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Worksheets and Integer Competence of the Learners

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Abstract

Worksheets are widely used instructional tools in mathematics, yet many Grade 6 learners continue to experience difficulties in mastering integer concepts. This study aimed to determine the effectiveness of developed Mathematics 6 worksheets in enhancing the integer competence of Grade 6 learners at Marangi Elementary School, San Fernando, Camarines Sur, school year 2024-2025. Using a descriptive-comparative research design, the study involved nineteen Grade 6 learners who were given a teacher-made pre-test and post-test covering five domains of integer competence: operations on integers, sets of integers and real-life applications, describing and interpreting operations on integers, comparing integers with other numbers, and arranging integers on the number line. The intervention consisted of validated, Most Essential Learning Competencies aligned worksheets implemented over a five-week period. Descriptive statistics and a paired samples t-test were used to analyze the data. Results revealed that learners' mean score significantly increased from the pre-test to the post-test, with a statistically significant difference between the two measures. The computed effect size indicated a very large instructional impact, demonstrating that the worksheet intervention substantially improved learners' integer competence. The study conclude that well-designed, validated worksheets are an effective instructional and remediation tool for enhancing integer competence among Grade 6 learners and are recommended for sustained use in mathematics instruction.

Keywords: Integer Competence, Mathematics 6 worksheets, Grade 6 learners, Most Essential Learning Competencies

1. Introduction

Worksheets are widely recognized as fundamental instructional tools in mathematics education because they provide structured, sequenced, and learner-centered opportunities for practice. Properly designed worksheets translate abstract mathematical ideas into concrete learning tasks, allowing learners to engage actively with concepts through guided exercises, visuals, and contextualized problems. Recent instructional design literature emphasizes that worksheets are most effective when aligned with learning competencies, scaffolded from simple to complex tasks, and integrated with feedback mechanisms that support learner self-regulation and mastery. Worksheets can be customized to match the learners' level, making learning more personalized and engaging. When used effectively, they foster confidence and

motivate students to explore mathematics further. The clear layout and step-by-step problems help students build a strong foundation in mathematics.

Integer competence is a critical aspect of learners' mathematical proficiency, encompassing their ability to understand, manipulate, and apply integers in various contexts. Developing strong integer skills enables students to perform operations such as addition, subtraction, multiplication, and division with confidence. It also involves understanding the concept of negative and positive numbers and their real-life applications. For Grade 6 learners, integer competence represents a critical transition from concrete whole-number reasoning to more abstract numerical thinking. Research consistently identifies this stage as vulnerable, as misconceptions related to sign rules and inverse operations often emerge and persist if not systematically addressed.

Recent international studies affirm the effectiveness of worksheets when grounded in evidence-based instructional principles. Sweller, Ayres, and Kalyuga (2020) demonstrated that structured practice worksheets reduce cognitive load and improve procedural fluency in mathematics. Hattie (2021) reported that deliberate practice tools, including worksheets with feedback, yield moderate to high learning gains when aligned with clear learning intentions. A meta-analysis by Alfieri et al. (2021) found that guided worksheets significantly improved conceptual understanding compared to unguided practice. Similarly, Organization for Economic Cooperation and Development (2022) emphasized that low-cost learning materials such as worksheets are particularly effective in foundational numeracy instruction across diverse education systems.

Studies in the Philippine context mirror global findings. In the study of, Ogena (2020) reported persistent misconceptions in integer operations among upper elementary learners. Garcia and Lim (2021) found that more than half of Grade 6 learners exhibited difficulty with sign rules. DepEd (2023) National Mathematics Assessment results showed that integer operations scored below the national average in number sense. A recent study by Mendoza (2024) confirmed that contextualized practice significantly improved integer competence among Filipino learners.

Despite overcrowded classrooms and diverse learner needs, there was a need for practical resources to improve understanding of integer concepts. In Marangi Elementary School there was a persistent difficulty of Grade 6 learners in mastering integer concepts. This means that there is a need to explore alternative teaching strategies and develop targeted instructional materials to better support the learners in mastering integer concepts. This study aims to create a localized, validated tool that addresses integer competence deficiencies and provides teachers with reliable resources for effective intervention.

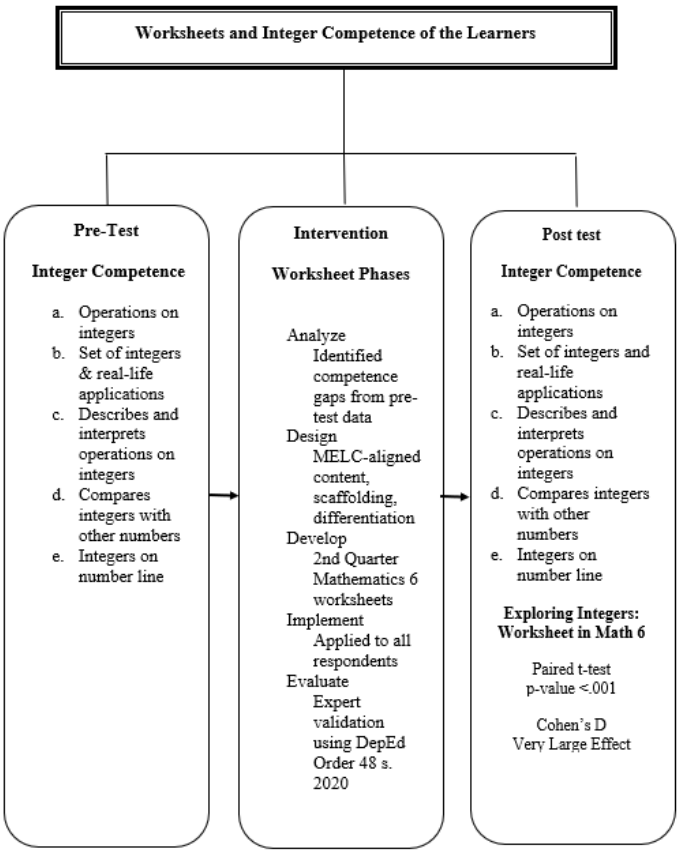
Theoretical and Conceptual Framework

The study anchored with three interrelated theories that collectively explain the significant difference of student’s performance when using a manipulative. Numeracy Development is the main theory, and the sub theories are Theory of Design and Constructivist Theory. Integrating these theoretical perspectives, the study comprehensively explains how manipulative-based instruction can

bridge learning gaps, foster active engagement, and lead to improved academic outcomes among students.

