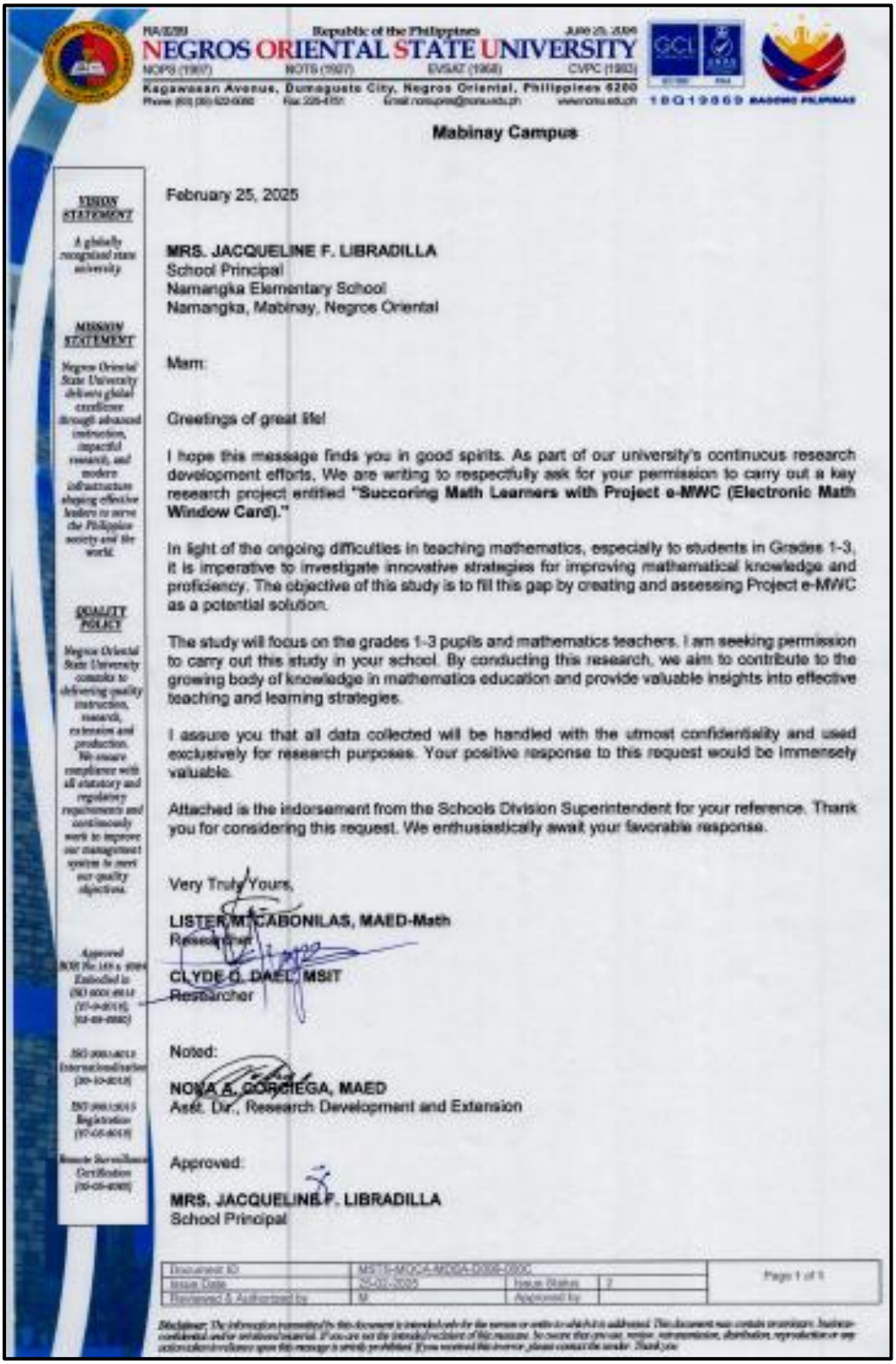
Noted:

NOVA A. GORDEGA, MAED
Asst. Dir., Research Development and Extension

Approved:

MRS. NADINE E. BALDOZA
School Principal

Document ID	[illegible]			Page 2 of 2
Issue Date	[illegible]	Issue Status	2	
Reviewed & Authorized by	[illegible]	Approved by		



Republic of the Philippines

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February 25, 2025

MRS. JACQUELINE F. LIBRADILLA
School Principal
Namangka Elementary School
Namangka, Mabinay, Negros Oriental

Mam:

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Noted:

NONA A. GORGIEGA, MAED
Asst. Dir., Research Development and Extension

Approved:

MRS. JACQUELINE F. LIBRADILLA
School Principal

Document ID			Page 1 of 1
Issue Date		Issue Status	
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