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Structured Reading-Supported Activity Sheets: A Strategy for Improving Grade 11 Learners' Performance in Business Mathematics

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ABSTRACT

This study examined the effectiveness of activity sheets in Business Mathematics that integrate structured reading support and 21st-century skills to improve learners' performance and problem-solving abilities. Designed to enhance knowledge construction, collaboration, and real-life problem-solving, the activity sheets were validated using the 21st Century Learning Design (21CLD) rubric, with feedback from evaluators for refinement. A total of 20 Grade 11 learners served as respondents, utilizing a 40-item achievement test and a problem-solving skills scale for pre- and post-intervention data collection. The subsequent statistical analysis revealed that the paired difference scores were non-normally distributed. Consequently, the non-parametric Wilcoxon Signed-Rank Test was employed to maintain analytical rigor and assess improvements in performance. This test showed significant improvements in learners' achievement ($Z = -2.657$, $p = .008$) and problem-solving skills ($Z = -3.888$, $p = .001$), with a notable shift in performance levels, reducing the number of beginning learners and increasing proficient and basic learners. Evaluators praised the activity sheets' relevance to real-world business contexts and their promotion of collaboration and creativity, suggesting improvements such as alternative strategy prompts and enhanced data presentation. The findings support the integration of reading strategies into mathematics instruction to foster 21st-century competencies and deeper learning experiences, encouraging teachers to adopt similar approaches.

Key Words: 21st Century Skills, ADDIE Model, Collaborative Problem-Solving Task, Performance task, Reading Comprehension.

1. INTRODUCTION

Mathematics is a foundational discipline, essential for developing critical thinking and problem-solving skills. However, many senior high school learners encounter significant performance barriers in solving word problems, primarily due to a deficit in the requisite reading comprehension skills, as documented in empirical research (Davis & Guthrie, 2015) and practitioner-oriented literature (Powley, 2022). This challenge stems from a crucial disconnect: while learners may possess conceptual mathematical knowledge, they often lack the literacy proficiency needed to interpret narrative text, identify key information, and accurately translate real-world scenarios into mathematical models' Longitudinal studies further demonstrate the significant association between reading and mathematics achievement (Grimm, 2008). This deficiency limits the effectiveness of traditional frameworks, such as Polya's four-step method, which rely on the presupposition of initial comprehension. The present research addresses this literacy-mathematics gap through the development and implementation of specialized activity sheets featuring structured reading support in Business Mathematics. The intervention systematically integrates literacy strategies—including the Three-Read Protocol and the RUN Strategy (Hamidi et al., 2024)—with essential 21st-century skills (Johnson et al., 2023). The sheets utilize 21st Century Learning Design (21CLD) rubrics to promote Collaboration (Rivera & Kim, 2024), Knowledge Construction, and Critical Thinking/Problem-Solving (Microsoft Corporation, 2012). Furthermore, the study acknowledges the critical role of the affective domain, as student confidence and perception of problem complexity are significant predictors of success (Fuchs et al., 2011; Hidayah et al., 2024; Serin et al., 2022).

The development and execution of this study are guided by three key learning theories—Constructivist Learning Theory (Piaget, 1973; Vygotsky, 1978) Schema Theory (Anderson et al., 2017; Bartlett, 1932), and Cognitive Load Theory (Paas et al., 2003; Sweller, 1988) —alongside the systematic structure of the ADDIE Model (Analysis, Design, Development, Implementation, and Evaluation) (Branch, 2009). These frameworks provide the foundation for understanding how specific features of the structured reading support embedded in the activity sheets influence knowledge construction, the activation and reorganization of prior knowledge, and the management of learners' limited working-memory resources during Business Mathematics problem-solving.

The intervention operationalizes these theoretical principles through the concrete design of the structured reading-supported activity sheets. Constructivism (Piaget, 1973; Vygotsky, 1978) is reflected in the collaborative nature of the tasks: learners work in pairs, discuss alternative solution strategies, justify their decisions, and present their outputs to classmates. These activities are intended to promote active engagement, social negotiation of meaning, and reflection, leading to deeper conceptual understanding of financial concepts. Schema Theory (Anderson et al., 2017; Bartlett, 1932) informs the integration of the Three-Read Protocol and the RUN Strategy (Hamidi et al., 2024). By repeatedly prompting learners to identify the situation, important quantities, and required computations in familiar real-world contexts, the activity sheets aim to activate and refine existing schemas related to borrowing, saving, and investing, and to connect them with formal notions of simple interest, compound interest, and annuities. Cognitive Load Theory (Paas et al., 2003; Sweller, 1988) guided the step-by-step structure and visual layout of the worksheets. Complex word problems are broken down into smaller prompts, key information is highlighted, and worked examples are provided to reduce extraneous load and focus learners' effort on essential problem-solving processes. Finally, the ADDIE Model (Branch, 2009) provided a systematic framework for analyzing learner needs, designing and developing the materials, implementing them in class, and evaluating and revising them based on expert feedback and learner performance.