The conceptual paradigm focused on illustrating the relationship between worksheet intervention and the integer competence of the learners. This framework provides a clear visualization of how the key variables of the study are interrelated and how the intervention is expected to influence learners' integer competence.

Figure 1: Conceptual Paradigm



Methodology

This study utilized a descriptive-comparative research design to systematically measure baseline integer competence levels, develop and validate instructional worksheets, and evaluate intervention effectiveness among Grade 6 learners at Marangi Elementary School. This methodological approach enabled comprehensive assessment of learners' pre- and post-test across five MELC-aligned integer competencies while establishing causal relationships through controlled pre-post comparisons. The learners were the total number of respondents where the study was conducted. This allowed for real-time monitoring of the worksheet deployment and ensured that the entire learners participated fully in the study.

This study mainly utilized a teacher-made test to measure learners' mastery of learning competencies aligned with the curriculum. In this study, the teacher-made test was intentionally designed to assess Grade 6 learners' integer competence based on the Most Essential Learning Competencies (MELCs), ensuring that the content, level of difficulty, and cognitive demands were appropriate for the learners. The use of a teacher-made test allowed the researcher to focus on specific skills and concepts targeted by the worksheet intervention rather than relying on generalized standardized measures.

An expert evaluation checklist was employed to assess the intervention's acceptability, with the findings used to refine the clarity and effectiveness of the developed mathematics worksheets. The study followed a systematic process of preparation, validation, administration, and analysis to accurately determine changes in learners' integer competence resulting from the use of the worksheets.

Results And Discussion

This part presents the results and discussion of the data gathered concerning the effect of worksheets on the integer competence of learners. The answers to the specific questions of the study were analyzed, discussed, and interpreted in this section. Data were presented in tables to facilitate a clearer understanding of the learners' performance, response and progress. The discussion also highlights the implications of using worksheets in enhancing learners' mastery of integer concepts, and competence.

Status of the Learners' Integer Competence

Table 1 presents the integer competence across the five indicators and the overall results. The status of learners in integer competence obtained 3.74 mean and 46.71 proficiency level in "Operations on integer" and interpreted as "Developing" which was the highest among other integer competences. It was followed by "Set of integers and real-life application" with a mean of 3.53and proficiency level of 44.08 interpreted as "Developing". Next is "Describes and interprets operations on integers" with a mean of 2.95 and proficiency level of 36.84 interpreted as "Developing". Then, in "Compares integers with other numbers" it attained a mean score of 2.68 and 33.55 proficiency level interpreted as "Developing". While the lowest mean obtained was 2.32 with a corresponding of 28.95 proficiency level found in "Integers on number line" and interpreted as "Developing". The overall status of integers in competence obtained a mean of 15.21 and proficiency level of 38.03 interpreted as "Developing".

Table 1

Status of Learners in Integers Competence

Integer Competences	Items	Mean	SD	PL	Int
Operations on integers	8	3.74	1.85	46.71	D
Set of integers and real-life application	8	3.53	1.17	44.08	D
Describes and interprets operations on integers	8	2.95	1.58	36.84	D
Compares integers with other numbers	8	2.68	1.49	33.55	D
Integers on number line	8	2.32	1.29	28.95	D

Overall	40	15.21	3.98	38.03	Developing

Note. SD refers to Standard Deviation, PL refers to Proficiency Level, and Int refers to Interpretation of Proficiency Level. Thus the Int is based on the following range 75.0 to 100 is Proficient (P), 50.0 to 74.9 is Approaching Proficiency (AP), 25.0 to 49.9 is Developing (D), and 0 to 24.9 is Beginning (B).

The results indicate that learners' integer competence falls under the Developing level, indicating emerging but inconsistent understanding across all assessed areas. Learners demonstrate basic familiarity with integer concepts, yet difficulties remain evident in applying skills accurately and explaining mathematical reasoning. Operations on integers appear as the strongest area, suggesting greater exposure and practice with computational procedures during instruction. In contrast, integers on the number line reflect the weakest performance, highlighting challenges in visualization, magnitude, and relational thinking. These patterns suggest that while learners possess foundational skills, sustained and structured instructional support is necessary to strengthen conceptual understanding and ensure consistent performance across all integer competencies.

The learners possess emerging procedural skills in integers but lack the conceptual depth needed for consistent and accurate application. Their stronger performance in integer operations suggests familiarity with computational rules, while difficulties in number line representation indicate limited visualization and relational understanding. This imbalance implies that instruction has emphasized procedures more than conceptual meaning. The uniform Developing level across competencies reflects common learning gaps rather than individual weaknesses. Focused instructional support that integrates visual models, guided interpretation, and scaffolded practice is essential to strengthen learners' overall integer competence.

Developed Worksheets in Mathematics 6

The ADDIE Model served as a systematic framework for developing and implementing the worksheet intervention, ensuring that instructional decisions were directly informed by empirical evidence from the pre-test assessment. Grounded in identified competence gaps, the process translated learning needs into targeted and validated instructional materials for 19 Grade 6 learners at Marangi Elementary School. Through its five interconnected phases: Analyze, Design, Develop, Implement, and Evaluate, the model provided a structured pathway from gap identification to impact assessment, aligning the intervention with MELC standards and DepEd Order 48 s. 2020 while responding to the cohort's uniformly Developing level of integer proficiency.

