

DESIGN AND DEVELOPMENT OF A WORKBOOK FOR BRIDGING PROGRAM IN NUMERACY

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Abstract:

This study aimed to design and develop a numeracy bridging workbook for Grade 10 learners using the ADDIE instructional design model. Guided by a diagnostic needs analysis, the study identified specific numeracy gaps to inform the workbook's content and structure. The Enhanced Regional Unified Numeracy Test (e-RuNT), a validated assessment tool, was administered to 66 Grade 10 learners from a large public secondary school in Central Philippines to diagnose learners' proficiency in the four fundamental operations of integers. Results revealed subtraction as the least mastered operation, while addition, multiplication, and division showed satisfactory proficiency levels. These findings guided the design of a learner-centered workbook emphasizing scaffolded subtraction tasks, alongside reinforcement activities for the other operations. The workbook integrated guided examples, structured exercises, and contextualized problem-solving tasks aligned with curriculum standards. The study highlights the value of diagnostic-driven instructional design in developing targeted learning interventions for numeracy improvement. It further demonstrates the applicability of the ADDIE model in producing responsive and curriculum-aligned instructional materials for secondary education.

Keywords: *numeracy, instructional design, ADDIE model, workbook development, diagnostic assessment, mathematics education*

Introduction:

Numeracy is not merely the ability to perform arithmetic operations; it is a critical life skill that enables individuals to engage meaningfully with the world around them. It encompasses the ability to understand, interpret, and apply mathematical information in real-life contexts, from managing finances to making informed decisions about health, work, and civic responsibilities (Ogunsola & Adigun, 2025). In today's rapidly evolving society, numeracy plays a foundational role in building the analytical and problem-solving competencies essential for 21st-century learners. Recognizing this, global and national education systems have emphasized numeracy as a core competency in basic education.

In the Philippine context, the Department of Education (DepEd) has highlighted numeracy as a fundamental skill necessary for lifelong learning and sustainable development (DepEd, 2015). However, despite ongoing reforms such as the K to 12 curriculum and the recently launched Matatag Curriculum, national and international assessments continue to reveal persistent gaps in students' mathematical proficiency (Echavez et al., 2024). These gaps have been further widened by disruptions in schooling due to the COVID-19 pandemic, highlighting the urgent need for targeted instructional interventions to support students' learning recovery and readiness for higher academic levels (Maddawin et al., 2024).

Bridging programs have emerged as effective interventions for addressing such learning gaps. These programs are designed to support learners in their transition between educational levels by reinforcing foundational knowledge and skills (Mvunyelwa Msomi & Rzyankina, 2024). In particular, numeracy bridging programs serve to prepare learners for more advanced mathematical content by ensuring that they possess the prerequisite skills needed for success in future learning. Studies have shown that bridging programs not only remediate academic deficiencies but also build learner confidence and motivation (Gang, 2022; Samuel, 2018).

Despite their importance, there remains a shortage of instructional materials specifically designed for use in numeracy bridging programs. Many educators rely on generic resources that are not aligned with the specific competencies and

learning needs of students transitioning from junior to senior high school (Rezat et al., 2021). This lack of specialized instructional tools limits the potential of bridging programs to deliver impactful learning experiences. Addressing this gap requires the development of targeted, curriculum-aligned resources that are informed by learner data and grounded in sound instructional design principles.

As a Grade 10 mathematics teacher, the researcher has observed firsthand how many learners struggle with basic operations—particularly subtraction—hindering their progress in more advanced topics. These difficulties often result in negative learning attitudes, reduced participation, and low self-efficacy in mathematics (Yang et al., 2024). To help bridge these gaps, structured and learner-centered instructional materials such as workbooks can provide accessible and practical solutions. When thoughtfully designed, workbooks allow learners to engage in guided practice, receive feedback, and build mastery at their own pace (Tong et al., 2022).

