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MDAS (Multiplication, Division, Addition, Subtraction)-IT-ALL: An Android-Based Supplementary Tool in Math 3

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Abstract

Aim: This study designed and developed an android-based math application to improve the numeracy skills of Grade 3 learners in the Paracale District, Division of Camarines Norte. It aimed to address gaps in numeracy skills, particularly for learners identified as needing major support, based on the Albay Numeracy Assessment Test (ALNAT) results.

Methodology: The study used a descriptive-developmental approach. It involved 303 Grade 3 learners from 24 elementary schools in the district and 36 evaluators including teachers, master teachers, and IT experts. The application was designed following the ADDIE model, focusing on stages of analysis, design, development, implementation, and evaluation. The effectiveness of the app was measured through pre- and post-test results, as well as evaluations based on the LRMDS Evaluation Rating Sheet and ISO 9126 Software Quality Standards.

Results: The post-test results indicated a significant improvement in the numeracy skills of learners after using the android-based math app. Furthermore, the application was rated highly in terms of content, instructional, and technical quality by the evaluators. The study showed that the app was an effective tool for improving basic numeracy skills among Grade 3 learners.

Conclusion: The study successfully developed and implemented an android-based math application that significantly improved numeracy skills among learners needing major support. The application was positively evaluated by educators, and its effectiveness was demonstrated through improved post-test results.

Keywords: android-based math app, numeracy skills, instructional quality, technology in education, ADDIE model

INTRODUCTION

Establishing a solid foundation in mathematics is crucial for young learners, promoting financial literacy, critical thinking, and decision-making. Early math learning links to school readiness and academic success. However, math remains challenging, with students relying on formal education to develop foundational skills. Education systems must ensure effective learning to prevent structural constraints.

Studies show poor math performance as a persistent issue. Beatty et al. (2021) found only a 10% proficiency increase from Grade 4 to Grade 12 in Indonesia. Mullis et al. (2012) reported that despite Taiwan's strong math literacy, low-achieving students remained.

In the Philippines, PISA (2022) showed only 16% of students met the minimum proficiency level in mathematics, placing the country among the lowest performers globally. This paper aims to support learners and educators by proposing targeted strategies to improve math outcomes. Public school students scored lower than private school students (DepEd, 2019). In Bicol, a numeracy assessment (DepEd Memo 104, s. 2022) found 79.35% of Grade 1-3 learners needed major support, revealing significant learning gaps. Pandemic-induced learning loss led DepEd Region V to implement an 8-week focused curriculum. Bustos (as cited in Yang, 2022) emphasized strengthening early math education to address these gaps.

Despite interventions like peer and self-assessment, students continue struggling (Bringula et al., 2021). This study aims to address this gap by developing an Android-based application for math learning. Division eNAT (2022) data showed students consistently falling under "Needs Major Support" in multiple competencies. Scores in

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Knowing and Understanding (44.13%) and Computing and Solving (44.68%) reflect weak math comprehension. Estimating (30.20%), Visualizing and Modeling (34.69%), and Conjecturing and Reasoning (35.25%) also showed deficiencies. Representing and Communicating (21.95%) and Proving and Decision-Making (19.66%) revealed poor higher-order thinking skills. The development of an Android-based application aligns with DepEd Order 24, s. 2022 under the Basic Education Development Plan (BEDP) 2030. This initiative leverages EdTech to address pandemic-related learning gaps, improve engagement, and anticipate future education needs while embedding children's rights in learning.

Objectives

This study designed and developed an android-based math application for Grade 3 learners in the Paracale District, Division of Camarines Norte.

