ISSN (online): 2094-9030

Studies in Technology and Education

Volume 5, Issue 3, 2026 | https://www.azalpub.com/index.php/ste

OPEN ACCESS

RESEARCH ARTICLE

DEVELOPMENT AND VALIDATION OF A MATH MANIPULATIVES INSTRUCTIONAL MATERIAL FOR GRADE 5

Article Info

Received: 2-7-2026

Accepted: 4-9-2026

Published: 6-1 -2026

Olivia G. Sacramed
Apayao State College

Abstract

This study aimed to develop and validate Mathematics manipulative instructional materials for Grade 5 learners of Atok Elementary School and determine their effectiveness in improving learners' academic performance in Mathematics. Specifically, it sought to identify the Grade 5 learning competencies that require manipulative tools, develop appropriate instructional materials, evaluate the materials through expert validation, and determine the significant difference between the learners' pre-test and post-test scores after using the developed materials. The study employed a descriptive-evaluative research design using a single-group pre-test and post-test approach. The respondents consisted of 14 Grade 5 learners and 3 expert validators from the school quality assurance team. The developed materials were evaluated using the Department of Education standard evaluation tool, while learners' academic performance was measured through pre-test and post-test assessments. Mean, standard deviation, and paired t-test were used in analyzing the data. Findings revealed that the developed manipulative instructional materials were rated Very Satisfactory by the validators. The learners' mean scores increased from 11.50 in the pre-test to 21.64 in the post-test, showing a significant improvement in performance. The study concluded that manipulative instructional materials effectively enhance learners' understanding of mathematical concepts and improve academic achievement, highlighting their importance in strengthening Mathematics instruction among elementary learners.

Keywords: Mathematics manipulative instructional materials, Grade 5 Mathematics, instructional material development, validation, academic performance, manipulative tools, mathematics achievement.

***Corresponding author: Olivia G. Sacramed**

INTRODUCTION

Mathematics is one of the core subjects in the basic education curriculum and plays a vital role in developing logical thinking, problem-solving skills, and analytical reasoning among learners. However, many pupils perceive Mathematics as a difficult and abstract subject, resulting in low academic performance and poor attitude toward learning. This challenge has motivated educators to explore effective teaching strategies and instructional materials that can make Mathematics more meaningful and engaging for learners.

The persistent challenges in mathematics performance among basic education learners across Asia highlight the need for innovative and student-centered instructional strategies. Many pupils at the elementary level develop negative attitudes toward mathematics due to abstract concepts and limited opportunities for hands-on learning. In the Philippines, similar issues are evident as learners struggle with conceptual understanding and problem-solving, contributing to low national assessment results. Asian research consistently emphasizes that the use of concrete manipulatives—such as blocks, tiles, and visual models—helps bridge the gap between abstract mathematical ideas and learners' real-world experiences. Studies in Malaysia and Indonesia show that manipulative-based lessons significantly improve engagement and reduce math anxiety among elementary pupils. These findings suggest that integrating manipulative tools may be an effective strategy to enhance interest and positive disposition toward mathematics among Filipino learners.

Furthermore, research conducted across Asia underscores the strong relationship between the use of manipulatives and improved academic performance. A study in Thailand reported that Grade 5 learners demonstrated higher achievement scores after participating in manipulative-supported instruction, especially in geometry and number sense. Similarly, in India, the use of hands-on materials was found to strengthen retention and problem-solving accuracy among upper-primary students, leading to better performance in summative assessments. These studies affirm the critical role of manipulatives in promoting deeper understanding and mastery of mathematical concepts. Given the limited local evidence in Apayao, Philippines, it becomes essential to investigate how manipulative tools influence both the attitude and academic performance of Grade 5 pupils in mathematics, thereby contributing to more effective instructional practices.

