

 Research Article

Evaluating the Effectiveness of a Mathematics Word Problem Mobile App in Enhancing Problem-Solving Skills Among Lower Secondary Students in Kicukiro District, Rwanda

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Abstract

Integrating technology into education has proven effective in enhancing both teaching and learning outcomes. In Rwanda, despite efforts to improve mathematics education, lower secondary students still perform poorly in solving word problems, as highlighted in national examination reports from 2019 to 2022 (NESA, 2023). This study aimed to evaluate the usability and effectiveness of a Mathematics Word Problem Mobile Application (Maths app) in improving students' problem-solving skills. The Maths app was developed in alignment with Rwanda's Competence-Based Curriculum (CBC), incorporating word problems across key mathematics topics such as Geometry, Algebra, Statistics, and Probability. The study used a mixed-methods approach and was conducted in two purposively selected day secondary schools in Kicukiro District. A total of 40 (32 males and 8 females) students participated in surveys, while a group of 20 (18 students and 2 teachers) took part in the usability evaluation. An additional 9 participants were interviewed. Purposive sampling targeted students with access to mobile phones and experienced mathematics teachers. Data collection methods included surveys, interviews, and the System Usability Scale (SUS). Quantitative data were analyzed using descriptive statistics and paired t-tests via SPSS, while qualitative responses were examined thematically. Findings revealed a significant improvement in students' problem-solving skills, demonstrated by higher posttest scores. The Maths app received a high SUS score of 80.875, indicating strong usability. Participants highlighted the app's alignment with the curriculum and its interactive features as major strengths. The study concludes that the Maths app is a valuable tool for enhancing mathematics learning among lower secondary students. It recommends future improvements, such as expanding the range of word problems and enabling offline access, to support broader implementation and accessibility in resource-constrained environments.

Keywords: Digital Learning, Mathematics App, Problem-Solving Skills, Usability, Rwanda

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1. INTRODUCTION

The integration of digital technologies into education has transformed the way teaching and learning take place across the globe. In particular, the use of mobile applications in mathematics instruction has gained prominence due to their potential to enhance problem-solving skills, provide interactive learning experiences, and foster learner engagement. In Rwanda, mathematics remains a key subject in secondary education and is central to the development of critical thinking and analytical skills. However, many students continue to face challenges in solving mathematics word problems, which often results in lower achievement levels and limited application of mathematical concepts in real-life contexts.

Previous studies have emphasized the importance of technology-enhanced learning in improving students' outcomes. For instance, Roschelle et al. (2016) found that digital learning platforms promote learner-centered instruction and provide immediate feedback, which supports conceptual understanding.

Similarly, Grinstein and Lipsey (2001) reported that the integration of interactive applications significantly improves mathematical competencies by engaging students in active problem-solving. Despite such findings, limited research has been conducted in Rwanda to evaluate the direct impact of mobile applications on mathematics word problem-solving among lower secondary school students. This gap highlights the need for locally relevant and empirically validated interventions that align with the national Competence-Based Curriculum (CBC).

This study sought to address this gap by developing and evaluating a mobile application designed specifically for mathematics word problems. The focus was on key mathematics topics, including Algebra, Geometry, Statistics, and Probability. The rationale behind choosing these topics lies in their complexity and the difficulties students frequently encounter when applying them to real-world problem-solving. By incorporating curriculum-aligned word problems into a mobile app, this study intended to create a user-friendly and effective tool for enhancing mathematical problem-solving skills.

The purpose of the literature review was to examine existing evidence on technology integration in mathematics education, identify gaps in current interventions, and provide a theoretical foundation for the development of the mobile application. The review also established the role of problem-solving in mathematics learning, the usability of digital tools, and the effectiveness of interactive technologies in supporting learners' competencies.

In line with this, the objective of the study was to evaluate the usability of the Maths app and the effectiveness of the interactive mathematics word problems included in the Maths app in improving the problem-solving skills of lower secondary school students.

This research is significant for several reasons. First, it contributes to the growing body of literature on digital learning by providing evidence from the Rwandan context, where such studies are still limited. Second, it offers practical solutions for mathematics educators by introducing an innovative tool that supports both teaching and learning. Finally, it informs policymakers and curriculum developers about the potential of integrating mobile technologies to improve educational outcomes in mathematics. By addressing both theoretical and practical dimensions, this study demonstrates the value of digital innovations in advancing mathematics education and fostering problem-solving competencies among learners.

