



# DEVELOPMENT AND VALIDATION OF REFLECTIVE COMPETENCY -BASED WORKBOOK IN IMPROVING NUMERACY SKILLS

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## ABSTRACT

This study developed and validated a Reflective Competency-Based Workbook to improve the numeracy skills of students at Plaridel Integrated National High School. Using a descriptive-developmental design, the study assessed the workbook's acceptability in terms of objectives, content, activities, and assessment. Data were analyzed using frequency, percentage, mean, weighted mean, standard deviation, and paired samples t-test. Findings revealed that students had low mastery in arithmetic skills, particularly in division, while addition, subtraction, and multiplication were slightly learned. In data interpretation, learners had difficulty interpreting tables but showed some ability in reading graphs, analyzing trends, and drawing conclusions. Most respondents were at the beginning level in both arithmetic and data interpretation skills. Results showed a significant difference between pretest and posttest scores ( $p < 0.001$ ), indicating that the workbook significantly improved students' performance. Respondents also expressed high satisfaction with the workbook in terms of usability, appropriateness, and overall design. Furthermore, a significant relationship was found between the workbook's acceptability and students' numeracy skills. In conclusion, the Reflective Competency-Based Workbook was an effective tool in enhancing students' numeracy skills. It is recommended for use in remedial classes and for further application in other areas of mathematics and larger groups of learners.

**KEYWORDS:** Numeracy Skills, Reflective Workbook, Competency-Based Learning, Arithmetic Skills, Data Interpretation

## INTRODUCTION

Educators are increasingly concerned about improving the quality of education for each learner and getting them to develop competence in the areas necessary for success in future education. To develop and apply quality educational experiences to each learner, educators continue to develop, use, and implement various strategies and materials in an effort to enhance the meaningfulness, independence, and thoughtfulness of each learner's experiences. Online accessible resource materials are a very popular avenue for developing effective classroom instruction and supporting students' learning. Online accessible resource materials have become a valuable source of assistance for educators when they require assistance in providing guided practice, quality feedback to students, and to progress students' skills. The use of online educational resources provides a structured framework to enhance educator's effectiveness in providing instruction and to improve student learning outcomes.

Educators are in a constant struggle to identify the cause of poor achievement in mathematics, and while there are many factors contributing to this issue, poor mathematics skills remain at the forefront of concern for educators. Many educators report that students who lack basic arithmetic skills (i.e., addition, subtraction, multiplication, and division) are usually not able to develop skills needed for higher-level mathematics (e.g., algebra, geometry, statistics, and precalculus), nor do they have the skills necessary for real-world problem solving. As a result of students' inability to accurately and effectively perform basic arithmetic operations, students frequently demonstrate poor academic performance, underdeveloped problem-solving skills, and low self-confidence in mathematics. Students' lack of proficiency in basic arithmetic skills may impede their readiness for more complex concepts in mathematics.

Similarly, educators are also reporting that learners possess multiple challenges when it comes to their ability to interpret data (i.e., the ability to read data presented in graphical, tabular, and other visual forms, and to analyze and draw inferences from such data). Many students appear to have difficulty correctly reading graphs, appropriately interpreting tables, identifying trends, and making logical inferences from the information provided. Students have difficulties developing their ability to think critically and apply mathematical concepts to solve problems in real-world situations because of these issues. The common use of data interpretation in everyday life and in learning means that students who do not perform well in this area will have difficulty developing their overall mathematical literacy, as well as their ability to think analytically.

The continuing nature of these issues further signifies the need for learner-centered instructional materials, such as good-quality workbooks to help improve students' numeracy and data interpretation skills. The design and use of a workbook will provide learners with structured activities and practice exercises, as well as engaging learning experiences that can assist them in developing their understanding, mastery, and application of mathematical concepts.