Specifically, it answered the following questions:

1. What are the numeracy skills of Grade 3 which are found to be "Needs Major Support" based on the ALNAT results for School Year 2022-23?
2. What android-based math application can be developed to address the numeracy skills of Grade 3 which are found to be "Needs Major Support"?
3. What is the evaluation of the android-based math application as to:
    - 3.1. LRMDS Evaluation Rating Sheet for Non-Print Materials;
        - 3.1.1. Content quality;
        - 3.1.2. Instructional quality;
        - 3.1.3. Technical quality; and
        - 3.1.4. Other findings
    - 3.2. ISO 9126 Software Quality Standard;
        - 3.2.1. Functionality;
        - 3.2.2. Efficiency;
        - 3.2.3. Maintainability; and
        - 3.2.4. Usability.
4. What is the post-test result of the Grade 3 learners in Mathematics after using the Android-based math application?
5. Is there a significant difference between the ALNAT results and the post-test results of Grade 3 learners in Mathematics?
6. What recommendations can be given to enhance the android-based math application for Grade 3 learners?

METHODS

Research Design

This study used a quantitative descriptive-evaluative design. Descriptive research identified Grade 3 learners needing "Major Support" based on ALNAT results (SY 2022-23). The evaluative design focused on developing an Android-based math app using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) to ensure a systematic process centered on learner needs, usability, and instructional effectiveness.

Population and Sampling

The study had two respondent groups: Grade 3 learners and app evaluators. A total of 309 learners from 24 elementary schools in Paracale District (SY 2022-23) were targeted. Using a 95% confidence level and 5% margin of error, 303 learners were selected through stratified sampling. Simple random sampling was conducted via Microsoft Excel, ensuring unbiased selection.

Instrument

Primary data included ALNAT and post-test results of 303 learners. ALNAT data were obtained through document analysis, while post-test data were gathered through a Math test. Permissions were secured from DepEd, school heads, and teachers for data access and test administration. Evaluators included elementary and master teachers, the Math supervisor, and the ICT coordinator.

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App Development Process

The ADDIE model guided the app's development, ensuring a structured and effective process. In the Analysis phase, learner needs were identified based on ALNAT results. The Design phase focused on creating learning objectives, exercises, and media selection. The Development phase involved building app components, storyboards, and graphics. During the Implementation phase, learners were trained to use the app on mobile phones and tablets. Finally, in the Evaluation phase, post-tests, statistical analysis, and evaluator reviews were conducted. Additionally, the Rapid Application Development (RAD) model allowed quick iterations to enhance usability and ensure quality.

For data analysis, percentage, ranking, mean, and t-tests were used to evaluate results. Percentage and ranking described ALNAT and post-test performance, while the mean assessed content, instructional, and technical quality. The t-test compared ALNAT and post-test scores for statistical significance. IBM SPSS Statistics (Version 21) was used for analysis, generating t-values, degrees of freedom, and significance levels for interpretation.

Ethical Considerations

Parental consent letters were obtained, ensuring respondents' rights, voluntary participation, and access to study findings.

RESULTS and DISCUSSION

This chapter reports, analyzes, and interprets data to meet the study's objectives. It identifies the numeracy support needed by Grade 3 learners classified as "Needs Major Support" in the ALNAT results (SY 2022-23). It then outlines the Android-based math app development using the ADDIE model, followed by evaluation results on content, instructional, and technical quality. Post-test scores are compared with ALNAT results to assess improvement. Lastly, recommendations for app enhancement are provided.

Numeracy Skills Identified as "Needs Major Support" Based on ALNAT Results

Based on the data from Table 1, the ALNAT pre-test results outlined that the Grade 3 learners in the Paracale District have serious learning gaps in all four numeracy skills. Data revealed that Applying and Connecting skills tallied the lowest mean score of 39.34%. Stevens and Brown (2020) found that students struggled to apply math concepts to real-life situations, highlighting the need for teaching strategies that connect abstract ideas to practical use. The poor performance indicated that pupils fail to use their mathematical skills in real-life situations.