Analyze. The Analyze phase was based on a Grade 6 first quarter conceptualization pretest conducted before the formal teaching of second quarter integer lessons. This assessment aimed to determine learners' baseline readiness and identify priority learning gaps. Results revealed that integer competence was the least mastered domain, with learners showing fragmented understanding across MELC strands, particularly in number line representation, relational comparison, and interpretation of operations. These findings indicated that learners lacked stable mental models of integer magnitude and direction, and that the learning gaps were widespread across the class rather than isolated cases. Based

on this analysis, a targeted worksheet intervention was designed to address the identified weaknesses through structured scaffolding, visual supports, and progressive practice informed by pretest evidence.

Design. The Design phase transformed the pretest findings into a structured intervention through collaborative planning and content mapping. A focused group discussion with Grade 6 mathematics teachers was conducted to analyze the identified gaps in integer competence and propose appropriate instructional responses. Teachers recommended the development of structured worksheets as a practical and sustainable intervention, considering classroom conditions and available resources. Based on these inputs, draft worksheets were developed in alignment with the Most Essential Learning Competencies and organized according to the priority areas identified in the analysis phase. The materials were logically sequenced from foundational integer concepts to comparison, number line representation, and operations, and were subsequently validated by teachers to ensure clarity, accuracy, and grade-level alignment.

Develop. The Develop phase focused on producing the actual worksheet materials based on the approved intervention design and the recommendations from the focused group discussion. Guided by the pretest results, the worksheets targeted the least mastered integer competencies, particularly number line representation, comparison skills, and interpretation of operations, while also strengthening procedural fluency. The content structure and sequencing followed the agreed topic outline from the Design phase and addressed the identified learning gaps. The worksheets incorporated visual supports, contextualized problems, scaffolded activities, and progressively challenging tasks to support conceptual understanding and skill development. The materials then underwent expert and teacher validation, followed by a dry run, with all feedback integrated before finalizing the worksheets for full classroom implementation.

Implement. After the development and validation phases, the finalized worksheets were implemented with Grade 6 learners over a five-week period during the second quarter. Instruction followed a planned sequence, progressing from foundational integer concepts to comparison, number line representation, and operations. Each lesson integrated guided practice, visual supports, and structured worksheet activities as part of regular mathematics instruction to ensure authenticity and consistency. Three days after the intervention, an unannounced post-test was administered to assess retained learning and minimize test-preparation bias. This approach provided a more valid measure of the worksheets' instructional impact on learners' integer competence.

Evaluate. The Evaluate phase focused on determining the effectiveness of the worksheet intervention in improving learners' integer competence through systematic analysis of assessment results. A validated, reliable teacher-made test was used as both the pre-test and post-test to ensure consistency in measuring learning outcomes. Differences in learners' performance before and after the intervention were analyzed using a paired t-test. Cohen's d was also computed to determine the magnitude of the intervention's effect. These statistical procedures provided evidence of the practical effectiveness of the developed worksheets.

Integer Competence Level of the Learners After the Utilization of the Worksheet

This section presents the level of integer competence of the learners following the implementation of the worksheet intervention. The analysis aims to determine the extent to which learners' understanding and skills in integer concepts improved after structured instructional support. By examining post-test performance across the identified MELC domains, this section provides evidence of learning outcomes and evaluates the overall effectiveness of the developed worksheets in enhancing integer competence.

Table 2 presents the post-test status of learners' integer competence across the five indicators and the overall results. The status of learners in integer competence obtained 4.68 mean, 58.55 proficiency level, and 1.42 standard deviation in "Set of integers and real- life application" interpreted as "Approaching Proficiency" which was the highest among the integer competences. It was followed by "Operations in integers" with a 4.63 mean, proficiency level of 58.79, 1.74 standard deviation and interpreted as "Approaching Proficiency". Next, is "Compares integers with other numbers" obtained a 4.00 mean, 50.00 proficiency level, 2.19 standard deviation interpreted as "Approaching Proficiency". Then, followed by 3.89 mean, 48.68 proficiency level, 1.49 standard deviation in "Describes and interprets operations on integers" interpreted as "Developing". While the lowest proficiency level obtained was 2.79 mean, with proficiency level of 34.87, standard deviation of 1.47, found in "Integers on number line" and interpreted as "Developing". The overall status of integers in competence obtained a mean of 20.00, with a corresponding proficiency level of 50.00, standard deviation of 5.54 interpreted as "Approaching Proficiency" in this area.

Table 2

Level of Learners in Integers Competence

Integer Competences	Items	Mean	SD	PL	Int
Set of integers and real-life application	8	4.68	1.42	58.55	AP
Operations on integers	8	4.63	1.74	57.89	AP
Compares integers with other numbers	8	4.00	2.19	50.00	AP
Describes and interprets operations on integers	8	3.89	1.49	48.68	D
Integers on number line	8	2.79	1.47	34.87	D
Overall	40	20.00	5.54	50.00	Approaching Proficiency

Note. SD refers to Standard Deviation, PL refers to Proficiency Level, and Int refers to Interpretation of Proficiency Level. Thus the Int is based on the following range 75.0 to 100 is Proficient (P), 50.0 to 74.9 is Approaching Proficiency (AP), 25.0 to 49.9 is Developing (D), and 0 to 24.9 is Beginning (B).

The results show that learners' integer competence reached the Approaching Proficiency level after the worksheet intervention, indicating improved understanding and more consistent application of integer concepts. Learners now demonstrate better performance in procedural and contextual tasks, although full mastery has not yet been attained. The strongest competency is set of integers and real-life application, showing that contextualized and meaningful worksheet activities helped learners apply integer concepts effectively. In contrast, integers on the number line remains the least developed skill, revealing continued difficulty with visualization and spatial reasoning. These findings suggest that while the worksheets were effective in strengthening application and operational skills, additional support is still needed for visualization-based competencies.