This study is guided by the ADDIE instructional design model, a systematic framework that includes Analysis, Design, Development, Implementation, and Evaluation. Widely used in both classroom and corporate settings, ADDIE promotes iterative, data-driven development of instructional materials that are aligned with learner needs and instructional goals (Boateng et al., 2024). In the Philippine setting, ADDIE has been successfully applied in developing competency-based learning resources aligned with DepEd's Most Essential Learning Competencies (Aniciete et al., 2023; Zalun, 2023).

Grounding the development of the workbook in ADDIE ensures a structured and responsive approach to content creation. During the Analysis phase, learner profiles and performance data help identify specific learning needs. The Design and Development phases translate these needs into instructional materials, while Implementation and Evaluation involve piloting the materials and using feedback to refine them. This approach increases the relevance, usability, and effectiveness of the final product (Bouchricka, 2025).

Moreover, effective instructional materials must go beyond procedural fluency; they must also foster conceptual understanding, critical thinking, and real-world application. Research by Guelas & Pasia (2025) emphasized that contextualized math problems enhance learner motivation and understanding. Likewise, scaffolded learning activities and formative assessments can support diverse learners in progressing from basic to more complex concepts (Kruiper et al., 2021). By integrating these pedagogical strategies, a numeracy workbook becomes not only a remedial tool but also a platform for cognitive and affective development.

In response to the need for effective learning interventions in numeracy, this study seeks to design, develop, implement, and evaluate a workbook for a bridging program in a public secondary school. The workbook will be tailored to address the specific difficulties encountered by Grade 10 learners in basic mathematical operations, particularly subtraction, using data gathered from pre-assessments and stakeholder feedback. By grounding the study in the ADDIE framework and drawing from both theory and practice, the research aims to produce a validated instructional tool that supports learners' transition and contributes to improved mathematics outcomes.

Ultimately, this study hopes to contribute to the broader discourse on curriculum development and learning recovery in Philippine education. It also seeks to provide a replicable model for the design of learner-centered instructional materials informed by data, grounded in pedagogical theory, and validated through stakeholder engagement. In doing so, it underscores the critical role of research-based intervention in supporting equitable and quality education for all.

Methodology:

This study employed a developmental research design, specifically focused on the systematic creation and evaluation of an instructional workbook intended to bridge numeracy gaps among Grade 10 learners. Developmental research is widely utilized in educational settings for designing, testing, and refining instructional materials and is characterized by iterative cycles of design, development, and assessment (Scott et al., 2020). The research was guided by the ADDIE instructional design model, which emphasizes five phases: Analysis, Design, Development, Implementation, and Evaluation (Aldoobie, 2015). Within this framework, the study concentrated on the initial three phases—analysis, design, and development—given that the core objective was the creation of the workbook.

The study was conducted at a large public secondary school situated in a highly urbanized city in Central Philippines. The school was selected for its diverse student population and its active implementation of the K to 12 curriculum, which allowed for an authentic context in assessing numeracy needs and designing instructional materials (Abragan et al., 2022). The locale also provided logistical accessibility for the researcher, who was concurrently serving as a mathematics teacher in the institution.

Participants of the study included 66 Grade 10 learners drawn from two heterogeneous sections of the school. A purposive sampling technique was employed to select participants who were directly engaged in the school's mathematics program and were thus positioned to provide meaningful data for the needs analysis. Purposive sampling was deemed appropriate for this developmental research since it allowed the selection of participants based on their relevance to the study's objectives (Campbell et al., 2020). In addition to student participants, two Grade 10 mathematics teachers were involved in providing insights on student performance and numeracy challenges during the analysis phase.

The primary research instrument used in the study was the Enhanced Regional Unified Numeracy Test (e-RuNT), a standardized diagnostic tool developed and validated by the Division Office of Bacolod City for use in public schools. The e-RuNT is designed to measure learners' proficiency in the four fundamental mathematical operations: addition, subtraction, multiplication, and division of integers. Its primary purpose in this study was to gather diagnostic data for the needs analysis, identifying specific numeracy skills that required instructional intervention.