Table 1
Numeracy Skills of Grade 3 in the pre test

School	Knowing and Understanding (Mean)	Computing and Solving (Mean)	Visualizing and Modelling (Mean)	Applying and Connecting (Mean)
School A	33.33	28.56	31.25	14.29
School B	64.75	59.78	53.25	52.29
School C	42.00	38.78	32.00	26.00
School D	29.17	34.11	31.25	28.57
School E	31.08	23.00	25.63	24.43
School F	60.67	57.11	30.38	29.57
School G	61.11	50.00	50.00	83.33
School H	68.42	50.78	52.63	43.57
School I	36.50	28.56	29.88	30.71
School J	59.08	43.44	55.75	71.43
School K	51.92	44.00	48.13	44.00
School L	62.08	62.11	29.13	39.00
School M	36.42	40.89	38.75	26.29
School N	40.92	50.11	51.13	42.86
School O	91.67	66.67	37.50	57.14
School P	37.75	32.56	26.13	29.43

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School Q	41.25	36.22	32.25	30.71
School R	36.92	33.00	31.63	27.14
School S	70.92	67.22	73.13	60.71
School T	40.33	29.67	41.75	24.14
School W	41.67	22.22	31.25	14.29
School X	51.33	51.56	54.13	49.00
School Y	54.83	40.89	32.00	29.43
School Z	81.67	72.33	74.25	66.00
TOTAL	**51.07**	**62.89**	**41.42**	**39.34**

Learners need critical support in Visualizing and Modeling (41.42% mastery), which involves representing concepts visually and applying models to problems. Results show they struggle to translate abstract math ideas into visual forms. Knowing and Understanding scored 51.07%, showing fundamental knowledge of concepts, facts, and procedures but still needing major support. Computing and Solving scored 62.89%, the highest among the skills, yet many learners still struggle with accurate and swift calculations. ALNAT pre-test results indicate Grade 3 learners lag in key numeracy areas, particularly in applying math to real-life situations, visualizing concepts, and mastering fundamental operations. Frye and Kahn (2020) found students struggle to connect theory with practical applications, highlighting the need for better instructional strategies. Chang (2023) emphasized that early numeracy, home resources, and math achievements are interconnected, supporting cognitive and emotional math programs to boost confidence and proficiency.

The Developed Math App

The developed math app adhered to a process based on the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) 2023 and RAD Model. This model was crucial in structuring the development phases to ensure the app was effective and aligned with educational goals. Specifically, ADDIE Model was Integrated in the RAD model during the Design Phase. This type of integration proves to be more strategic as it improves not only the quality of the educational value of the application, but also the development process, the responses to the needs and feedbacks of the users.