In the Philippines, improving mathematics learning outcomes remains a national priority as many elementary learners continue to demonstrate difficulties in mastering fundamental concepts and skills. National assessments such as the National Achievement Test (NAT) have consistently shown low proficiency levels among Grade 5 pupils, reflecting challenges in both conceptual understanding and motivation toward mathematics. Filipino learners often find mathematics abstract, leading to decreased interest and negative attitudes when instruction relies heavily on traditional, teacher-centered methods. Recent local studies affirm that integrating manipulative tools can enhance engagement and comprehension; for example, it was found that the use of concrete materials in teaching fractions significantly improved learners' participation and test performance. Given the scarcity of research specifically focused on rural contexts such as Apayao, investigating the effects of manipulative tools on pupils' attitudes and academic performance becomes crucial in promoting more effective and equitable mathematics instruction in Philippine schools.

In Flora, Apayao, mathematics instruction in the upper elementary grades continues to face challenges as many Grades 5 pupils struggle with developing both a positive attitude toward the subject and a strong grasp of fundamental mathematical skills. As a rural municipality within the Cordillera Administrative Region, Flora's schools often encounter limited access to diverse instructional resources, which can hinder learners' engagement and conceptual understanding. Teachers primarily rely on traditional, textbook-based strategies, making abstract mathematical concepts difficult for pupils to visualize, especially those who learn best through tactile and experiential approaches. With growing emphasis on improving mathematics performance and closing learning gaps in geographically isolated public schools, there is a need to explore the use of manipulative tools as an alternative teaching approach. Investigating their effect within the specific context of Flora, Apayao can provide evidence-based insights that may help enhance learners' attitudes and academic performance in mathematics while supporting more meaningful and inclusive classroom instruction.

The Rapid Mathematics Assessment (RMA) for Grades 4 to 6, aligned with Key Stage 2, is designed to efficiently measure learners' mastery of essential mathematical skills such as number sense, operations, measurement, geometry, and problem-solving. It provides teachers with quick but reliable diagnostic information that helps identify learners' strengths and learning gaps, allowing for immediate instructional adjustments to support differentiated learning in the classroom. By focusing on core competencies and fluency, the RMA supports data-driven teaching and promotes targeted interventions that enhance students' mathematical understanding and overall performance in upper elementary levels.

As a Grade 5 adviser, the researcher has found out that many pupils struggle to grasp mathematical concepts based on the result of Rapid Mathematics Assessment. The 86% of the pupils fall into Emerging categories (36% not proficient + 50% low proficient). This means nearly nine out of 10 pupils are not yet proficient in their foundational mathematical skills. The 86% of learners in the emerging categories represent a critical achievement gap.

The study is necessary because it directly proposes an intervention to address the massive gaps. When manipulative tools are introduced, pupils tend to participate more actively, show curiosity, and display improved confidence in solving mathematical problems. This observation supports several studies which indicate that the use of manipulatives can enhance learners' attitude and achievement in Mathematics. One promising approach to improving learners' understanding is the use of manipulative tools. Manipulatives are physical or visual objects such as blocks, counters, fraction strips, dots, mats, and other learning materials that help pupils explore mathematical concepts through hands-on experiences. These tools allow learners to construct their own understanding of abstract ideas by linking concrete objects to mathematical symbols and operations.

Despite this result, there is still a need to determine the extent of the effect of using manipulative tools on both the attitude and academic performance of pupils in Mathematics, particularly in the local context of Atok Elementary School. The findings of this study will serve as a basis for improving instructional practices and for encouraging the integration of manipulative-based learning in the mathematics classroom.

METHODOLOGY

This study employed a descriptive–evaluative research design utilizing a single-group pre-test and post-test approach to determine the effectiveness of developed Mathematics manipulative instructional materials for Grade 5 learners. The descriptive component was used to describe the characteristics, performance, and responses of the learners, while the evaluative component assessed the quality and effectiveness of the developed instructional materials.

The study followed a single-group pre-test/post-test design in which the same group of learners participated in both assessments. A pre-test was administered before the implementation of the developed manipulative instructional materials to determine the learners' baseline performance in Mathematics. After the intervention, a post-test was conducted to measure the improvement in learners' academic performance. The difference between the pre-test and post-test scores served as the basis for determining the effectiveness of the developed materials.