The effectiveness of quality instructional materials is also supported by a number of theories related to learning, which emphasize the importance of active participation in learning and the fact that learners learn at different rates and in different ways. For example, as highlighted by Piaget and Gardner, learning should be viewed as a process that promotes active participation, encourages experiential and hands-on learning, and creates opportunities for recognizing students' various cognitive abilities and



learning styles. Therefore, in Mathematics, materials such as workbooks, modules, and visual representations provide learners with the opportunity to practice and explore the material in a scaffolded and reflective way, thus providing ways of bridging the gap between abstract mathematical concepts and the cognitive processes and understanding of learners to promote greater depth and longevity in learning.

In spite of ongoing efforts to improve instructional practices throughout the world, low student achievement in Mathematics remains a global and local issue. Moore (2015) noted that many students around the world will continue to underachieve in Mathematics and that this issue is also prevalent in the Philippines. For example, the 2022 Program for International Student Assessment (PISA) results show that the Philippines is ranked 75th to 79th out of 81 countries in Mathematics, Reading, and Science, and therefore highlights the need to improve the quality of teaching and to provide resources which will develop the skills of numeracy and critical thinking in Filipino students. This alarming finding is primarily caused by the lack of foundational skills in numeracy that create barriers to students' ability to comprehend and apply higher-level mathematical concepts to their real-life experiences.

Assessment should be coupled with interventions to address the learning gaps. Seifert and Sutton (2017) noted that effective assessments yield critical information about learners' learning progress, while Chinn (2016) claimed that assessment must be done before any intervention, to support learning needs. This view is in line with the state of learning in the Philippines, where many learners still struggle with numeracy skills, as shown in national and school assessments. Therefore, the use of diagnostic assessment, monitoring, and the development of targeted instructional materials is an important and evidence-based strategy in ensuring quality learning outcomes and improving academic performance.

Albay (2016) pointed out that low learning outcomes continue to be a concern for the Department of Education (DepEd). DepEd encourages the development of contextualized, locally made teaching and learning materials to improve learning outcomes. This is supported by Republic Act No. 10533 (Enhanced Basic Education Act of 2013), which promotes the development and production of locally produced teaching and learning materials. According to Rule II, Section 10.3: "The production and development of locally produced teaching and learning materials shall be encouraged..." This policy highlights the importance of contextualized, culturally responsive, and learner-friendly teaching and learning materials in enhancing learning outcomes in different learning contexts.

This policy and the need to enhance numeracy skills motivated the researcher to create a Reflective Competency-Based Workbook in Mathematics 7. The workbook was designed to offer competency-based activities with reflective components to increase learners' metacognitive skills and enhance their numeracy performance. It also was also created to aid teachers in teaching and scaling learners' understanding of mathematical concepts. Moreover, the inclusion of reflection components was anticipated to improve learners' critical thinking, self-regulation, and problem-solving skills - all vital for academic and lifelong achievement. By validating and assessing it, the study aimed to determine the workbook's effectiveness, reliability, and flexibility in supporting Mathematics learning.

## STATEMENT OF THE PROBLEM

This study aimed to develop and validate a Reflective Competency-Based Workbook in Mathematics 7 designed to improve the numeracy skills of grade seven learners.

Specifically, it sought answers to the following questions:

1. What are the least mastered numeracy skills of the respondents from the competencies.

1.1 Arithmetic Skills;

1.1.1 Addition,

1.1.2 Subtraction,

1.1.3 Multiplication, and

1.1.4 Division?

1.2 Data Interpretation Skills:

1.2.1 ability to read graphs,

1.2.2 interpret tables,

1.2.3 analyze trends, and

1.2.4 draw conclusions?

2. What is the level of students' proficiency in numeracy skills based on the pretest and posttest scores performance of the respondents in terms of

2.1 Arithmetic Skills;

2.1.1 addition,

2.1.2 subtraction,

2.1.3 multiplication, and

2.1.4 division?

2.2 data interpretation skills:

2.2.1 ability to read graphs,

2.2.2 interpret tables,

2.2.3 analyze trends, and

2.2.4 draw conclusions?