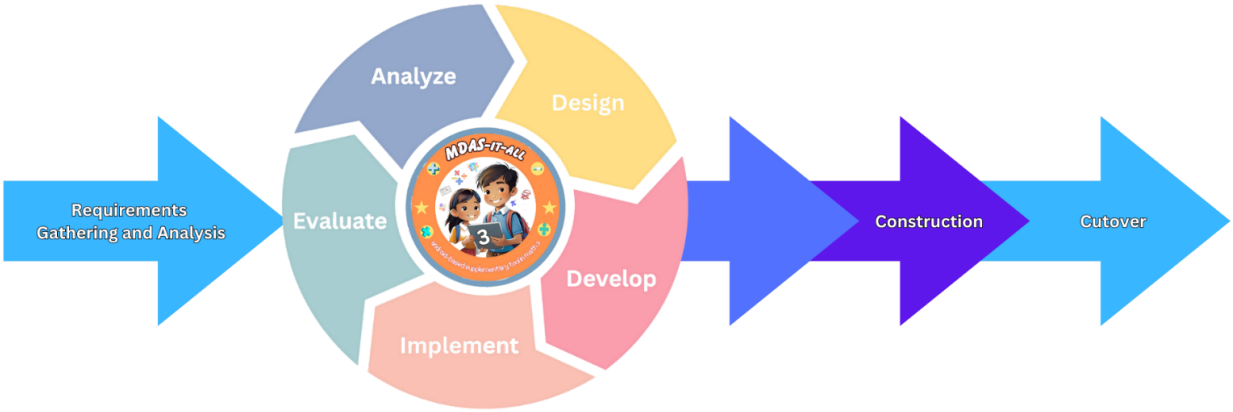

Figure 1
RAD and ADDIE Model

In the Requirements Gathering and Analysis Phase, 303 out of 1,423 Grade 3 learners with the lowest ALNAT scores used the app, focusing on Addition, Subtraction, Multiplication, and Division per MELCs. ALNAT data showed low mastery, requiring intervention. Exercises covered 3- to 4-digit operations, word problems, and computations per DepEd standards.

The Design Phase used ADDIE and RAD models, incorporating interactive features like drag-and-drop and fill-in-the-blank for engagement. The Development Phase used Android Studio (Java) and SQLite Database with

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localized graphics, puzzles, and games to enhance learning. During the Implementation Phase, teachers received training and manuals, and the app was set for 1.5 hours daily use. The Evaluation Phase compared pre-test and post-test scores, validated by LRMDS and ISO 9126 standards.

The Construction and Cutover Phases involved teacher orientation, testing, debugging, and expert validation, confirming the app's efficiency, effectiveness, and high-quality support.

Evaluation of the Android-based Math Application

Evaluators rated the developed math Android-based application to assess its properties related to the quality of content, instructional quality, technical quality, and, finally, its effectiveness in the development of the numeracy competencies aligned with the DepEd curriculum standards for pupils. It can be derived from the table that the developed Math-app passed all the criteria along content quality with a total point of 39.76 as scored by the evaluators which surpassed the minimum points required to pass in this criterion.

The resource aligns with DepEd Learning Competencies for the intended subject and grade level. The concepts developed reinforce, enrich, and lead to mastery of the identified learning objectives. The content is logically structured and accurate, with appropriate language suited for the target users. It also stimulates critical thinking while being free from cultural, gender, racial, or ethnic biases.

The evaluation shows that the app is well-suited for classroom use and addresses the required competencies effectively. Additionally, it promotes real-life applications and positive values, supporting the learners' formative growth. These results confirm the resource's overall quality, making it a valuable tool for educational purposes.

Table 2 portrays the mean ratings as well as the adjectival descriptions for content quality.

Table 2
Evaluation Rating Form Along Content Quality

Indicators	VS 4	S/NA 3	P 2	NS 1
1. Content is consistent with topics/skills found in the DepED Learning Competencies for the subject and grade/year level it was intended.	132			
2. Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives.	132			
3. Content is accurate.	120	9		
4. Content is up-to-date.	128	3		
5. Content is logically developed and organized.	132			
6. Content is free from cultural, gender, racial, or ethnic bias.	132			
7. Content stimulates and promotes critical thinking	116	12		
8. Content is relevant to real-life situations.	132			
9. Language (including vocabulary) is appropriate to the target user level.	132			
10. Content promotes positive values that support formative growth.	132			
Subtotal	1,288	24	1,312/33 = 39.76	
Total Points:	**39.76**			
Note: Resource must score **at least 30 points** out of a maximum **40 points** to pass this criterion. Please put a check mark on the appropriate box	/	Passed Failed		

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To support the findings, Etcuban and Pantinople (2020) also confirmed that the effectiveness of employing mobile applications can greatly enhance students' mathematical proficiency if applied instead of conventional approaches. From the results, he analyzed that the post-test of the control group which adopted only conventional approaches such as chalk-and-talk was relatively lower than that of the experimental group, which incorporated the mobile app.

Table 3. presents the results of the evaluation of the developed Math app along its instructional quality as rated by the evaluators.