The study was conducted at Atok Elementary School, a public elementary school located in Barangay Atok, Municipality of Flora, Province of Apayao, Philippines. The school serves learners from the local community and implements the Department of Education curriculum for elementary education.

The respondents of the study consisted of seventeen (17) participants. Fourteen (14) were Grade 5 learners of Atok Elementary School, composed of six (6) males and eight (8) females. These learners participated in the implementation of the developed manipulative instructional materials and took both the pre-test and post-test assessments. The remaining three (3) respondents were subject experts who served as validators of the developed instructional materials. They were composed of one (1) school head, one (1) master teacher, and one (1) Teacher VI who were members of the School Quality Assurance Team of the school. Their role was to evaluate the quality, accuracy, appropriateness, and usability of the developed Mathematics manipulative instructional materials.

Several research instruments were utilized in the conduct of the study. First, a list of Grade 5 Mathematics learning competencies requiring manipulative instructional materials was prepared based on the School Monitoring, Evaluation, and Adjustment (SMEA) results and the identified least-learned competencies. These competencies guided the development of the manipulative instructional materials. Second, the study utilized Department of Education standard evaluation tools for quality assurance. The first tool was the Evaluation Rating Sheet for Instructional Materials, which assessed the quality of the developed manipulative materials in terms of content, absence of errors, and appropriateness of manipulative features using a four-point rating scale. The tool evaluated the alignment of the materials with learning competencies, learner engagement, instructional usefulness, and technical design. To pass the evaluation, the material had to meet the minimum required scores in all evaluation factors and contain no significant conceptual, factual, grammatical, or computational errors. The second tool used was the Evaluation Rating Sheet for Print Resources, which assessed the developed assessment materials in terms of content, format, presentation and organization, and accuracy and up-to-datedness. This ensured that the assessment tools used in the study were valid, reliable, and suitable for Grade 5 learners. Lastly, validated pre-test and post-test assessment tools were administered to determine the learners' Mathematics performance before and after the implementation of the developed manipulative instructional materials.

The conduct of the study followed a systematic process to ensure the validity and reliability of the gathered data. First, the researcher identified the Grade 5 Mathematics competencies that required manipulative instructional materials based on the results of the School Monitoring, Evaluation, and Adjustment (SMEA) and the least-learned competencies of learners.

Identifying the competencies, the researcher developed Mathematics manipulative instructional materials appropriate for the selected competencies. The developed materials were then submitted to the School Quality Assurance Team for validation using the Department of Education standard evaluation tools. Suggestions and recommendations provided by the validators were incorporated before the final approval and utilization of the materials. Before the implementation of the study, formal letters requesting permission to conduct the research were submitted to the Schools Division Superintendent, District Supervisor, and School Head of Atok Elementary School. Parental consent was also secured from the parents or guardians of the participating learners. An orientation was conducted to explain the objectives, procedures, and ethical considerations of the study. After securing the necessary approvals, the researcher administered a pre-test to the Grade 5 learners to determine their baseline Mathematics performance. The validated manipulative instructional materials were then integrated into the daily Mathematics instruction for one academic quarter. During the implementation, the teacher-researcher facilitated classroom activities using appropriate manipulatives and learner-centered teaching strategies to promote active participation and understanding of mathematical concepts. At the end of the implementation period, a post-test was administered using the same assessment tool given during the pre-test. The results of the post-test were compared with the pre-test scores to determine the effectiveness of the developed manipulative instructional materials in improving the Mathematics performance of Grade 5 learners.

The data gathered in the study were analyzed using appropriate statistical tools. The evaluation ratings of the expert validators on the developed Mathematics manipulative instructional materials were analyzed using weighted mean and interpreted using the Department of Education standard evaluation criteria.

To determine the effectiveness of the developed manipulative instructional materials, the learners' pre-test and post-test scores were analyzed using mean and standard deviation to describe their performance levels. Furthermore, a paired sample t-test was employed to determine whether there was a significant difference between the pre-test and post-test scores of the learners after the implementation of the developed instructional materials.

RESULTS AND DISCUSSION

This presents results and discussion from the data gathered.