1.1. Literature Review

1.1.1. Introduction

The literature review examines existing studies on mathematics education, technology integration, and the development of problem-solving skills through digital tools. The section identifies challenges faced by lower secondary school students in mathematics, particularly in word problems, and highlights the effectiveness of mobile applications in addressing these challenges. It also establishes the theoretical and empirical foundation for developing the Mathematics Word Problem Mobile Application (Maths App) used in this study. The review focuses on the role of curriculum alignment, interactive learning, and usability in enhancing learning outcomes, providing context for the research objectives and methodology.

1.1.2. Challenges in Mathematics Problem-Solving

Mathematics is widely recognized as a core subject that develops critical thinking, logical reasoning, and problem-solving competencies. However, students frequently encounter difficulties when solving word problems due to the abstract nature of mathematical concepts and the requirement to translate real-world scenarios into mathematical representations (Grinstein & Lipsey, 2001). Geometry and algebra have consistently been reported as particularly challenging areas for secondary school learners, with difficulties arising from spatial reasoning, symbolic manipulation, and the application of theoretical concepts to practical problems (Clements & Battista, 1992).

Statistics and probability, though generally perceived as more accessible due to their practical applications, can also pose challenges for students unfamiliar with data interpretation and probabilistic reasoning (Puspitasari et al., 2019). These challenges contribute to low performance in mathematics and

limit students' ability to develop higher-order cognitive skills, which are essential for competence-based learning frameworks like Rwanda's CBC.

1.1.3. Technology Integration in Mathematics Education

The integration of digital technologies in teaching and learning mathematics has shown positive effects on student engagement, comprehension, and achievement. Interactive learning tools, such as mobile applications, simulations, and digital problem-solving platforms, provide opportunities for students to actively engage with mathematical concepts (Roschelle et al., 2016). These tools support scaffolded learning, personalized feedback, and adaptive learning pathways, all of which contribute to deeper understanding and improved problem-solving skills.

Studies conducted in low-resource settings have highlighted the potential of mobile learning applications to bridge gaps in educational quality. Martin (2016) emphasized that mobile apps can deliver curriculum-aligned content to students who otherwise face limited access to instructional resources. Similarly, Watson et al. (2018) found that immediate feedback and interactive problem-solving tasks enhance students' critical thinking and learning outcomes.

Despite these benefits, successful technology integration requires attention to usability, accessibility, and alignment with curriculum objectives. Nielsen (2020) underscores that user-centered design is essential for maximizing the effectiveness of educational applications, ensuring that students can navigate and interact with content efficiently.

1.1.4. Mobile Applications and Mathematics Word Problems

Mobile applications have emerged as effective tools for addressing challenges in mathematics education, particularly in solving word problems. These applications provide structured, interactive, and engaging problem-solving opportunities that reinforce classroom learning. Previous research indicates that mobile applications can increase student motivation, offer differentiated learning experiences, and improve conceptual understanding by presenting problems in a variety of formats (Roschelle et al., 2016).

In the Rwandan context, the use of mobile applications for mathematics instruction remains limited. Existing studies have primarily focused on general technology integration rather than the development of curriculum-aligned problem-solving tools. This gap underscores the relevance of developing a Mathematics Word Problem Mobile Application tailored to the lower secondary school curriculum, with a focus on Senior One to Senior Three topics, including Geometry, Algebra, and Statistics.

1.1.5. Usability and Effectiveness of Educational Applications

The effectiveness of educational mobile applications depends not only on content quality but also on usability. The System Usability Scale (SUS) is widely used to assess the ease of use, satisfaction, and learnability of digital tools. High usability scores are associated with improved learner engagement, better task completion, and higher academic achievement (Nielsen, 2020). Studies have shown that applications with intuitive interfaces, immediate feedback, and interactive elements enhance student learning outcomes in mathematics by enabling learners to practice at their own pace and receive real-time guidance (Watson et al., 2018).

In addition, usability considerations such as offline functionality and multi-device compatibility are critical in low-resource contexts where internet access and device availability may be limited. Ensuring that applications are accessible and inclusive maximizes their potential impact on learners' problem-solving skills.

1.1.6. Theoretical Framework

This study is grounded in constructivist learning theory, which posits that learners actively construct knowledge through interaction, exploration, and reflection. According to McLeod (2025), constructivist

approaches promote problem-solving by encouraging learners to engage with meaningful tasks and receive feedback to guide understanding. The integration of interactive mathematics word problems within the mobile application aligns with this framework, allowing students to actively practice and internalize mathematical concepts while developing critical thinking skills.