This study is designed to evaluate the efficacy of structured reading support embedded within activity sheets in enhancing problem-solving performance in Business Mathematics among senior high school learners.

The specific objectives are:

1. To develop and establish the validation of activity sheets in Business Mathematics incorporating structured reading support for problem-solving.
2. To ascertain the level of improvement in learners' performance in solving mathematical word problems subsequent to the implementation of the developed activity sheets.
3. To determine the change in students' perception towards solving word problems in Business Mathematics before and after the implementation of the intervention.

2. METHODS

This study employs a Quasi-Experimental, One-Group Pretest-Posttest Design to measure the impact of the structured reading support intervention on learners' problem-solving performance. An Action Research component, utilizing the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), guides the systematic creation and validation of the instructional activity sheets.

The participants belonged to the Accountancy, Business, and Management (ABM) strand and were enrolled in the same Business Mathematics class. Their ages ranged from 16-20 years. Low performance was identified using their report card grades and teacher records in both English (reading) and Mathematics from the preceding grading period. Participation in the study was voluntary, and the conduct of the research complied with the school's and division's ethical guidelines for classroom-based action research.

Data collection was conducted in three sequential phases. Initially, all research instruments—the 40-item researcher made Achievement Test that underwent validation, the 20-item Perception Survey on problem-solving adopted from (Medina et al., 2019), and the structured reading support activity sheets—underwent rigorous expert validation to ensure instructional quality and refinement. Subsequently, the 20 purposely sampled Grade 11 learners completed the Pretest and the initial Problem-Solving Perception Survey to establish baseline performance and affective data. Finally, the intervention, involving the use of the validated activity sheets during regular Business Mathematics

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instruction over 10 days was implemented. Following the intervention, the Posttest and the re-administration of the Perception Survey were utilized to capture performance gains and statistically significant changes in learners' confidence and attitudes.

As a classroom-based action research, the study employed a one-group pretest–posttest design without a comparison group. This design allowed an initial exploration of the potential of structured reading-supported activity sheets but also introduced threats to internal validity such as history, maturation, and test sensitization. Thus, while changes in learners' performance and problem-solving perceptions can be associated with the intervention, causal claims must be made with caution.

3. RESULTS AND DISCUSSION

3.1 Development Process of Structured Reading-Supported Activity Sheets

The ADDIE model was used by the researcher in developing the activities. The five phases: Analysis, Design, Development, Implementation, and Evaluation were followed to produce effective activities that support 21st Century learning. This creates better objective alignment, making sure to teach what to test.

In the *Analysis Phase,* one group (block) in Grade 11 learners was the selected respondents in the study having 20 learners. To set learning objectives and understand the knowledge and skill gaps of the learners, prior knowledge was gathered through an achievement test. Learners' low performance in solving problems in business mathematics should be addressed using reading comprehension strategy in the development of activity sheets; learners' performance in business mathematics may improve. 21st century learners should also develop their 21st century skills. They specifically need to improve their real-world problem-solving skills, and be able to construct new knowledge in learning mathematics.

The *Design Phase* should be systematic and specific. Using the information gathered during the analysis phase about learners' performance in business mathematics and their attitudes toward problem-solving, the researcher developed real-world, localized problems and incorporated reading comprehension strategies into performance tasks. These tasks aimed to integrate knowledge construction and problem-solving skills to improve the low pretest performance levels and align with 21st-century skills. Additionally, appropriate instruments for measuring student learning were identified, guided by the K-12 curriculum framework.