Table 3
Evaluation Rating Form Along Instructional Quality

Indicators	VS 4	S/NA 3	P 2	NS 1
1. Purpose of the material is well defined.	132			
2. Material achieves its defined purpose.	132			
3. Learning objectives are clearly stated and measurable.	132			
4. Level of difficulty is appropriate for the intended target user.	112	15		
5. Graphics / colors / sounds are used for appropriate instructional reasons.	132			
6. Material is enjoyable, stimulating, challenging, and engaging.	132			
7. Material effectively stimulates creativity of target user.	116	12		
8. Feedback on target user's responses is effectively employed.	112	15		
9. Target user can control the rate and sequence of presentation and review.	112	15		
10. Instruction is integrated with target user's previous experience.	132			
Subtotal	1,244	57	1,301/33 = 39.76	
Total Points:	**39.42**			
Note: Resource must score **at least 30 points** out of a maximum **40 points** to pass this criterion. Please put a check mark on the appropriate box	/	Passed		
		Failed		

The developed Math app scored 39.42, exceeding the minimum required for instructional quality. Findings suggest it was well-conceptualized, met its purpose, and had clear, measurable learning objectives. The difficulty level was appropriate for users. Non-textual elements like graphics, colors, and sounds were effective for learning. Evaluators found the material interesting, challenging, and fun, fostering creativity and problem-solving. Users could review their learning through user feedback, making content easier to understand.

Meanwhile, Table 4 shows the app's technical quality evaluation. The app passed all criteria, scoring 51.18, surpassing the required minimum.

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Table 4
Evaluation Rating Form Along Technical Quality

Indicators	VS 4	S/NA 3	P 2	NS 1
1. Audio enhances understanding of the concept.	132			
2. Speech and narration (correct pacing, intonation, and pronunciation) is clear and can be easily understood.	132			
3. There is complete synchronization of audio with the visuals, if any.	132			
4. Music and sound effects are appropriate and effective for instructional purposes.	132			
5. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing.	132			
6. Visual presentations (non-text) are clear and easy to interpret.	112	15		
7. Visuals sustain interest and do not distract user's attention.	116	12		
8. Visuals provide accurate representation of the concept discussed.	112	15		
9. The user support materials (if any) are effective.	120	9		
10. The design allows the target user to navigate freely through the material.	120	9		
11. The material can easily and independently be used.	116	12		
12. The material will run using minimum system requirements.	132			
13. The program is free from technical problems.	120	9		
Subtotal	1,608	81	1,608/33 = 39.76	
Total Points:	**51.18**			
Note: Resource must score **at least 39 points** out of a maximum **52 points** to pass this criterion. Please put a check mark on the appropriate box	/	Passed		
		Failed		

The data concludes that the app has smooth audio-visual synchronization, making learning enjoyable. Music and sound effects were suitable for instructional purposes, enhancing engagement. The app used the right font size, making text readable for users. Non-text information was clear and easy to comprehend without confusion. Moreover, visuals sustained interest without distracting users. Images were carefully selected to accurately represent concepts. The user manual effectively guided navigation, making the app easy to use. Lastly, the app runs smoothly on minimum system requirements without technical failure, ensuring a trouble-free learning experience.

Table 5 presents the evaluation along other findings which includes conceptual errors, factual errors, grammatical and/or typographical errors and other errors including computational error, obsolete information and errors in the visuals.

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Table 5
Evaluation Rating Form Along Other Findings

Indicators	Not present 4	Present but very minor and must be fixed 3	Present & requires major redevelopment 2	Do not evaluate further 1
1. Conceptual errors.	132			
2. Factual errors.	132			
3. Grammatical and / or typographical errors.	132			
4. Other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.).	132			
Subtotal	528		528/33 = 16	
Total Points:	**16**			
Note: Resource must score **at least 16 points** out of a maximum **16 points** to **pass** this criterion. Please put a check mark on the appropriate box	/	Passed		
		Failed		

It can be gleaned from the table that the developed Math app passed in all the criteria along with other findings. The app gained a total score of 16 which met the minimum points required to pass in the pre-determined criterion. It can be concluded that there are no errors present in the developed app. Based on the data, it can be inferred that content will not lead to the development of misconceptions or misunderstanding because of error are not present in the developed math app. This further implies that the app has the capability to improve the math skills of grade 3 pupils.