1.1.7. Empirical Evidence on Mobile Learning in Mathematics

Empirical studies have consistently demonstrated the positive impact of mobile learning applications on mathematics achievement. Roschelle et al. (2016) reported that students using interactive mathematics apps showed significant improvements in problem-solving skills compared to traditional instruction. In Rwanda, studies have highlighted challenges in delivering high-quality mathematics education due to limited resources, teacher capacity, and student engagement (Grinstein & Lipsey, 2001). The current research addresses these gaps by providing a contextually relevant, curriculum-aligned mobile application that targets students’ most challenging topics.

1.1.8. Conceptual Framework of the Study

This conceptual foundation of the study centres for integration of mobile-based mathematics word problems into lower secondary education. As students engage with mathematics word problems through the Maths app, they encounter various levels of problem-solving tasks that support understanding, application, and analysis. Drawing on Vygotsky’s social constructivism, which posits that knowledge is constructed through interactive and contextualized experiences, the framework emphasizes the importance of digital interactivity in enhancing students’ engagement and understanding (Vygotsky, 1978). The mobile app in this study leverages interactive word problems aligned with the Rwandan syllabus, providing scaffolding through hints and step-by-step solutions, thus creating a contextualized, supportive learning environment.

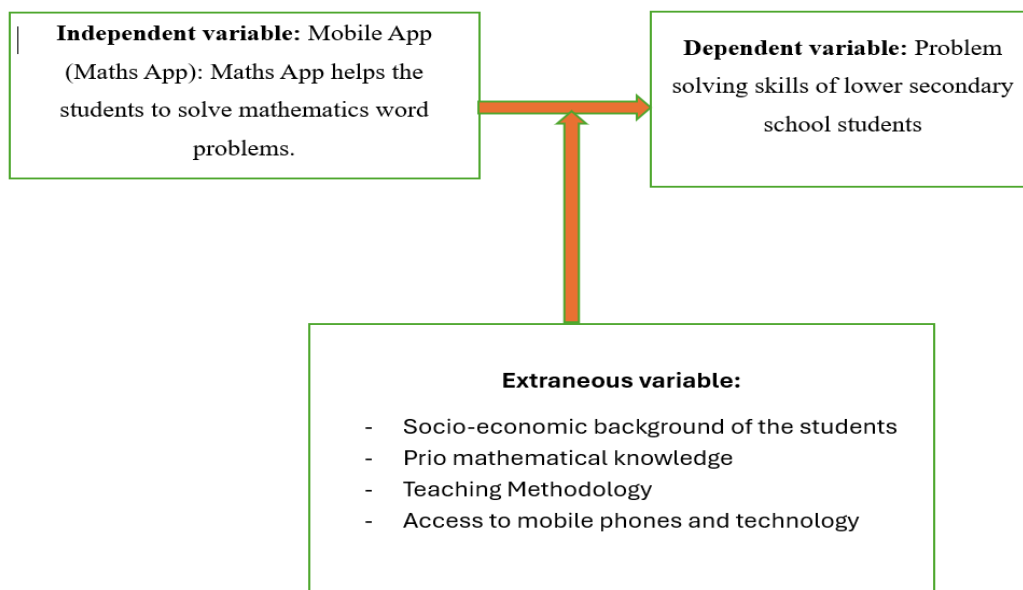


Figure 1. Conceptual Framework of the Study

The conceptual framework outlines the key components, relationships, and processes involved in the Mobile app (Maths app), providing a structured approach to solve the research problem and attain the intended results.

Relationship between variables

- The way the mathematical word problem solved is an independent variable. It is anticipated that utilizing a mobile application (Maths app) on a phone will directly affect the dependent variable, which is the enhancement of problem-solving abilities among lower secondary Rwandan students.
- The link between the independent and dependent variables may be impacted by external factors (extraneous variables) such as socioeconomic background, prior mathematics knowledge, instructional methods, and access to technology and mobile phones. For instance, students who have less access to technology or cell phones could not gain as much from the intervention as those who have more.
- In this conceptual framework, the arrows show the direction of influence between the variables. Changes in the independent variable cause changes in the dependent variable, and this connection might be impacted by extraneous variables.