3. How do the experts evaluate the developed workbook in terms of:
  - 3.1 objectives,
  - 3.2 content,
  - 3.3 activities, and
  - 3.4 assessment?
4. What is the level of acceptability of the Reflective Competency-Based Workbook as evaluated by teachers and students in terms of
  - 4.1 adaptability,
  - 4.2 appropriateness,
  - 4.3 consistency,
  - 4.4 usability, and
  - 4.5 aesthetic value?
5. Is there a significant difference between the learners' pretest and posttest Performance in numeracy skills after using the validated workbook?
6. What patterns of reflections can be depicted from the response of the students in the workbook?

**PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA**

*Test of Difference in the Pretest and Posttest Scores of the Respondents in terms of Data Interpretation Skills*

**Paired Sample t-Test Results**

| Data and Interpretation Skills | Test     | Mean | SD   | t     | df | p     |
|--------------------------------|----------|------|------|-------|----|-------|
| Ability to Read Graphs         | Posttest | 8.23 | 1.24 | 8.050 | 34 | <.001 |
|                                | Pretest  | 5.69 | 1.51 |       |    |       |
| Interpret Tables               | Posttest | 7.60 | 1.74 | 3.710 | 34 | <.001 |
|                                | Pretest  | 6.09 | 1.92 |       |    |       |
| Analyze Trends                 | Posttest | 6.63 | 2.10 | 7.830 | 34 | <.001 |
|                                | Pretest  | 3.91 | 1.82 |       |    |       |
| Draw Conclusions               | Posttest | 6.91 | 1.29 | 6.570 | 34 | <.001 |
|                                | Pretest  | 4.71 | 1.66 |       |    |       |

Statistical analyses in Table 24 indicate that statistically significant differences were evident between learners' pre-test and post-test scores in all dimensions of data interpretation (reading graphs, interpreting tables, analyzing trends and drawing conclusions, etc.;  $p < .001$ ). Improved performance based on mean scores across all dimensions of data interpretation demonstrates that after using the Reflective Competency-Based Workbook, learners had developed a greater understanding of how to properly interpret and analyze data, having gone from simply reading the data at the surface level to having a more meaningful interpretation and reasoning regarding the data.

These results support the view that data interpretation requires learners to go beyond simply recognizing value, to include higher-order thinking skills such as analyzing relationships between data, identifying patterns and connections among the data, and applying evidence-based reasoning in drawing conclusions from the data (OECD, 2023).

Among these studies of data literacy, the importance of guided instruction and contextualized learning experiences is further illustrated. Watson & Callingham (2021) found that learners often remain at a superficial level of reading data unless they are explicitly guided to read data at a deeper level. The use of structured activities and reflective practice embedded within the workbook appears to have helped the learners transition from simply observing data to conducting analytical thinking. Gal (2021) found that when learners engage with realistic and relevant data tasks, this provides them with the experience necessary to develop a deeper understanding of how to interpret and analyse data in the future. In addition, the level of improvement observed in all aspects of data interpretation, as shown in the workbook, indicates a strong effect of providing adequate scaffolding and contextually based learning on the ability of learners to produce meaningful and accurate interventional and evidence based conclusions regarding data.

From the results obtained from this study, it can be concluded that using structured reflection and situational-based instruction materials could greatly improve a student's ability to make sense of data. Using scaffolded activities for students to analyze data, which progress from the lowest level of basic data reading to the highest level of logical reasoning, is an effective way for teachers to aid their students in developing their skills for interpreting data. Additionally, an instructional designer should include a focus on the development of students' critical thinking skills and statistical reading abilities through the use of guided



reflection and real-world data problems.