Table 1. Curriculum Guide From K-12 Standards And Its Competencies In Business Mathematics

Performance Standards	Learning Competency	Developed Activity Sheets
The learner is able to investigate, analyze and solve problems involving simple and compound interests and simple and general annuities using appropriate business and financial instruments.	The learner illustrates simple and compound interests. The learner distinguishes between simple and compound interests. The learner computes interest, maturity value, future value, and present value in simple interest and compound interest environments. The learner solves problems involving simple and compound interests.	Solving Simple Interest real-life problems Solving Compound Interest real-life problems Exploring Real-Life Loans and Annuities: A Business Mathematics Investigation

The Development Phase is where the researcher creates and assembles the content assets that were considered in the Analyze and Design phases. Lesson activities were generated in this phase.

The lesson activities were designed by the researcher to promote student knowledge construction and deeper engagement in problem-solving tasks. These activities aimed to enhance learners' critical thinking, and ability to construct new knowledge. The learners' work and solutions were assessed using the 21st Century Learning Design (21CLD) rubric. The study included two types of activities: problem-solving activities and a major performance task.

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Two activities were developed to foster knowledge construction, and real-world problem-solving. These tasks were designed to supplement the lessons in Business Mathematics and were based on the "Three Reads Protocol," a reading comprehension strategy. Each read had a distinct goal.

Each activity sheet followed a common structure. First, a short, localized scenario introduced a realistic financial situation familiar to learners (for example, savings for a gadget purchase, sari-sari store inventory loans, or installment payments for appliances). Second, the Three-Read Protocol was applied: during the first read, learners answered prompts about what the situation was generally about; during the second read, they identified and underlined important quantities and relationships; and during the third read, they determined what was being asked and anticipated possible strategies. Third, the RUN Strategy (Hamidi et al., 2024) guided learners to Read the entire problem, Underline the question, and note important information, translating the narrative into symbols or equations. Fourth, space was provided for partners to propose at least two possible solution paths, decide which strategy to adopt, and justify their choice. Finally, each activity concluded with short reflection questions asking learners to describe difficulties encountered, explain how the reading prompts helped them, and identify what new mathematical ideas they had constructed.

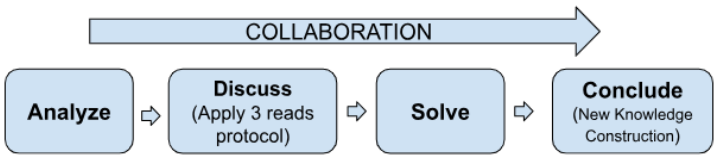
The integration of this protocol ensured that learners approached problems methodically, improving both comprehension and problem-solving skills. Sample answered activities from the implementation can be found in Appendix.

A major performance task was introduced at the beginning of the implementation of the activity sheets. Learners, working in pairs, were required to solve a real-world problem and construct new knowledge collaboratively.

Learners were given two weeks to complete the task and present their outputs in class. During the presentation, they demonstrated not only their solutions but also their ability to synthesize and communicate their findings effectively.

During *the Implementation Phase*, the teacher-researcher ensured that all instruments and activities were prepared and ready for use. At the start of this phase, learners were oriented, assigned to groups, and provided with clear instructions for the performance task.

In facilitating the lesson activities, the teacher assumed the role of a learning facilitator, encouraging learners to explore and learn independently. A key focus during this phase was the application of the Three Reads Protocol and RUN Strategy for reading comprehension, which guided learners in systematically analyzing and solving real-world



problems in Business Mathematics.

Figure 1. Implementation flow of the Developed Activities

Learners began by carefully analyzing the problem (Fig.1), reading through the context to understand its narrative and identify its real-world relevance. They applied the Three Reads Protocol, starting with the first read to grasp the overall context of the problem. The second read allowed them to identify important mathematical information and relationships, while the third read focused on exploring potential strategies to solve the problem effectively.

After this initial analysis, learners discuss possible solutions, refine their ideas, and reach a consensus on the most appropriate conclusion. Through this process, they not only solved the problem but also constructed new knowledge and deepened their understanding of mathematical concepts.

The lesson activities and performance tasks were implemented over two weeks, providing learners with ample time to engage in critical thinking, teamwork, and problem-solving to successfully complete their goals.

The *Evaluation Phase* measures the effectiveness of the instruction in the developed activities. Evaluation occurred throughout the entire design phases- within phases, between phases and after implementation. Pretest and posttest

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were conducted and compared to assess the overall effectiveness of the instruction. Formative assessment was also conducted by the teacher-researcher during the learning process in order to modify teaching and learning activities to improve student attainment.