Key elements of the conceptual framework

- **Problem – Solving Skills:** The framework identifies the specific problem – solving skills targeted for improvement, such as mathematical reasoning, critical thinking, and application of mathematical concepts in real–world situations.
- **Intervention Strategies:** It delineates the intervention strategies to be employed, including instructional methods, learning materials, and assessment tools tailored to enhance students’ problem – solving abilities.
- **Cultural Relevance:** Recognizing the cultural context of Rwanda, the framework integrates culturally relevant examples, language, and contexts into the Mobile app to enhance students’ engagement and understanding.
- **Collaborative Approach:** Emphasizing collaboration among teachers, researchers, and education stakeholders, the framework promotes a collective effort to implement and evaluate the intervention effectively.
- **Evaluation criteria:** The framework establishes clear criteria and indicators for evaluating the effectiveness of the Mobile app (Maths), such as pre- and post-assessment measures, student performance data, and feedback mechanisms.

1.1.9. Summary

The literature highlights that lower secondary school students face considerable difficulties in solving mathematics word problems, particularly in Geometry and Algebra. Technology-enhanced learning, particularly mobile applications, offers promising solutions by providing interactive, scaffolded, and curriculum-aligned learning experiences. Usability and accessibility are critical to the effectiveness of such applications, especially in low-resource contexts like Rwanda. Constructivist learning theory supports the integration of interactive word problems to facilitate active learning and problem-solving skill development. This review establishes the foundation for the development and evaluation of the Maths App, demonstrating its potential to improve students’ mathematics problem-solving skills and enhance learning outcomes.

2. METHODS

This chapter presents the methodological approach employed in evaluating the effectiveness and usability of a Mathematics Word Problem Mobile Application (Maths App) for enhancing problem-solving skills of lower secondary school students in Kicukiro District, Rwanda. The chapter outlines the research design, participants, research instruments, procedures, and data analysis, providing sufficient detail for replication.

2.1. Research Design

The study employed a mixed-methods research design combining both quantitative and qualitative approaches. A system usability scale (SUS) was used to quantitatively assess the effectiveness and Usability of the Maths App on students' problem-solving skills. Qualitative methods, including interviews and surveys, were utilized to evaluate the usability, usefulness, and relevance of the Maths App. This approach allowed for an in-depth understanding of user experiences, engagement, and satisfaction with the mobile application. The integration of both quantitative and qualitative methods enhanced the reliability and validity of the findings and provided a comprehensive perspective on the app's effectiveness.

2.2. Participants

The study involved 40 lower secondary school students (32 males and 8 females) drawn from selected schools in Kicukiro District, Rwanda. The students' ages ranged from 11 to 16 years, with three students aged 11–13 years, nine students aged 14–15 years, and twenty-eight students aged 16 years or older. Participants were recruited from Senior One to Senior Three classes, thereby representing a range of mathematical proficiency levels. Eligibility criteria included current enrollment in lower secondary school during the study period (November 2024 to February 2025) and a willingness to participate in the Maths App intervention.

In addition to the student participants, two mathematics teachers (one male and one female) were included to provide expert perspectives on the relevance and curricular alignment of the app's content with the Rwandan lower secondary mathematics curriculum. The teachers' ages ranged from 26 to over 31 years. All participants were selected through purposive sampling to ensure the inclusion of students and teachers who could provide meaningful and relevant data for evaluating both the usability and effectiveness of the Maths App.

2.3. Research Instruments

The study employed multiple instruments to collect comprehensive data:

2.3.1. System Usability Scale (SUS) and System Usability Questionnaire

The System Usability Scale (SUS) and the System Usability Questionnaire were employed to evaluate students' perceptions of the usability of the Maths App. These instruments consisted of a standardized 10-item questionnaire designed to assess key aspects of usability, including ease of use, learnability, efficiency, and overall user satisfaction. The SUS scores were calculated on a scale ranging from 0 to 100, with higher scores reflecting better perceived usability of the application.

2.3.2. Surveys and Interviews

Surveys and interviews were conducted to examine the usefulness, relevance, and challenges associated with the Maths App from both student and teacher perspectives. The data collection involved a combination of open-ended and closed-ended questions aimed at exploring perceptions of content alignment, levels of engagement, and suggestions or recommendations for further improvement of the application.

2.4. Procedures

The study was implemented through a series of structured stages. First, a mathematics application was developed by professional app developers, incorporating 520 mathematics word problems that were systematically categorized according to levels of difficulty and aligned with the Rwandan lower secondary curriculum (S1–S3). The application was designed to include interactive problem-solving tasks, immediate feedback mechanisms, and adaptive problem sets to accommodate students' varying proficiency levels. Following the development phase, an intervention was conducted in which students used the Maths App over a three-month period, from November 2024 to February 2025, under supervised conditions. During

this period, teachers provided instructional guidance and continuously monitored students' engagement with the application. Subsequently, a usability evaluation was carried out to examine users' perceptions of the application. Both students and teachers completed the System Usability Scale (SUS) questionnaire and additional surveys to assess the app's usability and perceived usefulness. In addition, teachers participated in semi-structured interviews to further elaborate on their experiences, as well as to offer insights and recommendations for improvement. Finally, all survey responses and interview data were systematically recorded, organized, and coded to facilitate rigorous data analysis.