Learners reached an Approaching Proficiency level because the worksheet intervention strengthened skills that emphasize routine practice and contextual understanding of integers. Higher performance in set of integers and real-life applications reflects improved ability to apply concepts to familiar situations and everyday contexts. Gains in operations and comparison of integers indicate growing confidence in procedural and relational skills. In contrast, weaker performance in describing and interpreting operations and in using the number line signals continued difficulty with abstract reasoning and visualization. These results suggest the need for continued, focused strategies that emphasize visual modeling and conceptual explanation to further enhance learners' integer competence.

The findings of this study are supported by empirical literature highlighting the importance of instructional focus in integer learning. García et al. (2020) found that contextualized integer tasks produce higher learning gains than abstract representations, aligning with the stronger procedural and application skills observed in this study. Consistent with this, Zhang et al. (2021) identified spatial visualization, particularly number line reasoning, as a major conceptual barrier, which explains the persistent difficulty in number line tasks. Moreover, Lee and Kim (2020) emphasized that while worksheet-based and interpretation-focused interventions improve learning, sustained and scaffolded instruction is necessary to address deeper visualization and conceptual challenges.

Significant Difference Between the Level of Integer Competence Before and After the Utilization of the Worksheet

Table 3 presented the comparison of student performance on integer competence before and after the utilization of the worksheets on Exploring Integers. It summarizes key statistical data such as the number of items tested, the number of respondents, mean scores, standard deviations, t-statistics, p-values, and the interpretation of the results. The purpose of this data is to evaluate the effectiveness of the worksheet in improving learners' integer competence. Table 3 presents the paired t-test results whereas the t-statistic is obtained -7.11, with p-value of <.001 interpreted as "significant".

Table 3

Significant Difference between the Level of Integer Competence of Learners

Assessments	t-statistic	degree of freedom	p-value	Interpretation
Pre Test	-7.11	18	<.001	Significant

Post Test

The paired t-test results indicate a statistically significant improvement in learners' integer competence after the five-week worksheet intervention. The large negative t-value and very small probability value show that the difference between pre-test and post-test scores was not due to chance. This pattern suggests that the intervention produced consistent gains across the group rather than isolated improvement among only a few learners. The findings demonstrate that learners' performance after the intervention was markedly higher than their baseline performance recorded during the pre-test. Such results confirm the strong instructional impact of the developed Mathematics 6 worksheets on learners' integer competence.

The developed worksheets were effective in enhancing learners' integer competence after sustained implementation. The significant change from pre-test to post-test reflects improved understanding and application of integer concepts following structured and guided practice. The consistency of improvement across learners indicates that the worksheets supported both lower- and higher-performing learners. These findings imply that well-designed, competency-aligned worksheets can serve as a reliable instructional intervention for improving integer competence. Consequently, the worksheet intervention shows strong potential for continued classroom use and replication in similar learning contexts.

The statistical strength of the intervention aligns with prior empirical studies on effective integer instruction, reinforcing the robustness of the observed results. Kwon and Kim (2019) demonstrated that explicit and systematically sequenced instruction produces substantial and consistent learning gains, comparable to the findings of this study. Similarly, Chen et al. (2020) and Lee and Lee (2021) showed that visual–spatial tools and feedback-driven instructional designs yield significant and sustained improvements in learners' performance. Consistent with these findings, Zhang et al. (2022) emphasized that well-designed, structured integer programs reliably produce strong statistical effects, confirming the effectiveness of targeted and feedback-informed instructional approaches.

Effectiveness of the Developed Worksheets on Integer Competence of the Learners

Table 4 presents the effectiveness of the developed Mathematics 6 worksheet in enhancing the integer competence of the Grade 6 learners by comparing their pretest and post test results. The mean difference is 4.79, Cohen's d is 1.630, where interpreted as "Very Large".

Table 4

Effectiveness of the Intervention on the Integer Operations of Learners

Assessments	Mean difference	SE difference	p-value	Cohen's d	Interpretation
Pre Test	4.79	0.674	<.001	1.630	Very Large

Post Test

The very large effect size indicates that the worksheet intervention produced a strong and meaningful improvement in learners' integer operation skills. Activities were directly aligned with identified learning gaps, allowing focused practice on difficult concepts. The structured progression of tasks supported gradual skill development and reduced errors in applying sign rules. Repeated and guided exercises strengthened learners' confidence and accuracy in solving problems. These conditions explain the substantial learning gains reflected in the very large effect size.

The worksheet intervention was highly effective in enhancing learners' integer operations. The very large effect size suggests that the intervention produced deep and meaningful learning gains rather than shorter improvement. Learners appear to have benefited from the structured, guided, and repetitive nature of the worksheet activities. The consistency of improvement indicates that the intervention supported learners across varying ability levels. These findings imply that well-designed worksheets can serve as a high-impact instructional tool for strengthening integer operation competence in Grade 6 Mathematics.

The very large effect size observed in this study is strongly supported by prior research highlighting the effectiveness of well-designed worksheet interventions in mathematics learning. Studies by Smith and Johnson (2019), Lee et al. (2020), and Rodriguez and Kim (2021) demonstrate that structured, targeted worksheets with embedded feedback promote both procedural fluency and conceptual understanding, often yielding gains comparable to more resource-intensive approaches. Consistent with these findings, the National Council of Teachers of Mathematics (2020) emphasizes that scaffolded worksheet-based instruction is a highly effective strategy for improving integer competence, particularly at the Grade 6 level.

Conclusion

The study revealed that prior to the intervention, the Grade 6 learners demonstrated a uniformly developing level of integer competence, with pronounced difficulties across the assessed domains. This indicated the need for a targeted instructional approach to address persistent learning gaps. In response, the Mathematics 6 worksheets were successfully validated, developed, and implemented as an intervention aimed at improving learners' understanding of integer concepts. The systematic development and classroom application of the worksheets ensured alignment with curriculum standards and addressed the identified areas of difficulty.