These results correlate with the work of Arends (2021) who paid special attention to the necessity of reducing misunderstandings and creating effective instructional clarity. The research stressed that correct educational applications not only promote understanding but also keep students interested through well organized and precise content.

ISO 9126 Software Quality Standard. ISO 9126 Software Quality Standard. Other than those criteria, the functionality, efficiency, maintainability, and usability of the software application was assessed by 3 IT Experts with the relevant metrics as illustrated in Tables 6, 7, 8.

Table 6
ISO Software Metrics Along Functionality

Indicators	Yes	No
1. The app can give a quick response to the ser's input.	3	0
2 The app has secure access through passwords.	3	0
3. The app is precise in executing its function and its result.	3	0

In addition to those standards, the following pertinent metrics were used to evaluate the software application's Mandatory Parameters: the ISO software metrics, as shown in Table 6. Data revealed that the app meets all the mandatory parameters recording 3 yes and 0 no based on the tallied responses.

Moreover, the app received "Strongly Agree" ratings for all three software quality metrics, with mean scores ranging from 4.88 to 4.99. This suggests that the app is highly efficient in its performance and resource utilization (Efficiency), easy to maintain and modify (Maintainability), and user-friendly and easy to learn (Usability). These factors contribute to the app's overall effectiveness in supporting the development of numeracy competencies aligned with the DepEd curriculum standards.

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Table 7
ISO Software Metrics Along Efficiency

Indicators	Weighted Mean	Interpretation
1. The app provides appropriate response on time when performing its function.	4.75	Strongly Agree
2. The app data used are sufficient.	4.78	Strongly Agree
3. The app adheres to standards or convention relating to efficiency.	4.89	Strongly Agree
Total	**4.81**	Strongly Agree

Rating Scale	Descriptive Interpretation:
4.20 – 5.00	Strongly Agree
3.41 – 4.20	Agree
2.61 – 3.40	Neutral
1.81 – 2.60	Disagree
1.00 – 1.80	Strongly Disagree

The app demonstrated high efficiency, providing timely responses, sufficient data, and adhering to efficiency standards. It received a high overall weighted mean of 4.81 ("Strongly Agree") in ISO software metrics. The highest rating (4.89) was for adherence to efficiency standards, while data sufficiency scored 4.78. Response time received 4.75, indicating minor areas for improvement but maintaining prompt functionality. These results highlight the app's effectiveness in enhancing math learning and addressing learning gaps. This aligns with Garcia and Lopez's (2021) findings, which emphasized the impact of efficient, high-performing educational tools on user engagement.

Table 8
ISO Software Metrics Along Maintainability

Indicators	Weighted Mean	Interpretation
1. The app changes are easy to test.	4.75	Strongly Agree
2. The app is easy to find a failure when it occurs	4.75	Strongly Agree
3. The app is easy to modify and adapt	4.75	Strongly Agree
4. The app adheres to standards or convention relating to maintainability.	4.75	Strongly Agree
Total	**4.75**	Strongly Agree

Rating Scale	**Descriptive Interpretation:**
4.20 – 5.00	Strongly Agree
3.41 – 4.20	Agree
2.61 – 3.40	Neutral
1.81 – 2.60	Disagree
1.00 – 1.80	Strongly Disagree

Table 8 also shows high maintainability ratings for the app based on ISO metrics. The app earned an overall weighted mean of 4.75 ("Strongly Agree"), indicating it is easy to test, modify, and adapt while adhering to maintainability standards. This ensures the app's robustness and ease of future updates. Chen and Davis (2022) similarly emphasized that high maintainability reduces costs and builds user trust.