2.5. Data Analysis

Data analysis was conducted using both quantitative and qualitative techniques. Quantitative analysis focused on evaluating the usability of the Maths App through the System Usability Scale (SUS). The SUS score was calculated using a system usability questionnaire consisting of ten items measured on a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5), as outlined by Grier et al. (2013) and developed with reference to Brooke (2020). The scoring procedure involved summing the adjusted values for all items, where one point was subtracted from responses to positively worded (odd-numbered) items, and responses to negatively worded (even-numbered) items were subtracted from five. The total adjusted score was then multiplied by 2.5 to yield a final SUS score on a scale of 0 to 100. In addition, mean scores for each statement were calculated by assigning numerical values to the Likert-scale responses, with higher scores indicating more positive perceptions of usability.

Qualitative analysis employed content analysis to examine open-ended survey responses and interview data. Descriptive statistics were used to summarize survey responses, while interview transcripts were thematically coded to identify recurring patterns related to usability, engagement, relevance, and suggestions for improvement. To enhance the credibility of the findings, triangulation was applied by comparing qualitative insights with quantitative results, thereby validating interpretations and strengthening the overall conclusions.

Quantitative data were analyzed using SPSS version 25, whereas qualitative data were managed and analyzed manually through systematic thematic coding and categorization procedures. This comprehensive methodological approach enabled a robust evaluation of the Maths App by capturing both its effectiveness in enhancing problem-solving skills and its usability from the perspectives of students and teachers.

3. RESULTS

This chapter presents the main findings of the study on the effectiveness and usability of the Mathematics Word Problem Mobile Application (Maths App) among lower secondary school students in Kicukiro District, Rwanda. The results are organized into subheadings corresponding to the main focus areas: usability, relevance of mathematics word problems, challenges in mathematics topics, and suggested improvements for the Maths App.

3.1. Usability of the Maths App

The System Usability Scale (SUS) was used to assess students' perceptions of the Maths App. Table 1 presents the distribution of usability ratings.

Table 1. Usability Evaluation of the Maths App (SUS Score)

| SUS Dimension | Usability evaluation (%) Score |
|-------------------|--------------------------------|
| Overall Usability | 80.875 |
| Learnability | 56 |
| Efficiency | 32.5 |
| Satisfaction | 84 |

Source: Field data, November 2024 – February 2025

The usability of the Maths app was evaluated using the System Usability Questionnaire (SUQ) to examine how effectively the application supports the enhancement of problem-solving skills among

Rwandan lower secondary school students. The assessment focused on key usability dimensions, including learnability, efficiency, and user satisfaction. Learnability reflects the ease with which users can understand and begin using the Maths app, efficiency refers to the speed and effectiveness with which users can complete tasks, and satisfaction represents users' comfort and overall experience with the application.

The results indicate that both students and teachers perceived the Maths app as highly usable, as reflected by a high overall System Usability Scale (SUS) score of 80.875 and a satisfaction level of 84%. Although learnability (56%) and efficiency (32.5%) were relatively lower than satisfaction, these results primarily point to areas for further refinement rather than fundamental usability issues. Overall, the SUS score of 80.875 demonstrates that the Maths app possesses excellent usability and is considered very user-friendly.

Consistent with usability evaluation standards, the SUS score of 80.875 corresponds to a high usability grade, indicating strong acceptance among users (Brooke, 2020b). The Maths app is designed to be intuitive, engaging, and pedagogically effective, thereby supporting its role in facilitating meaningful learning experiences. The findings confirm that the application successfully bridges learning gaps through its user-friendly design and instructional features. Consequently, the Maths app can be regarded as a valuable tool for supporting mathematics education in Rwanda, in line with the objectives of the study, and demonstrates clear potential in enhancing the problem-solving skills of lower secondary school students.

3.2. Relevance of Mathematics Word Problems

The relevance and alignment of the word problems included in the Maths App were assessed through teacher feedback.