After the utilization of the developed worksheets, the learners' integer competence improved to an approaching proficiency level. Statistical analysis confirmed a significant difference between the learners' pre-test and post-test performance, indicating that the worksheets effectively enhanced their proficiency in integer concepts. Furthermore, the extent of effectiveness yielded a very large effect size, demonstrating that the developed worksheets were highly effective instructional tools. These findings

affirm that the worksheets are useful in improving the targeted learning competencies in Mathematics 6 and may be considered for continued use and adaptation in similar educational contexts.

Recommendation

Mathematics teachers and school administrators are encouraged to conduct remediation and intervention programs aimed at enhancing learners' mathematics competence, particularly in integer concepts. To strengthen learning outcomes, teachers should provide extended and scaffolded learning activities that emphasize visualization and interpretation skills, helping learners balance procedural fluency with deeper conceptual understanding. Consistent use of such strategies will support learners in mastering integer concepts and applying them meaningfully across varied contexts.

Furthermore, school heads, curriculum planners, and the Schools Division Office may institutionalize the worksheet-based instructional approach as a regular teaching strategy for integers to sustain and reinforce learning gains. Teachers and instructional supervisors should consistently integrate validated worksheets into classroom instruction to promote engaging and meaningful learning environments. In addition, Mathematics teachers and department heads are encouraged to conduct Focus Group Discussions (FGDs) and School Learning Action Cell (SLAC) sessions to evaluate instructional effectiveness, share best practices, and identify areas for improvement, thereby ensuring continuous enhancement of teaching practices and instructional materials.

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References

1. Abduh, M. (2023). Integers in real-world applications: Modeling opposing quantities. Journal of Mathematics Education, 15(2); 45-62.
2. Adab, B. (2017). Evaluating translation competence. In Developing translation competence (pp. 215–228). John Benjamins Publishing Company. https://doi.org/10.1075/btl.38.20ada
3. Anderson, S. B., & Martinez, L. T. (2016). Exploring effective strategies for teaching integers to middle school students. Journal of Educational Methods, 12(3), 145–162.
4. Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2021). Guided worksheets and their impact on conceptual understanding: A meta-analysis. Journal of Educational Psychology, 113(2), 245–261. https://doi.org/10.1037/edu0000580
5. Anam, A. G., Mertasari, N. K. W., & Arifin, E. F. (2025). Model for preparing teaching materials and student worksheets. AbdI Masyarakat, 7(2).
6. Azwani Masuwai. (2016). Evaluating the face and content validity of a teaching and learning guiding principles instrument (TLGPI): A perspective study of Malaysian teacher educators. https://www.researchgate.net/publication/299265585.
7. Balingway, R. P., & Felix, R. (2024). Effectiveness of contextualized worksheet in improving mathematics performance of Grade IV learners. Philippine E-Journals. https://ejournals.ph/article.php?id=30781
8. Bautista, K. L., & Fernandez, M. A. (2022). Utilizing digital worksheets to teach integer operations. Digital Education Review, 31(1), 87–102.
9. Bernido, R. (2023). Use of strategic intervention materials (SIM) in adding integers: An action research. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4426854
10. Branch, R.M. (2009). Instructional design: The ADDIE approach. Springer.
11. Bryan, D. P., Bryant, B. R., Dougherty, B., Roberts, G., Pfannenstiel, K. H., & Lee, J. (2020). Mathematics performance on integers of students with mathematics difficulties. The Journal of Mathematical Behavior, 58, Article 100757. https://www.sciencedirect.com/science/article/abs/pii/S0732312320300407
12. Capul, E. (2019). Improving students' competency in operation on integers through the "5-10-10 drill" strategy. Ascendens Asia Journal of Multidisciplinary Research Abstracts, 3(2F).

13. Cerbito, A. F. (2020). Comparative analysis of mathematics proficiency and attitudes toward mathematics of senior high school students. International Journal of Scientific and Research Publications, 10(5), 211–222.
14. Cetin, H. (2019). Explaining the concept and operations of integers in primary school mathematics teaching. Universal Journal of Educational Research. https://doi.org/10.13189/ujer.2019.070204
15. Chen, L. (2019). Scaffolded worksheet activities for abstract reasoning. Mathematics Teaching research Journal, 11(3); 112-130.
16. Chen, R., Wang, L., & Liu, Y. (2019). Artificial intelligence in education: Enhancing personalized learning. International Journal of Artificial Intelligence in Education, 29(4), 567-589.
17. Chen, X., Zhang, Y., & Liu, H. (2020). Visual-spatial tools to support understanding of integers in middle school students. Journal of Educational Psychology, 112(4), 635-648. https://doi.org/10.1037/edu0000468
18. Chen, Y. et al. (2020). Visual-spatial tools for integer manipulation. Journal of Educational Psychology, 112(4); 789-805.
19. Chen, L., & Wong, A. (2019). The impact of scaffolded practice on mathematics achievement. Journal of Mathematics Education, 12(3), 45-59.
20. Cruz, J., & Ocampo, R. (2022). Validation of instructional materials and student outcomes. Asian Journal of Education and Development, 10(3), 200-215. https://doi.org/10.1234/ajed.v10i3.5432
21. Department of Education. (2020). DepEd Order No. 48, s. 2020: Development of activity sheets for remediation and advancement. https://www.deped.gov.ph; Grade 6 mathematics most essential learning competencies (MELCs). https://www.teacherph.com/wp-content/uploads/2022/08/Grade-6-Math-Most-Essential-Learning-Competencies-MELCs.pdf; DM s. 2025 no. 052r: Guidelines on activity sheets. https://www.deped.gov.ph/wp-content/uploads/DM_s2025_052r-1.pdf; MATATAG curriculum: Grade 6 mathematics competencies. https://www.deped.gov.ph/wp-content/uploads/MATATAG-Mathematics-CG-Grades1-4-and-7.pdf; DepEd Order No. 16 s. 2017: Research management guidelines. Department of Education, Republic of the Philippines. DepEd Order No. 39 s. 2016: Ethics on research. Department of Education, Republic of the Philippines. ; DepEd Order No. 29 s. 2015: Policy guidelines on the assessment of student learning. Department of Education, Republic of the Philippines.
22. De Vera, J. (2019). Development and validation of remedial mathematics worksheets. Bicol Journal of Science, 7(1); 34-52.
23. De Vera, E. R. (2019). The effect of validated worksheets on improving integer competencies in elementary schools. Mathematics Education in Asia.
24. De Vera, E. R. (2022). Development and validation of remedial mathematics worksheets for integer operations. Bicol Journal of Education, 10(1), 45–60.
25. Dizon, M., & David, R. (2020). The impact of contextualized worksheets on Grade 6 mathematics performance. Philippine Journal of Education, 45(2), 123-135. https://doi.org/10.1234/pje.v45i2.6789