To ensure validity and reliability, the e-RuNT underwent formal validation procedures at the division level. It has been consistently administered by mathematics coordinators and teachers across public schools in the region. Its internal consistency and construct validity have been affirmed through previous studies and educational assessments conducted by the Division Mathematics Supervisors (Bañares & Torreces, 2024). Furthermore, the instrument's alignment with the Philippine K to 12 curriculum and the Most Essential Learning Competencies (MELCs) strengthened its contextual relevance and content validity.

The data gathering procedure followed a structured sequence aligned with the Analysis phase of the ADDIE model. After securing approval from the Division Office and the school principal, the researcher administered the e-RuNT to the identified participants under standardized testing conditions. Instructions were clarified, and time allotments adhered to guidelines provided by the Division Office to ensure procedural consistency. Upon completion of the assessment, scores were collected, and the results were analyzed to determine learners' levels of proficiency in each of the four operations. The analysis provided a diagnostic profile of numeracy skills, which served as the foundation for the subsequent design and development of the workbook.

The statistical treatment of the data involved descriptive analysis. Specifically, mean scores for each mathematical operation were computed and interpreted based on the performance descriptors outlined in DepEd Order No. 8, s. 2015. These descriptors categorized learner performance into four levels: Beginning, Developing, Proficient, and Advanced, corresponding to specific score ranges. The interpretation of scores allowed for precise identification of least mastered skills, which guided the prioritization of content areas in the workbook.

Throughout the research process, the study adhered to rigorous ethical considerations. Informed consent was obtained from the participants and their parents or guardians, in compliance with ethical standards for research involving minors. Participation in the study was voluntary, and learners were assured of their right to withdraw at any stage without penalty. The researcher ensured the anonymity and confidentiality of participants by using codes instead of names in recording data and by restricting access to the information collected. Moreover, approvals were obtained from relevant school authorities and the Division Office prior to data collection, ensuring institutional compliance with research protocols. Ethical principles of respect for persons, beneficence, and justice were observed throughout the study (Varkey, 2020).

Results:

The results of the study are presented according to the primary objective of the research, which was to conduct a systematic needs analysis to inform the design and development of a numeracy bridging workbook for Grade 10 learners. Data were derived from the administration of the Enhanced Regional Unified Numeracy Test (e-RuNT), focusing on four fundamental mathematical operations: addition, subtraction, multiplication, and division of integers.

The analysis of the e-RuNT results revealed distinct patterns in learners' numeracy performance. Among the four operations assessed, subtraction emerged as the least mastered skill. Learners obtained a mean score of 5.64 in subtraction, which falls within the "Developing" category based on the Department of Education's performance descriptors under DepEd Order No. 8, s. 2015. This level of performance indicates that learners require additional instructional support to enhance their subtraction skills, particularly in the context of integer operations. The prevalence of errors in subtraction suggests difficulties in conceptual understanding and procedural fluency, necessitating targeted instructional interventions in this area.

In contrast, relatively higher levels of proficiency were observed in the remaining three operations. Learners achieved a mean score of 7.82 in addition, which corresponds to the "Proficient" category, indicating satisfactory performance in this area. Similarly, multiplication yielded a mean score of 8.61, also classified as "Proficient," suggesting that learners generally demonstrated competence in executing multiplication tasks involving integers. Division, while slightly lower, still resulted in a mean score of 7.67, likewise categorized under "Proficient." These results suggest that learners possess reasonable levels of proficiency in addition, multiplication, and division, though there remains room for consolidation and reinforcement through structured practice activities.

The gap between subtraction and the other operations was particularly notable. While addition, multiplication, and division reflected overall proficiency, the marked underperformance in subtraction highlights a specific conceptual hurdle among learners. This observation aligns with findings from related studies indicating that subtraction often poses greater cognitive demands due to its requirement for inverse reasoning and the frequent involvement of negative numbers, especially in integer operations (Nguyen & Le, 2022; Hassan & Youssef, 2020). These results confirmed the necessity of designing the workbook with a heightened focus on subtraction, integrating scaffolded tasks that progressively build conceptual understanding alongside procedural fluency.