Table 2. Effectiveness and Alignment of Word Problems in the Maths App

| Effectiveness of Word Problems | Frequency | Percent (%) |
|---------------------------------------|-----------|-------------|
| Effective and aligned with curriculum | 2 | 100 |
| Not effective or misaligned | 0 | 0 |
| Total | 2 | 100 |

Source: Field data, November 2024 – February 2025

As indicated in Table 2, all respondents unanimously agreed that the word problems embedded in the Maths App were effective and well aligned with the lower secondary school curriculum. This finding highlights the app's strong capacity to address curriculum-based learning objectives and reinforces its relevance within formal classroom contexts. The complete consensus regarding the appropriateness and curricular alignment of the content underscores the Maths App's potential as a meaningful and pedagogically sound educational tool. Moreover, this result directly supports the study's specific objective of evaluating the usefulness of the word problems incorporated into the application.

The demonstrated alignment further implies that the Maths App has considerable potential to support students in mastering essential mathematical concepts and developing problem-solving competencies. These findings emphasize the importance of sustaining curricular alignment when refining existing features and integrating additional word problems in future development. Overall, the results support the general objective of the study by showing that the Maths App is relevant to lower secondary school learners, aligns well with curriculum requirements, and has the capacity for further enhancement, particularly in terms of accessibility, functionality, and content diversity. The feedback also suggests that when curriculum alignment is maintained and recommended improvements are implemented, the Maths App can contribute meaningfully to the enhancement of students' mathematical problem-solving skills.

Table 3. Most Challenging Mathematics Topics

| Mathematics Topic | Frequency | Percent (%) |
|----------------------------|-----------|-------------|
| Geometry | 4 | 44.4 |
| Algebra | 3 | 33.3 |
| Statistics and Probability | 2 | 22.2 |
| Total | 9 | 100 |

Source: Field data, November 2024 – February 2025

3.3. Most Challenging Mathematics Topics

Students identified topics they found most challenging. The responses were categorized and ranked by frequency. The results in Table 3 indicate that the teachers from the interview found that Geometry was the most challenging topic for students (44.4%), followed by Algebra (33.3%), and Statistics and Probability (22.2%). These findings suggest that curriculum support in Geometry and Algebra is particularly needed.

4. DISCUSSION

This chapter presents an interpretation of the study findings, situating them within existing literature on digital learning tools and mathematics education. The discussion focuses on the usability of the Maths App, the relevance of integrated word problems, students' challenges in mathematics, and suggested improvements, highlighting implications for teaching practices and future research.

4.1. Usability of the Maths App

The study found that the Maths App scored highly on the System Usability Scale (SUS = 80.875) and received strong satisfaction ratings (84%), indicating that students and teachers found it easy to navigate, responsive, and enjoyable to use. This aligns with research showing that highly usable educational technology enhances engagement and motivation among learners (Nielsen, 2020). The slightly lower scores in learnability (56%) and efficiency (32.5%) suggest that students may require initial guidance to maximize the app's potential. This is consistent with prior findings that digital tools are most effective when users receive adequate orientation and scaffolding (Watson, Franklin, & Shaughnessy, 2018).

The high usability of the Maths App demonstrates that mobile applications can serve as practical and accessible platforms for improving mathematics learning, particularly in low-resource settings where conventional resources may be limited (Martin, 2016). By providing an intuitive interface and interactive features, the app supports student-centered learning, enabling learners to engage independently with curriculum content.

4.2. Relevance of Integrated Word Problems

All respondents (100%) agreed that the word problems in the Maths App were effective and aligned with the lower secondary school curriculum. This finding underscores the importance of curriculum alignment in digital educational resources, as well-designed problems ensure meaningful learning and skill development (Roschelle et al., 2016). The inclusion of 520 structured word problems covering key topics from S1 to S3 demonstrates the comprehensiveness of the Maths App. This aligns with research suggesting that well-designed digital tasks that reflect curriculum objectives improve student engagement and problem-solving skills (Clements & Battista, 1992). By integrating problems with varying difficulty levels, the app offers scaffolded learning experiences that support different learner needs, echoing constructivist principles of learning (McLeod, 2025).

4.3. Most Challenging Mathematics Topics

Students identified Geometry (44.4%) and Algebra (33.3%) as the most challenging topics, while Statistics and Probability (22.2%) was perceived as less difficult. This finding is consistent with previous research highlighting that spatial reasoning demands in geometry and abstract symbolic reasoning in algebra often present barriers for learners (Grinstein & Lipsey, 2001; Clements & Battista, 1992).