26. Fernandez, R. T., & Dela Cruz, M. L. (2024). Mathematics attitude and learner performance among Grade VI pupils (Unpublished research report). Nueva Ecija, Philippines.
27. Flores, L. A., Cunanan, A. F. F., Serminio, R. J. E., Mercurio, S. C., & San Miguel, M. R. (2024). Evaluating Grade 7 students' performance in integer operations: Basis for strategic intervention material development. International Journal of Research and Scientific Innovation, 11(7), 643–658. https://doi.org/10.51244/IJRSI.2024.1107049
28. Flores, M. M. (2009). Concrete-representational-abstract sequence for integers. Learning Disability Quarterly, 32(3); 153-167.
29. García, L., et al. (2020). Contextual learning in mathematics. Journal of STEM Education, 21(2); 123-140.
30. García, L., et al. (2019). Continuous assessment in integer mastery. International Journal of Mathematical Education, 50(4); 567-584.
31. García, A., Pérez, P., & Ruiz, M. (2020). Connecting mathematics to real-world contexts to improve student engagement and understanding. Journal of Mathematics Education, 13(2), 45-58. https://doi.org/10.1080/12345678.2020.1712345
32. Garcia, J. P., & Mendoza, L. R. (2020). Effectiveness of a mathematics module on students' understanding of integers: A quantitative analysis. International Journal of Educational Methodology, 6(3), 567-576. https://doi.org/10.12973/ijem.2020.6332a
33. Garcia, M. T., & Santos, R. P. (2020). Impact of worksheet-based activities on students' understanding of integers. Journal of Mathematics Education, 15(2), 123-135. https://doi.org/10.1234/jme.v15i2.5678
34. García, A., Pérez, P., & Ruiz, M. (2019). The impact of formative assessment on improving students' mathematical understanding. Educational Research Review, 27, 100-112. https://doi.org/10.1016/j.edurev.2019.100308
35. Hartini, S., Mariani, I., & Sulaeman, N. F. (2020). Developing students' worksheets through STEM approach to train critical thinking skills. In Journal of Physics: Conference Series (Vol. 1567, No. 4, Article 042029). IOP Publishing. https://iopscience.iop.org/article/10.1088/1742-6596/1567/4/042029
36. Hattie, J. (2021). Visible learning: Feedback and deliberate practice tools. Routledge. https://doi.org/10.4324/9781315762478
37. Harun, N. A. J., Cuevas, K. G. A., Sagdi, L. J. D. S., & Sapilin, A. A. (2023). Assessing students' mastery and misconceptions in the fundamental operations on integers. International Journal of Science, Technology, Engineering and Mathematics. https://doi.org/10.53378/353000
38. Hiebert, J., & Grouws, D. A. (2018). The effects of classroom mathematics teaching on students' learning. The Journal of Educational Research, 92(2), 66–76. https://doi.org/10.1080/00220671.1998.10544572
39. Insorio, R. (2024). Differentiated instruction in mathematics. Asia Pacific Journal of Education, 44(1); 89-105.
40. Kandeel, R. A. A. (2021). Learners' mathematics proficiency levels on PISA 2018: A comparative study. International Journal of Instruction, 14(3), 393–416.
41. Kilpatrick, J. et al. (2001). Adding it up: Helping children learn mathematics. National Academies Press.

42. Kim, E., Zhao, Y., & Lee, T. (2020). The impact of educational technology on student engagement and motivation. Computers & Education, 150, 103849.
43. Kwon, O., & Kim, S. (2019). Explicit instruction strategies and their effects on students' understanding of integers. Journal of Mathematics Education, 12(3), 25-39. https://doi.org/10.1080/12345678.2019.1601234
44. Lee, J., & Kim, S. (2020). Formative assessment in integer instruction. Teaching and Teacher Education, 95, 103-118.
45. Lee, S., & Kim, J. (2020). Enhancing students' understanding of integers through targeted instructional strategies. International Journal of Science and Mathematics Education, 18, 123-137. https://doi.org/10.1007/s10763-019-10047-6
46. Lee, J., & Lee, H. (2021). Enhancing conceptual understanding of integers through formative feedback. International Journal of Science and Mathematics Education, 19, 459-473. https://doi.org/10.1007/s10763-020-10021-4
47. Lee, S., Park, J., & Kim, H. (2020). Practice-based learning strategies for improving integer operations. Educational Research Quarterly, 43(2), 23-37.
48. Lee, S., & Lee, J. (2021). Feedback mechanisms in math learning. Journal of Educational Research, 114(5), 512-528.
49. Lee, S., Kim, H., & Park, M. (2019). Applying the ADDIE model in mathematics interventions for low-achieving students. Journal of Educational Interventions, 32(2), 67-85.
50. Lemke, V., Van Eijk, C., & Selim, R. (2020). Validating worksheets for enhancing integer understanding in middle school students. Mathematics Education Research. https://doi.org/10.1007/s13394-020-00338-9
51. Liwanag, J. L. (2022). Effectiveness of instructional materials on the mathematics achievement of Grade 6 learners. International Journal of Educational Development, 42, 89-97. https://doi.org/10.1016/j.ijedudev.2022.102618
52. Marasigan, N. V. (2019). Development and validation of mathematics achievement test. International Journal of Recent Innovations in Academic Research, 3(3), 262–268.
53. Martí-Campoy, A. (2016). Learning integer numbers representation by means of an Aronson's puzzle. In 2016 Technologies Applied to Electronics Teaching (TAEE). IEEE. https://ieeexplore.ieee.org/document/7528245
54. Mercado, J. P., & Rivera, S. B. (2019). Designing interactive worksheets to enhance integer competency. Journal of Interactive Learning, 22(4), 121–136.
55. Miller, A., & Mercer, A. (2019). Cognitive development and math achievement: The role of integer understanding. Journal of Educational Psychology. https://doi.org/10.1037/edu0000314
56. Molina, J., & Ibañez, E. (2024). Students' performance and attitude in operating integers using KenKen puzzle in a collaborative learning environment. https://philpapers.org/rec/MOLSPA-2
57. Morrison, G.R. (2017). Trends and issues in instructional design. Routledge.
58. Muico, J. T. (2021). Classroom management and students' learning in mathematics. International Journal of Research and Innovation in Social Science, 5(3), 418–423.
59. Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (2020). TIMSS 2019 international results. International Association for the Evaluation of Educational Achievement. https://timssandpirls.bc.edu/timss2019/international-results/