Table 1. The First Quarter Learning Competencies of Grade 5 that Use Mathematics Manipulatives

FIRST QUARTER COMPETENCIES
1. Perform three or more different operations by applying the GMDAS rules.
2. Multiply fraction by a fraction
3. Solve multi-step problems involving multiplication of fraction that may or may not also involve addition or subtraction of fraction
4. Find the area of parallelogram, triangle, and trapezoid, in sq. cm or sq. m, using formulas (Problem Solving)
5. Find the area of parallelogram, triangle, and trapezoid, in sq. cm or sq. m, using formulas (Illustrations with Formulas)

The table 1 shows the **First Quarter Competencies in Mathematics for Grade 5**, highlighting the key skills that learners are expected to develop during the grading period. It shows that the focus is on strengthening students' understanding of fundamental mathematical operations and problem-solving abilities. Specifically, the competencies include applying the GMDAS rule in solving multiple operations, performing multiplication of fractions, and solving multi-step problems involving fractions. It also emphasizes geometry skills, particularly finding the area of parallelogram, triangle, and trapezoid using formulas, both through problem-solving and visual or illustrated approaches.

The inclusion of manipulatives in these areas such as fraction bars, grids, or base-ten blocks—is critical for helping students visualize the scaling effects of multiplying fractions or the place value shifts inherent in decimal division.

The use of physical models (manipulatives) for these competencies allows students to "unfold" three-dimensional shapes into two-dimensional nets, providing a concrete bridge to understanding abstract surface area formulas.

The data also suggested that manipulatives serve as a cognitive scaffold, allowing students to deconstruct these complex, multi-layered word problems into manageable, visual components.

Table 2. The Manipulative Tools that can be developed based on the First quarter competencies in Grade 5 Mathematics

Mathematics for Grade 5 Competencies	**Mathematics Manipulatives**
1. Perform three or more different operations by applying the GMDAS rules.	• Division strategy board • Multiplication dots • Addition Board • Subtra-/shape board
2. Multiply fraction by a fraction	• Multiplication Dots
3. Solve multi-step problems involving multiplication of fraction that may or may not also involve addition or subtraction of fraction	• Multiplication Dots • Subtra-shape Board • Addition Board
4. Find the area of parallelogram, triangle, and trapezoid, in sq. cm or sq. m, using formulas (Problem Solving)	• Multiplication Dots • Multiplication Guided Arrow Board • Division Strategy Board • Addition Board
5. Find the area of parallelogram, triangle, and trapezoid, in sq. cm or sq. m, using formulas (Illustrations with Formulas)	• Multiplication Dots • Multiplication Guided Arrow Board • Division Strategy Board • Addition Board

Table 2 shows the catalogue learning competencies under the revised K-10 of the K-12 program. Opposite to each learning competency is the different suggested Manipulative Learning Materials.

The five learning competencies were selected based on the Grade 5 Mathematics Curriculum Guide for the first quarter of the School Year 2025–2026.

The data reflects a highly targeted approach to material selection, ensuring that each mathematical operation from basic arithmetic to complex geometry is paired with a physical instructional aid.

A notable feature of this alignment is the versatility of materials such as the Multiplication Dots and Addition Boards, which are utilized across multiple competencies ranging from GMDAS rules to multi-step fractional problems. This suggests that the developed manipulatives are not only competency-specific but also integrated, allowing learners to utilize familiar tools as they transition into more advanced mathematical concepts.