The Maths App addresses these challenges by providing interactive word problems that allow students to practice and consolidate concepts in these difficult areas. This aligns with the view that technology-enhanced learning environments can mitigate learning difficulties by offering personalized, scaffolded problem-solving opportunities (Roschelle et al., 2016). The findings imply that targeted interventions focusing on these challenging topics can improve overall mathematics competency among lower secondary students.

4.4. Suggested Improvements for the Maths App

Participants suggested several enhancements to increase the app's effectiveness, including more word problems, offline functionality, compatibility with multiple devices, and broader accessibility. These suggestions reflect broader trends in digital education research, which emphasize the importance of accessibility, flexibility, and contextual adaptability in educational technologies (Fabian et al., 2016).

Offline functionality and multi-device compatibility are particularly important in low-resource contexts like Rwanda, where internet access and personal device availability may be limited (Martin, 2016). Incorporating real-life problem scenarios into word problems could further increase relevance and engagement, supporting deeper understanding and transfer of skills to practical contexts (Puspitasari et al., 2019).

4.5. Implications for Practice and Future Studies

The findings highlight several practical implications:

1. **Curriculum Integration:** Educators should integrate the Maths App into regular classroom instruction, especially for challenging topics like Geometry and Algebra, to complement traditional teaching methods.
2. **Teacher Training:** Providing professional development on using digital learning tools effectively will maximize the app's impact on student learning outcomes.
3. **Accessibility and Scalability:** Developers and policymakers should prioritize offline functionality, multi-device support, and broader distribution to ensure equitable access across different regions.

For future research, longitudinal studies could assess the sustained impact of the Maths App on learning outcomes. Additionally, examining the app's application in other subjects and education levels could provide insights into its broader educational potential.

4.6. Summary

This discussion highlights that the Maths App is a usable, curriculum-aligned, and effective tool for supporting mathematics learning among lower secondary students. It addresses the challenges students face in Geometry and Algebra, while user feedback suggests areas for improvement to enhance accessibility and engagement. The findings support prior research on the potential of digital learning tools to improve problem-solving skills, particularly in low-resource settings (Martin, 2016; Roschelle et al., 2016).

5. CONCLUSION

This study set out to evaluate the usability and effectiveness of the Mathematics Word Problem Mobile Application (Maths App) in enhancing problem-solving skills among lower secondary school students in Kicukiro District, Rwanda. The findings indicate that the Maths App is a highly usable, curriculum-aligned, and effective educational tool, providing interactive and structured word problems that address the most challenging mathematics topics, particularly Geometry and Algebra.

The unanimous agreement among participants regarding the relevance of the integrated word problems highlights the app's alignment with the lower secondary school curriculum, demonstrating its capacity to support meaningful learning and bridge gaps in mathematics education. Feedback on usability, accessibility, and suggested improvements provides practical guidance for enhancing the app's reach and functionality, including offline use, multi-device compatibility, and inclusion of additional real-life problem scenarios.

Overall, the Maths App offers a scalable and sustainable approach to supporting competence-based learning in mathematics, particularly in low-resource settings. Its interactive design fosters student engagement, promotes critical thinking, and encourages independent problem-solving skills, emphasizing the potential of mobile learning tools to complement traditional teaching practices.

6. LIMITATIONS AND RECOMMENDATIONS

This study was conducted within a limited number of schools in Kicukiro District, which may constrain the generalizability of the findings to broader educational contexts. Furthermore, the analysis primarily relied on feedback from teachers and students without incorporating long-term tracking of learning outcomes, thereby limiting insights into the sustained impact of the intervention. To strengthen the evidence base, future research is encouraged to employ longitudinal designs, involve larger and more diverse samples, and implement cross-regional studies to further examine the effectiveness and scalability of the application.

In light of the findings, it is recommended that the mathematics application be systematically integrated into regular classroom instruction, particularly for topics that students commonly perceive as challenging. Teacher professional development programs should also be strengthened to ensure educators are adequately prepared to incorporate mobile learning tools effectively into their pedagogical practices. In addition, expanding the application's accessibility across a wider range of devices and regions is essential to promote equitable learning opportunities. Further research is also warranted to investigate the application's potential applicability across different subjects and educational levels, thereby extending its educational value beyond the current scope.

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Research Ethics. This study was conducted in accordance with the ethical standards and regulations of the University of Rwanda – College of Education. Ethical approval was obtained from the Director of Research and Innovation Unit, University of Rwanda – College of Education, Rukara, on 21st October, 2024 (Ref: DRI-CE/085(a)/EN/gi/2024). Informed consent was obtained from all participants prior to data collection, and confidentiality and anonymity were ensured throughout the research process.