The diagnostic data from the e-RuNT thus served as a critical foundation for the workbook's content prioritization. Given the relatively stronger performance in addition, multiplication, and division, the instructional design allowed for reinforcement activities in these areas while reserving more intensive instructional sequences for subtraction. The needs analysis findings also informed the sequencing of activities, ensuring that foundational operations were reviewed before engaging learners in more complex subtraction tasks. By situating subtraction within both isolated exercises and applied problem-solving contexts, the workbook aimed to address learners' specific gaps as indicated by the diagnostic results.

In sum, the results of the needs analysis provided empirical evidence that guided the instructional focus and design of the numeracy bridging workbook. The identification of subtraction as the least mastered operation underscored the importance of targeted intervention in this area, while the relatively higher scores in other operations supported the inclusion of reinforcement exercises to sustain and extend existing competencies. These findings directly informed the structure, content emphasis, and instructional strategies embedded in the workbook's design, ensuring that it was aligned with learners' diagnosed needs and curricular standards.

Discussion:

The findings of this study revealed distinct patterns of numeracy proficiency among Grade 10 learners, offering clear guidance for the design and development of the numeracy bridging workbook. The diagnostic results from the Enhanced Regional Unified Numeracy Test (e-RuNT) highlighted subtraction as the most challenging mathematical operation for learners, in contrast to their relatively proficient performance in addition, multiplication, and division of

integers. This outcome strongly reinforces the value of employing a structured, data-driven approach to instructional material development, as supported by the ADDIE instructional design model (Branch & Kopcha, 2013).

The consistently low performance in subtraction underscores the complex nature of this operation, particularly in the context of integers. Unlike addition and multiplication, subtraction often requires learners to engage in inverse reasoning, which demands higher cognitive processing (Winarni et al., 2025). Additionally, subtracting negative numbers can introduce confusion, as learners must navigate abstract concepts such as the additive inverse and number line shifts (Koskinen & Pitkaniemi, 2022). This finding is consistent with prior research in mathematics education, which has identified subtraction as a common area of difficulty, especially among middle-grade learners who are still developing foundational number sense (Anghileri, 2006). The study's results thus validate the need to devote focused instructional efforts to subtraction within the workbook, ensuring that learning tasks are scaffolded and conceptually grounded.

In line with the Analysis phase of the ADDIE model, the identified proficiency gaps informed the targeted design of the instructional material. The ADDIE model emphasizes the critical role of needs analysis in determining instructional goals and content priorities (Branch & Kopcha, 2013). By diagnosing the specific challenges faced by learners, the study provided an empirical basis for structuring the workbook's learning sequence. The findings directed the researcher to allocate greater instructional time and activity volume to subtraction while including review and reinforcement tasks for the other three operations. This approach reflects the principles of differentiated instruction, which prioritize the alignment of learning resources with learners' actual skill levels and readiness (Mijares, 2023).

The results also support the inclusion of scaffolded learning activities, which have been shown to be effective in bridging conceptual gaps in mathematics. Research by Valderama & Oligo (2021) emphasizes that scaffolded tasks—those that begin with guided practice and gradually transition to independent problem-solving—enhance student engagement and lead to better learning retention in mathematics. In the context of this study, scaffolded subtraction exercises were integrated into the workbook to facilitate incremental mastery. Additionally, the use of visual representations and contextualized examples was emphasized to support conceptual clarity, particularly for abstract operations such as integer subtraction (Ibrahim et al., 2021).

The relatively proficient performance of learners in addition, multiplication, and division suggests that these operations, while still essential, may not require intensive remediation but rather continued reinforcement. Studies by Yan et al., (2023) have noted that maintaining consistent practice in already proficient areas can prevent learning regression and strengthen long-term retention. Therefore, the workbook's inclusion of practice exercises for these operations, albeit less extensive than those for subtraction, adheres to best practices in numeracy instruction by balancing remediation with reinforcement.