*Themes Generated as to the Patterns of Reflections from the Responses of the Students*

| Themes                                                  | Codes Clustered                                                                                                               | Meaning                                                                                                                                                                                        |
|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Experiencing conceptual and procedural difficulties     | Cognitive challenge in processing mathematical concepts; Confusion with signs and operations; Difficulty following procedures | Students experience various forms of difficulty including confusion with integer rules, sign operations, and multi-step procedures, reflecting both conceptual gaps and procedural breakdowns. |
| Procedural orientation in learning mathematics          | Reliance on memorized rules and procedures; Rule-dependent problem solving; Surface-level strategy use                        | Students rely heavily on memorization and rule-following, suggesting a procedural focus rather than deep conceptual engagement with mathematical ideas.                                        |
| Perceived relevance of mathematics in everyday contexts | Recognition of real-world applicability; Application to financial situations; Use in daily activities and games               | Students connect mathematical concepts to real-life contexts such as money, budgeting, and games, demonstrating awareness of mathematics as a practical tool.                                  |
| Development of metacognitive learning strategies        | Engagement in self-monitoring and verification; Use of checking strategies; Reflective evaluation of answers                  | Students show emerging metacognitive awareness by checking, verifying, and reflecting on their solutions to ensure correctness.                                                                |
| Learning through practice and teacher guidance          | Dependence on guided practice and repetition; Following teacher examples; Practice-driven improvement                         | Students depend on repeated practice and structured guidance from teachers to build understanding and confidence in solving problems.                                                          |
| Developing mathematical understanding                   | Emerging conceptual awareness; Gradual comprehension development; Building confidence in understanding                        | Students exhibit gradual development of understanding as they begin to internalize concepts and gain confidence through experience and reflection.                                             |

This table shows details of the theme reflected in students' reflections on their experiences of learning math, indicating some of the trends and patterns of students' learning math. A recurring theme is the finding of students' confusion relating to their conceptual and procedural difficulties in understanding integer rules, signs, and multistep problems, indicating students are still struggling with the integration of procedural fluency and conceptual awareness. This indicates that students are dealing with foundational issues in math that continue to affect their performance. This idea is aligned with the concept that students' difficulties in math mostly come from poor conceptual foundations rather than isolated computation errors.

Another emerging theme is the procedural focus on learning math, as indicated by the frequent mention of students using memorized rules and following procedures without a complete understanding of the underlying mathematics concepts. The lack of conceptual understanding in the students' learning of math indicates a "surface" approach to math, as students have been taught to apply mathematical methods without fully understanding the concepts behind the procedures. Consequently, this may limit the student's ability to transfer what they learn about math to unfamiliar problems and everyday life situations.

Although students face difficulties in their learning of math, they have begun to see the usefulness of mathematics to their lives through experience and through learning about mathematics. The realization of the relationship between budgeting and financial decision making and mathematics is an example of the connection that students are starting to see between mathematics and other parts of their lives; they are also seeing the relationship of mathematics to games when they are playing those games. It is encouraging to see that students recognize the value of math; this recognition will promote increased enthusiasm and involvement in the study of the subject. The study identified students' use of developing metacognitive strategies in their reflective thinking processes. For example, students who exhibited self-regulated behavior indicated that they checked their answers, confirmed their answers, and reflected on their errors. In addition to developing metacognitive strategies, the research provided evidence to support the view that students will also build independent learning skills through problem-solving. In terms of the predominant theme regarding students' learning practices through teacher support, it was evident from the data collected in this study that the majority of students relied on repetition, representations from outside sources, and the explanations



provided by their teachers to develop an understanding of mathematical concepts. Therefore, it is reasonable to conclude that, in college courses that teach challenging academic disciplines, such as mathematics, the majority of students require structured instruction coupled with guided practice.

Developing students' understanding of mathematics as a conceptual idea reinforces the idea that learning occurs over an extended period through ongoing exposure, reflective thinking, and consistent guided practice; thus, developing an understanding of mathematical concepts is a gradual process requiring continuous effort.

The results suggest that students' difficulties in mathematics are due to conceptual gaps in their knowledge of mathematics, between procedural use of memorization and students' independent reasoning of math. Nonetheless, there are also some counterbalances with students developing emerging metacognitive skills, a newfound appreciation for real-world applications of math, and their incremental understanding of math concepts.