Data Availability Statement. All data can be obtained from the corresponding author.

Conflicts of Interest. The authors declare that there are no conflicts of interest.

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APPENDICES

Appendix 1. System Usability Scale of Maths App Results and Analysis

Table 4. Results of the Usability of Maths App Evaluation

| User ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Raw Score | SUS Score |
|---------|----|----|----|----|----|----|----|----|----|-----|-----------|-----------|
| 1 | 5 | 2 | 4 | 1 | 5 | 2 | 5 | 1 | 4 | 1 | 35 | 87.5 |
| 2 | 3 | 2 | 4 | 2 | 4 | 2 | 5 | 2 | 4 | 2 | 30 | 75 |
| 3 | 4 | 1 | 4 | 2 | 3 | 2 | 5 | 2 | 4 | 2 | 35 | 87.5 |
| 4 | 4 | 2 | 4 | 1 | 4 | 2 | 4 | 1 | 4 | 2 | 32 | 80 |
| 5 | 4 | 2 | 4 | 2 | 3 | 2 | 4 | 2 | 4 | 2 | 29 | 72.5 |
| 6 | 3 | 2 | 3 | 1 | 4 | 2 | 4 | 2 | 4 | 2 | 35 | 80 |
| 7 | 4 | 2 | 4 | 2 | 4 | 2 | 3 | 2 | 4 | 2 | 29 | 72.5 |
| 8 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 30 | 75 |
| 9 | 4 | 1 | 3 | 1 | 4 | 1 | 5 | 2 | 5 | 1 | 34 | 85 |
| 10 | 4 | 1 | 3 | 1 | 4 | 1 | 3 | 1 | 5 | 1 | 29 | 72.5 |
| 11 | 4 | 2 | 5 | 1 | 5 | 2 | 5 | 1 | 5 | 1 | 36 | 90 |
| 12 | 4 | 1 | 4 | 1 | 3 | 1 | 4 | 1 | 4 | 1 | 29 | 72.5 |
| 13 | 4 | 2 | 3 | 1 | 3 | 2 | 4 | 1 | 4 | 2 | 30 | 75 |
| 14 | 4 | 2 | 5 | 1 | 5 | 2 | 5 | 1 | 5 | 1 | 36 | 90 |
| 15 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 30 | 75 |
| 16 | 4 | 2 | 4 | 2 | 4 | 2 | 5 | 2 | 4 | 2 | 31 | 77.5 |
| 17 | 4 | 2 | 5 | 1 | 5 | 2 | 5 | 1 | 5 | 1 | 36 | 90 |
| 18 | 4 | 2 | 3 | 1 | 4 | 1 | 3 | 2 | 5 | 1 | 32 | 80 |
| 19 | 4 | 2 | 3 | 1 | 4 | 2 | 4 | 1 | 5 | 1 | 33 | 82.5 |
| 20 | 5 | 1 | 5 | 1 | 4 | 1 | 5 | 1 | 5 | 1 | 39 | 97.5 |

Source: Field data, November, 2024 – February 2025

Appendix 2. Frequency of respondents from Strongly Disagree to Strongly Agree**Table 5.** Frequencies of Individual responses for the System Usability scale of the Maths app

| Statement | Strongly Disagree(1) | Disagree(2) | Neutral(3) | Agree(4) | Strongly Agree(5) |
|--|----------------------|-------------|------------|----------|-------------------|
| 1. I think I would like to use Maths app frequently | 0 | 0 | 2 | 16 | 2 |
| 2. I found the Maths app unnecessary complex | 5 | 15 | 0 | 0 | 0 |
| 3. I found the Maths app easy to use | 0 | 0 | 6 | 10 | 4 |
| 4. I think I would need help from a technical person to use this app. | 13 | 7 | 0 | 0 | 0 |
| 5. It was easy to understand how to navigate through different sections of the Maths app. | 0 | 0 | 4 | 12 | 4 |
| 6. I found too much inconsistency in the Maths app | 5 | 15 | 0 | 0 | 0 |
| 7. I would imagine that most people would learn to use Maths app very quickly | 0 | 0 | 3 | 8 | 9 |
| 8. I found the Maths app very cumbersome to use. | 10 | 10 | 0 | 0 | 0 |
| 9. I feel confident in my ability to use the Maths app to solve Mathematics word problems. | 0 | 0 | 0 | 12 | 8 |
| 10. I need to learn a lot of things before I could get going with the Maths app. | 10 | 10 | 0 | 0 | 0 |

Source: Field data, November, 2024 - February, 2025