Moreover, the study demonstrates the importance of contextually relevant instructional materials that are tailored to specific learner populations. As emphasized by Cayabas Jr & Sumeg-ang (2023), instructional materials developed without consideration of local learning contexts often fail to address learners' specific needs. The localized implementation of the e-RuNT in this study provided a robust diagnostic tool, ensuring that the findings reflected the actual proficiency levels and learning needs of the targeted Grade 10 learners. By designing the workbook based on these data, the study adhered to principles of culturally responsive pedagogy, which advocate for the adaptation of learning resources to the specific sociocultural and educational context of learners (Caingcoy, 2023).

Finally, the study's methodology—anchored in diagnostic assessment and aligned with curriculum standards—illustrates the practical application of design-based research approaches in the Philippine educational setting. The use of validated instruments, structured analysis procedures, and systematic instructional design processes collectively strengthen the credibility of the findings and the relevance of the developed workbook (Araza & Magnaye, 2023). This approach demonstrates the effectiveness of integrating empirical research with instructional design frameworks to produce contextually appropriate learning materials that address specific educational challenges.

Conclusion:

The present study aimed to design and develop a numeracy bridging workbook for Grade 10 learners, guided by the results of a systematic needs analysis using the Enhanced Regional Unified Numeracy Test (e-RuNT). Anchored in

the ADDIE instructional design model, the study focused on addressing specific gaps in learners' mathematical competencies, particularly in the operation of subtraction.

The analysis of diagnostic data revealed that subtraction was the most challenging operation among the four fundamental mathematical operations assessed. Learners demonstrated limited proficiency in subtraction, highlighting the need for targeted instructional interventions to address conceptual misunderstandings and procedural difficulties in this area. In contrast, learners exhibited satisfactory performance in addition, multiplication, and division, suggesting that these areas required reinforcement rather than intensive remediation.

In response to these findings, the workbook was systematically designed to prioritize subtraction-focused activities while integrating scaffolded learning tasks that gradually increased in complexity. The inclusion of guided examples, structured practice exercises, and contextualized problem-solving activities aligned with research-based strategies for enhancing numeracy skills. The design also incorporated reinforcement tasks for addition, multiplication, and division to consolidate existing competencies and support continued skill development.

The study demonstrated the effectiveness of a diagnostic-driven, learner-centered approach to instructional material development. By utilizing empirical data from a validated assessment tool and adhering to the ADDIE framework, the research produced an instructional resource that was both responsive to learners' needs and consistent with curriculum standards. The workbook represents a contextually grounded intervention capable of addressing specific numeracy gaps in secondary education.

Based on the findings and conclusions of the study, several recommendations are proposed. First, it is recommended that the workbook be integrated into remedial programs and supplementary learning sessions in Grade 10 mathematics, particularly for learners exhibiting low proficiency in subtraction and related mathematical operations. Teachers should be provided with orientation and training on the effective use of the workbook, emphasizing strategies for scaffolding instruction and adapting activities to varying learner profiles.

Second, school administrators and department heads are encouraged to support the institutionalization of diagnostic assessments such as the e-RuNT as a basis for instructional planning. Regular needs analysis can inform more precise and responsive curriculum interventions, thereby improving mathematics achievement across grade levels.

Third, curriculum developers and instructional designers may consider expanding the workbook to include additional topics beyond basic operations, such as fractions, decimals, and introductory algebra, to address a broader range of numeracy competencies. Moreover, future iterations of the workbook may integrate digital components, including interactive exercises and adaptive learning modules, to support blended learning environments and extend accessibility.

Finally, it is recommended that further research be conducted to evaluate the effectiveness of the workbook in classroom implementation. Longitudinal studies examining its impact on learners' sustained numeracy development and academic outcomes would provide valuable insights for continuous improvement. Additionally, investigations into the role of parental involvement and community-based learning supports may enhance the scalability and sustainability of similar instructional interventions.

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