There were three in-service mathematics teachers who helped the improvement of the activities. The researcher adopted the rubrics from 21st CLD which determined the level of problem-solving skills, collaboration and knowledge construction as designed by the researcher in developing the activities. Comments and suggestions were also gathered for the activity's revision and improvement.

Table 2. Evaluation of the Developed Lesson Activities

21st Century Skills	Mean Rating	Description	Interpretation
Knowledge Construction	4.67	Excellent	The activity sheet's primary focus **is** on promoting knowledge construction, enabling learners to achieve deep conceptual understanding. It does support learners in applying their knowledge to real-world business scenarios or making interdisciplinary connections.
Real-world Problem Solving	4	Excellent	The activity sheets are designed to make problem-solving the central focus, with tasks that address real-world challenges. The worksheet promotes innovation by encouraging learners to think creatively, propose novel solutions, and consider practical implementation in real-world contexts.
Collaboration	4.33	Excellent	The activity sheets ensure that students share responsibilities fairly, engage in substantive decision-making, and produce an interdependent work product. Collaboration is central to the activity, fostering meaningful and collective outcomes.

Table 2 shows the ratings of the evaluators to the developed activities. The 21st Century skills that were focused for the learners to acquire gained an excellent rating.

In addition to the numerical ratings, evaluators provided comments and suggestions to improve the activity sheets. These were analyzed thematically, and the following insights were identified

Real-World Application and Contextual Relevance:

"*The worksheets effectively integrate real-world business challenges, such as borrowing and investing scenarios relevant to the students' context (e.g., sari-sari store operations). They encourage students to apply mathematical principles while fostering problem-solving skills.*"

-Evaluator 3

Enhancing Creativity and Critical Thinking:

"*To further enhance innovation, you might include prompts that encourage students to propose alternative financial strategies or compare outcomes across different borrowing or investment options. Adding these elements could deepen engagement and stimulate creative thinking.*"

-Evaluator 3

These comments and suggestions provided valuable insights into refining the materials to better align with the 21st-century skills framework and further engage learners in meaningful learning experiences.

3.2 Performance Level of the Learners in their Achievement Test

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Table 3 presents the performance levels of learners in the pretest and posttest, categorized into five groups: Beginning, Emerging, Basic, Proficient, and Advanced. The results indicate improvements in learners' performance after the implementation of the developed activity sheets. Specifically, the number of students at the Beginning level decreased from 8 in the pretest to 6 in the posttest, and those at the Emerging level reduced slightly from 11 to 10. Meanwhile, the number of learners at the Basic level increased from 1 to 3, and one student progressed to the Proficient level, where no learners had been previously. Notably, none of the students reached the Advanced level in either the pretest or posttest, suggesting further room for growth.

Descriptive statistics also indicated gains in achievement. On the 40-item researcher-made test, the mean pretest score was 15.5 (SD =6.84), while the mean posttest score increased to 21.2 (SD =6.32). The median score likewise increased from 16 to 19.5, reflecting the upward shift in performance levels summarized in Table 3

Table 3. Learners' Performance Level in the Pretest and Posttest

Groups	Before	After
Advanced(90-100%)	0	0
Proficient(75-89%)	0	1
Basic (60-74%)	1	3
Emerging((40-59%)	11	10
Beginning (below 40%)	8	6

A Wilcoxon Signed-Rank Test was employed to analyze the learners' performance in the pretest and posttest after the implementation of the developed activity sheets, since the data failed the normality test.

The results revealed a statistically significant improvement in learners' performance, $Z=-2.657$, $p=.008$, which is below the significance level $\alpha=.05$. Among the 20 learners, 16 exhibited positive ranks (Mean Rank = 11, Sum of Ranks = 176), indicating an increase in scores, while 4 showed negative ranks (Mean Rank = 8.5, Sum of Ranks = 34). No ties were observed in the data. The significant p-value demonstrates that the developed activity sheets effectively enhanced the learners' mathematical performance.

Previous studies, such as (Hamidi et al., 2024), highlight the benefits of combining reading strategies with mathematics instruction. This study reaffirms these findings, showing significant improvement in learners' achievement and problem-solving perceptions after implementing activity sheets that incorporate reading comprehension strategies.