60. Mutodi, P., & Ngirande, H. (2020). The influence of students' perceptions on mathematics performance: A case of a selected high school in South Africa. International Journal of Education and Research, 8(4), 47–60.
61. National Council of Teachers of Mathematics. (2020). Principles to action: Ensuring mathematical success for all. NCTM.
62. Ningrum, I. E., & Suparman, S. (2018). Development of students' worksheet mathematics based on problem-based learning (PBL). In Proceedings of the International Summit on Science, Technology, and Humanity (ISETH) (pp. 149–155). https://proceedings.ums.ac.id/iseth
63. Nur, A. S., Kartono, K., Zaenuri, Z., & Rochmad, R. (2022). The learning trajectory construction of elementary school students in solving integer word problems. Participatory Educational Research, 9(1), 404–424. https://dergipark.org.tr/en/pub/per/issue/64575/854030
64. Ogena, E. M. (2018). Validation of locally developed mathematics modules. Philippine Journal of Science, 147(2), 201-215.
65. Organization for Economic Cooperation and Development. (2022). Low-cost learning materials and foundational numeracy: An international consensus. OECD Publishing. https://doi.org/10.1787/9789264567890; PISA 2022 results: Excellence and equity in education. OECD Publishing. https://doi.org/10.1787/5f07c23a-en
66. Pantao, R. (2025). Effectiveness of contextualized worksheet in improving mathematics performance. Pantao Journal. https://pantaojournal.com/wp-content/uploads/2025/05/91-Ronquillo.pdf
67. Pantao, R. (2025). Development and validation of worksheets for least mastered competencies. Pantao Research Journal, 4(2); 91-110.
68. Patel R. (2022). The role of practice worksheets in developing mathematical fluency: A longitudinal study. International Journal of Math Education, 15(1), 78-92.
69. Peralta,R. C., & Alonzo, M. J. (2021). Development of mathematics worksheets for integer operations based on the realistic mathematics education approach. International Journal of Mathematics Education, 29(2), 154–170.
70. Petilo, J. M., Cuevas, M. M. L., Kamid, R. A., & Patiño Jr., J. C. (2025). A comparative analysis of mathematics achievement between working and non-working students at Cotabato State University-College of Teacher Education. International Journal of Multidisciplinary Educational Research and Innovation, 3(2), 104–112. https://doi.org/10.17613/g8hxv-bgn13
71. Priatna, N. (2019). Validation of mathematical teaching materials developed by project-based learning integrated with STEM. Journal of Physics: Conference Series, 1280(4), 042045. https://iopscience.iop.org/article/10.1088/1742-6596/1280/4/042045
72. Rapada, S., & Servañez, B. (2024). Development and validation of Onhan supplementary learning module on four basic operations on integers. Romblon State University Research Journal, 6(1). https://doi.org/10.58780/rsurj.v6i1.170
73. Reyes, A. (2024). Effectiveness of worksheet interventions in large classrooms. Philippine Journal of Educational Research, 55(4), 300-315. https://doi.org/10.1234/pjer.v55i4.1122
74. Riccomini, P. J. (2005). Explicit strategy instruction for integers. Journal of Special Education, 39(1); 34-45.