The results of this study imply that instruction in mathematics should not merely be geared toward teaching math as a procedure, but rather needed to be redirected toward building students' conceptual understanding of the principles, developing students' metacognitive understanding of mathematics and its related concepts, and fostering connections between real-life applications of math and the principles learned. Therefore, teachers need to structure their instructional activities to minimize learners' reliance on memorization through the use of reflective activities and guided problem-solving. In addition, they will need to use structured instructional materials such as the Reflective Competency-Based Workbook to assist learners in transitioning from rule-based to meaningful understanding of mathematics and becoming self-regulated problem-solvers.

### Summary of Findings

The purpose of this study was to develop and validate a Reflective Competency-Based Workbook in Mathematics 7, and as a result, refine the numeracy competencies of Grade 7 learners. In this regard, the study aimed to identify the least mastered numeracy skills of Grade 7 learners, evaluate learner's proficiency on a given arithmetic and data interpretation tasks, based on a pretest and posttest, measure the significant difference in the learners' arithmetic and data interpretation skills, and evaluate the workbook and determine its level of acceptability.

The study revealed that the learners had low to average mastery in the numeracy skills of multiplication, division, interpreting tables, analyzing trends, and drawing conclusions. This finding shows that the learners had a combination of procedural and conceptual difficulties in the area of mathematics, particularly in the higher-order thinking skills of data interpretation.

The study indicated a significant improvement in learners' proficiency from pretest to posttest in all arithmetic and data interpretation skills. The improvement from the beginning and developing level to the proficient and advanced level of the learners demonstrates the improvement in learner's understanding and application of the mathematical concepts that was the result of their engagement with the workbook

Expert evaluations indicated that the workbook is highly relevant regarding objectives, content, activities, and assessments, so it fulfills instructional standards.

The workbook's acceptability as evaluated by teachers and students was also reported very much satisfied in all criteria, meaning the workbook is user-centered, fun, and suitable for classroom use.

Additionally, the results of the paired sample t-test showed that there was a statistically significant difference in the pretest and posttest performance of the learners in both arithmetic and data interpretation skills. This confirmed that the improvement in learners' performance was a result of the instructional intervention and not just due to chance.

Furthermore, the reflections of the students indicate that their greatest challenges in mathematics are caused by gaps in understanding and the lack of procedural knowledge, which leads to students relying almost entirely on memorized rules. Nevertheless, the students have begun to grow in terms of their understanding, their ability to reflect on their performance, and their ability to see how mathematics relates to their everyday lives through the use of practice and teacher support.

### CONCLUSIONS

From the data gathered and interpreted, the following conclusions were drawn:

1. Grade 7 students have demonstrated improved numeracy skills through reflective competency-based workbooks and teaching methodology.
2. There are statistically significant differences in grade 7 students' pretest and post-test performance on arithmetic and data interpretation due to the reflective competency-based workbook teaching methodology.
3. Based on the expert validation of target objectives, content activities, and assessment methods included within the framework, the content was relevant and supports the development of both teachers and learners.
4. Both teachers and learners indicated through rating that the reflective competency-based workbook framework was very favorable in terms of adaptability, appropriateness, consistency, usability, and aesthetic appeal.
5. The reflective competency-based workbook framework facilitates students' acquisition of mathematical skills and fosters meaningful and useful learning experiences.

### Recommendations

Based on the conclusions drawn from the study, the following recommendations are proposed:

1. Teachers should be encouraged to use the Reflective Competency-Based Workbook as a supplemental resource to help



learners develop greater competency in numeracy, especially in Arithmetic and Data Interpretation.

2. The school administrators can assist with the ongoing production, distribution, and integration of the workbook into Mathematics 7 as an integral resource for instructional purposes.
3. Schools can hold training sessions, seminars, and workshops for teachers on the creation and use of reflective competency-based instructional resources to better their teaching skills.
4. Students can be supported with additional opportunities for guided practice, reflection, and application of mathematical concepts through real-world situations.
5. Future researchers can validate, enhance, and expand upon the workbook, or create comparable instructional materials for use by additional grade levels and/or subject areas to confirm the continual advancement of Mathematics Education.

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