Table 4. Learners' Achievement Test Performance in the Pretest and Posttest

Comparison	N	Mean Rank
Scores Decreased	4	8.5
Scores Increased	16	11
Ties	0	-
Wilcoxon Test Statistics	Z	p-value
	-2.657	0.008

** Significant at $\alpha<0.05$*

3.3 Learners' Problem-Solving Perceptions

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To measure the perception toward problem-solving, a Likert scale was used. This instrument helped the researcher in determining the change of learners' perceptions of their problem-solving skills after the implementation. The instrument was given as a pretest and posttest.

Descriptive analysis of the 20-item perception scale (1-4) showed that learners' self-reported problem-solving perception became more positive after the intervention. The mean pretest score was 3.10 (SD =0.27), increasing to 3.41 (SD =0.16) in the posttest. The median score also rose from 3.11 to 3.39, indicating that most learners moved toward more favorable ratings of their confidence, persistence, and use of strategies when solving word problems

A Wilcoxon Signed-Rank Test was conducted to compare learners' perception in problem-solving before and after the implementation of the developed activity sheets. The results revealed a significant improvement in problem-solving skills, $Z = -3.888$, $p < 0.001$, indicating a statistically significant difference between pretest and posttest scores. Of the 20 learners, 18 showed a positive increase in their ranks (Mean Rank = 11), while only 1 learner demonstrated a negative rank (Mean Rank = 1), and 1 learner had no change (tie). These findings suggest that the developed activity sheets effectively enhanced students' problem-solving skills.

Table 5. Problem Solving Skills in Pretest and Posttest

Comparison	N	Mean Rank
Problem-solving Perception Decreased	1	1
Problem-solving Perception Increased	18	11
Ties	1	
Wilcoxon Test Statistics	Z	p-value
	-3.888	0.001

** Significant at $\alpha<0.05$*

The results further affirm that addressing learners perceived behaviors and attitudes towards mathematics is critical for improving problem-solving performance. Research by (Fuchs et al., 2011) highlights that cognitive resources and self-perceptions significantly influence problem-solving abilities, suggesting that interventions aimed at enhancing these factors can lead to better outcomes. By combining structured reading strategies with collaborative, real-world problem-solving activities, the developed activity sheets effectively addressed these critical aspects, fostering significant improvements in learners' problem-solving skills and overall confidence.

Although the findings of this study are promising, several limitations must be acknowledged. The absence of a control or comparison group in the one-group pretest–posttest design means that alternative explanations for the observed improvements, such as maturation or exposure to other instructional activities, cannot be fully ruled out. The small, purposively selected sample of 20 Grade 11 learners from a single school also limits the generalizability of the results. Furthermore, the data relied on a researcher-made test and self-reported perceptions, which may be influenced by measurement error or social desirability. Future studies should consider employing a quasi-experimental design with control and experimental groups, a larger and more diverse sample, and additional measures of retention and transfer to strengthen the evidence for the effectiveness of structured reading-supported activity sheets in Business Mathematics.

4. CONCLUSION AND RECOMMENDATIONS

The evaluation of the developed instructional materials using the ADDIE model confirmed the validity and usefulness of the structured reading-supported activity sheets for Business Mathematics. Statistically significant improvements in posttest scores compared to pretest scores indicated that the intervention helped bridge the gap between reading comprehension and mathematical problem-solving skills among the participating Grade 11 learners. In addition, learners showed a significant positive shift in their problem-solving perceptions, reflected in higher self-reported

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levels of self-efficacy and confidence when working with word problems. These outcomes affirm the theoretical alignment between Schema Theory and Constructivism (Anderson et al., 2017; Bartlett, 1932; Piaget, 1973; Vygotsky, 1978), suggesting that systematic literacy scaffolding and collaborative knowledge construction can support deeper understanding of financial concepts and foster more adaptive attitudes toward complex mathematical tasks.

In light of these findings, it is highly recommended that the developed, validated structured reading support materials be formally integrated into the Senior High School Mathematics curriculum, serving as a standard resource for addressing reading-based challenges in problem-solving. This integration should be accompanied by professional development training for educators, focusing on the effective application of the Three-Read Protocol and RUN Strategy to sustain the intervention's positive effects. For future research, it is recommended to conduct a Quasi-Experimental Control Group Study to compare the structured reading approach against traditional methods, thereby isolating the efficacy of the intervention and establishing stronger external validity. Additionally, investigating the long-term retention of problem-solving skills and positive perceptions beyond the immediate post-intervention period is warranted.

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