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Table 9
ISO Software Metrics Along Usability

Indicators	Weighted Mean	Interpretation
1. The app is easy to learn how to use.	4.75	Strongly Agree
2. The app is attractive to users.	4.80	Strongly Agree
3. The app has capability for multisuser processing.	4.79	Strongly Agree
Total	**4.78**	Strongly Agree

Rating Scale	Descriptive Interpretation:
4.20 – 5.00	Strongly Agree
3.41 – 4.20	Agree
2.61 – 3.40	Neutral
1.81 – 2.60	Disagree
1.00 – 1.80	Strongly Disagree

Based on Table 9, the app shows high usability with a mean score of 4.78 ("Strongly Agree"). It is easy to learn, user-friendly, and supports multiuser processing. These features enhance accessibility and engagement. This aligns with Smith and Johnson's (2021) findings on the value of usability in educational apps.

Post-Test Results of Grade 3 Learners After Using the Math App

Table 10 presents the post-test results of 303 Grade 3 learners from 24 schools in Paracale District after using the Android-based math app. "Knowing and Understanding" scores averaged 79.56, while "Computing and Solving" averaged 79.33. "Visualizing and Modeling" ranged from 77.25 to 78.50, and "Applying and Connecting" averaged 77.56. School H had the highest score (81.00) in "Knowing and Understanding," while Schools E and S led in "Applying and Connecting" (79.50). Overall scores fell within the "Anchoring" range (75-79), showing considerable improvement. Learners used the app for 6 hours across four operations before post-testing, demonstrating its positive impact on numeracy skills.

Table 10
Post-test Result

School	Knowing and Understanding (Mean)	Computing and Solving (Mean)	Visualizing and Modelling (Mean)	Applying and Connecting (Mean)
School A	78.25	79.50	77.75	76.50
School B	79.25	80.50	78.25	79.00
School C	79.00	79.25	77.75	76.25
School D	80.50	79.75	78.00	77.50
School E	77.75	79.00	77.50	76.25
School F	80.75	79.25	77.25	77.00
School G	80.25	79.50	77.75	78.00
School H	81.00	80.25	78.25	79.00
School I	77.50	78.00	77.75	76.75
School J	80.00	79.50	79.00	79.25
School K	79.75	78.75	78.00	77.25
School L	80.50	80.00	78.25	77.50
School M	78.75	79.00	77.50	77.25
School N	79.25	79.50	78.75	78.00
School O	81.00	80.75	78.50	79.00
School P	79.00	78.50	77.75	77.00
School Q	80.00	79.25	78.50	77.25
School R	79.50	78.75	77.75	77.00
School S	81.00	80.75	78.50	79.50

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School T	77.75	78.00	77.75	76.25
School W	78.75	78.25	78.00	77.25
School X	80.25	79.75	78.25	77.50
School Y	80.50	79.25	78.00	77.75
School Z	79.25	79.00	78.00	77.50
TOTAL	**79.56**	**79.33**	**78.03**	**77.56**

The post-test results indicated that after using the Android-based math application, Grade 3 learners from the different schools demonstrated varying levels of improvement in their numeracy skills. While some schools performed better than others, the overall mean score suggests that the app positively impacted learners' mathematical proficiency.

Significant Difference Between ALNAT Results and Post-Test Scores

A paired samples t-test was conducted to compare ALNAT and post-test scores in "Knowing and Understanding," "Computing and Solving," "Visualizing and Modeling," and "Applying and Connecting." Results showed significant improvements across all areas, with post-test scores consistently higher (e.g., $t = -42.58$, $p < .01$ for "Knowing and Understanding"). The greatest gains were in "Applying and Connecting," highlighting the app's effectiveness in using real-world contexts. These findings align with Abate et al. (2022), who emphasized visual aids in enhancing understanding and engagement. The app's interactive features—instant feedback, rewards, and personalized learning—further boosted motivation, improved outcomes, and fostered a positive attitude toward mathematics.