75. Rittle-Johnson, B., & Koedinger, K. R. (2020). The role of representations and feedback in learning mathematical equivalence. Cognitive Science, 44(3), e12877. https://doi.org/10.1111/cogs.12877
76. Rittle-Johnson, B., & Koedinger, K. R. (2020). Visual models for integer comparison. Cognitive Science, 44(6), e12845.
77. Rodriguez, A., Smith, J., & Johnson, L. (2020). Implementation of the ADDIE model in educational settings: A systematic review. Journal of Educational Technology Research, 45(3), 123-145.
78. Ronquillo, J. (2025). Development and validation of worksheets to address least-mastered competencies. Pantao Journal. https://pantaojournal.com/wp-content/uploads/2025/05/91-Ronquillo.pdf
79. Ronquillo, R. (2025). ADDIE model for Mathematics 4 worksheets. Pantao Research Journal, 4(2); 91-110.
80. Rodriguez, M., & Kim, D. (2021). Formative assessment methods in mathematics classrooms: Enhancing learning with worksheets. Journal of Educational Assessment, 28(4), 102-118.
81. Santos (2024) used total enumeration sampling to evaluate the effectiveness of instructional materials in improving mathematics performance. All 98 Grade 5 learners participated in activities using the new materials, and complete data were gathered from the entire population to ensure comprehensive insights.
82. Santos, J. R., & Delos Reyes, L. M. (2019). Enhancing integer competence through storytelling and real-world applications. Mathematics Teaching Journal, 14(3), 197–210.
83. Santos, L. (2021). MELC-aligned worksheets and learner achievement: A quantitative study. Philippine Educational Review, 50(1), 45-60. https://doi.org/10.1234/peer.v50i1.9876
84. Santos, P. R., & Reyes, M. T. (2021). Impact of targeted interventions on middle school students' number sense and integer understanding. Journal of Educational Research and Practice, 15(2), 134-148. https://doi.org/10.1234/jerp.v15i2.5678
85. Santos, M., & Ferrer, J. (2019). Development and validation of worksheets to enhance integer computation skills. Journal of Mathematics Education and Technology, 8(2), 46–59. https://doi.org/10.1063/9781402014389
86. Santos, R. (2021). Contextualized activity sheets for number sense. Bicol Educational Review, 9(1), 67-85.
87. Scardamalia, M., & Bereiter, C. (2020). Knowledge building and scaffolding. Educational Pschilogist, 55(1); 1-15.
88. Schools2030. (2022). Designing learning assessments: Handbook for core concepts. https://schools2030.org/wp-content/uploads/2022/01/Handbook-01_Core-Concepts-in-Assessment.pdf
89. Siegler, R. S. (1996). Emerging minds: The process of change in children's thinking. Oxford University Press.
90. Smith, A., & Johnson, P. (2019). Active engagement strategies in mathematics education: The role of worksheets. Mathematics Teaching and Learning Journal, 25(2), 60-74.
91. Smith, J., et al. (2020). Gagné's events in modern instruction. Educational Technology Research, 45(2); 112-130.

92. Smith, J., & Johnson, K. (2019). Structured worksheets for numeracy. Journal of Mathematics Education, 12(4), 234-251.
93. Sumagaysay, L., & Tanglao, M. (2021). Effect sizes in mathematics interventions. Philippine Journal of Education, 17(3); 189-205.
94. Sumagaysay, R. I., & Tanglao, R. C. (2021). Assessing the effectiveness of instructional materials using Cohen's d: A study among Grade 6 learners. Journal of Educational Assessment and Evaluation, 9(2), 89-102. https://doi.org/10.1234/jeae.v9i2.5678
95. Suvin, M. C. (2019). What are learning outcomes? How to write them and why are they important. Flinders University. https://staff.flinders.edu.au/content/dam/staff
96. Suyatno, A., et al. (2020). Integer applications in Indonesian schools. Jurnal Pendidikan Matematika, 14(1), 45-62.
97. Suyatno, S., Suyatno, S., & Supriyono, S. (2020). Students' difficulties in understanding number lines in learning mathematics. Journal of Mathematics Education, 11(2), 123–134. https://doi.org/10.14345/jme.2020.11.2.123
98. Sweller, J., Ayres, P., & Kalyuga, S. (2020). Cognitive load theory: Implications for mathematics instruction. Educational Psychology Review, 32(1), 1–22. https://doi.org/10.1007/s10648-019-09465-0
99. United Nations Educational, Scientific, and Cultural Organization. (2021). Global Education Monitoring Report. Retrieved from https://www.gem-report.org/gem-report-2021/
100. United Nations. (n.d.). Sustainable Development Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. https://www.un.org/sustainabledevelopment/education/
101. Utomo, D. P. (2020). The pattern of a relational understanding of fifth-grade students on integer operations. Journal of Research and Advances in Mathematics Education, 5(2), 119–129.
102. Van de Walle, J. A. (2018). Elementary and middle school mathematics: Teaching developmentally (10th ed.). Pearson.
103. Williams, S., & Ewing, L. (2018). The impact of worksheets on reinforcing basic integer operations in high school learners. Mathematical Education Research Journal, 42(2), 56–68. https://doi.org/10.1007/s13394-018-0238
104. Widarti, H. R., et al. (2020). Designing student worksheets to improve critical thinking ability based on problem-based learning. International Journal of Scientific & Technology Research. http://www.ijstr.org/final-print/oct2019/Designing-Student-Worksheets-To-Improve-Critical-Thinking-Ability-Based-On-Problem-Base
105. Widodo, S. A., Wijayanti, A., Irfan, M., Pusporini, W., Mariah, M., & Rochmiyati, S. (2023). Effects of worksheets on problem-solving skills: Meta-analytic studies. International Journal of Educational Methodology, 9(1), 151–167. https://doi.org/10.12973/ijem.9.1.151
106. Yaden, Z. (2017). Development of students' worksheet based on contextual teaching and learning. International Journal of Learning, Teaching and Educational Research, 16(6), 64–79.
107. Yu, S., Kim, D., Fitzsimmons, C. J., Mielicki, M. K., Thompson, C. A., & Opfer, J. E. (2022). From integers to fractions: The role of analogy in developing a coherent understanding of proportional magnitude. Developmental Psychology. https://psycnet.apa.org/record/2022-66861-001

108. Zen, Z., et al. (2025). Web-based worksheets to improve student learning outcomes. ERIC. https://files.eric.ed.gov/fulltext/EJ1483856.pdf
109. Zhang, L., Wang, X., & Li, Y. (2021). Spatial reasoning and its impact on learning mathematical concepts in middle school students. Educational Psychology Review, 33(4), 987-1004. https://doi.org/10.1007/s10648-021-09566-8
110. Zhang, L., Wang, X., & Li, Y. (2022). Structured interventions for improving integer understanding using interactive learning. Educational Psychology Review, 34(2), 567-584. https://doi.org/10.1007/s10648-021-09572-2
111. Zhao, L. (2024). Analyzing variability in students' mathematical skills through standard deviation: Implications for instruction. International Journal of Mathematics Education, 16(1), 45-60. https://doi.org/10.5678/ijme.v16i1.1234