Table 11
Test for Significant Difference between the Pretest and Post Test Results

Pretest and Posttest	Mean	Std. Deviation	t	df	p-value
Knowing and Understanding	-34.15	13.96	-42.58**	302	.000
Computing and Solving	-40.20	13.12	-53.32**	302	.000
Visualizing and Modeling	-41.35	11.63	-61.88**	302	.000
Applying and Connecting	-43.54	15.47	-48.99**	302	.000

Recommendations to Enhance the Android-Based Math Application

The evaluators of the developed Math app provided recommendations for further improvement, as shown in Table 12.

Table 12
Recommendations of the Evaluators for the Enhancement of the Math app

Recommendations	Frequency	Percentage	Rank
1. Increase interactivity and use gamification features to enhance learning of the user.	28	84.85	1
2. Build a learning tracking interface for learners and teachers to track progress and identify declined areas and thus improve them.	25	75.76	2
3. Include hints on problems with high cognitive demands.	23	. 69.70	3
4. Place demo videos/tutorials on how to solve the problems, especially on hard ones.	21	63.64	4
5. Include IOS to cater different devices.	20	60.61	5
6. Ensure the compatibility of the app with other Android devices without compromising the screen resolution integrity.	18	54.55	6
7. Extend the app's coverage into other grade levels.	17	51.52	7

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8. Offer user assistance in using the app by placing contact number of the researcher.	15	45.45	8
9. Lessen the number of activities per operation.	13	39.39	9

These suggestions were integrated into the final version of the app to create a more engaging and effective learning tool aimed at boosting pupils' mathematical skills. The evaluators made nine key recommendations, with the most frequent being to increase interactivity and add gamification features (84.85%). Other suggestions included adding a learning progress tracker, providing hints for complex problems, including demo videos or tutorials, expanding compatibility to iOS devices, ensuring screen resolution integrity across Android devices, extending coverage to other grade levels, offering user assistance, and reducing the number of activities per operation. Similarly, Santos (2021) emphasized the importance of incorporating evaluator feedback in his study on a language learning app, highlighting how user-driven recommendations enhance usability and learning outcomes. Both studies underscore the value of gathering feedback to improve educational apps and support student learning.

Conclusions

Based on the findings, the following conclusions were drawn:

1. The Android-based math app significantly improved numeracy skills among Grade 3 pupils, as seen in the notable increase in post-test scores.
2. The app received Very Satisfactory ratings across evaluation factors and met ISO 9126 standards, ensuring usability, functionality, and quality.
3. Interactive features, such as drag-and-drop and localized graphics, made the app engaging and relevant, contributing to its success.
4. The average 40.31-point improvement in post-test scores confirmed the app's effectiveness in enhancing understanding and mathematical skills.
5. Evaluators consistently provided "Strongly Agree" ratings across software quality metrics, proving the app's reliability, usability, and effectiveness as a learning tool.
6. Recommended enhancements include gamification, tracking features, hints, tutorial videos, validation, compatibility expansion, and reduced activities per operation to further improve user experience.

Recommendations

1. The Division Math Supervisor may refine the content to align with curriculum standards and promote a comprehensive understanding of mathematical concepts.
2. App developers may implement interactive development to enhance features based on user feedback and evolving educational needs.
3. Teachers should develop instructional materials catering to diverse learning styles and abilities for an effective learning experience.
4. The District ICT Coordinator may maintain a proactive approach in resolving technical issues to ensure smooth usability.
5. Teachers and programmers may optimize compatibility with various Android devices to maximize accessibility.
6. Teachers and School Heads may integrate additional resources like animated videos and illustrations to simplify complex mathematical concepts.
7. Teacher-developers may design a user-friendly progress tracking system to help learners and teachers monitor progress and identify areas for improvement.
8. The app may be regularly updated with new content, challenges, and interactive elements to sustain learner engagement.
9. Local app developers and education technology specialists may incorporate adaptive learning technology to personalize exercises and provide hints for challenging problems.
10. Future researchers may explore the app's long-term impact on numeracy skills and its application in other grade levels and subjects.

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