FACTORS	MEAN	Descriptive Value
A. CONTENT		
1. Content reinforces, enriches, and / or leads to the mastery of certain learning competencies for the level and subject it was intended.	4.00	Very Satisfactory
2. Material has the potential to arouse interest of the target users.	3.67	Very Satisfactory
3. Facts are accurate.	4.00	Very Satisfactory
4. Information provided is up-to-date.	4.00	Very Satisfactory
5. Visuals are relevant to the text.	4.00	Very Satisfactory
6. Visuals are suitable to the age level and interests of the target user.	4.00	Very Satisfactory
7. Visuals are clear and adequately convey the message of the subject or topic.	4.00	Very Satisfactory
8. Typographic layout / design facilitates understanding of concepts presented.	4.00	Very Satisfactory
9. Size of the material is appropriate for use in school.	4.00	Very Satisfactory
10.Material is easy to use and durable.	4.00	Very Satisfactory
Category Mean **Score**	**3.97** **39.67**	**Very Satisfactory** **Passed**
B. OTHER FINDINGS		
1. Conceptual errors.	4.00	Very Satisfactory
2. Factual errors.	4.00	Very Satisfactory
3. Grammatical and/or typographical errors.	4.00	Very Satisfactory
4. Other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.)	4.00	Very Satisfactory
Category Mean **Score**	**4.00** **16.00**	**Very Satisfactory** **Passed**
C. ADDITIONAL REQUIREMENTS FOR MANIPULATIVE		
Instructional design		
1. Adequate support material is provided.	3.67	Very Satisfactory
2. Activities are summarized; extension activities are provided.	3.67	Very Satisfactory
3. Suggested activities support innovative pedagogy.	3.67	Very Satisfactory
Technical design		
4. Manipulative is safe to use.	4.00	Very Satisfactory
5. Size and composition of manipulative is appropriate for intended audience.	4.00	Very Satisfactory

6. Suggested manual tasks within the activities are compatible with the motor skills of the intended users.	4.00	Very Satisfactory
Category Mean **Score**	**3.84** **23.00**	**Very Satisfactory** **Passed**

In the domain of Geometry, the consistent application of the Multiplication Guided Arrow Board and Division Strategy Board for area calculations highlights an emphasis on providing structured, procedural guidance for formula application. Overall, the mapping provided in Table 2 confirms that the developed materials are comprehensively designed to cover the core technical requirements of the Grade 5 Mathematics curriculum.

Table 3 presents the evaluation ratings provided by the experts regarding the Developed Math Manipulative Instructional Material. The evaluation utilized a comprehensive rubric covering instructional content, the presence of errors, and specific design requirements for manipulative tools.

Under Criterion A: Content Quality and Pedagogy, the experts' assessment of the content indicates a high level of pedagogical alignment, yielding a category mean of 3.97, interpreted as Very Satisfactory. Notably, the manipulative achieved perfect scores (4.00) in several critical areas, including its ability to reinforce mastery of learning competencies, factual accuracy, and the relevance of visuals to the text. Furthermore, the physical and technical aspects such as the typographic layout, material size, ease of use, and durability—were all rated at 4.00, suggesting the tool is well-suited for the rigors of a classroom environment. A slightly lower, yet still robust, mean of 3.67 was observed regarding the material's potential to arouse student interest, suggesting that while the tool is academically sound, its engagement factor is its only area for marginal refinement.

For Criterion B, which is Error Assessment in terms of technical and conceptual integrity, the manipulative received a perfect category mean of 4.00 (Very Satisfactory). The experts found no evidence of conceptual, factual, grammatical, or computational errors. This absolute score confirms the reliability of the manipulative as an instructional medium, ensuring that it does not propagate misconceptions or provide obsolete information to the target users.

Criterion C, which is the Additional Requirements for Manipulatives, the instructional and technical design of the tool was rated with a category mean of 3.84, maintaining a Very Satisfactory descriptive value. Under Technical Design, the manipulative was rated at 4.00 for safety, appropriate composition, and compatibility with the motor skills of the intended audience. Under Instructional Design, the provision of support materials and the support of innovative pedagogy received scores of 3.67, indicating that the supplementary resources effectively complement the physical manipulative.

As summarized in Table 4, the Developed Mathematics Manipulative successfully passed all evaluation criteria established by the experts. With composite scores reflecting a Very Satisfactory performance across all categories, the data suggests that the tool is a highly effective, safe, and accurate instructional resource. These findings validate the readiness of the manipulative for integration into the mathematics curriculum, as it meets the necessary standards for both content delivery and technical design.

Table 4. The comparison between the pre-test and post-test scores of Grades 5

Test	**Mean**	**Sd**	**t-computed**	**t crit. value**	**Interpretation**
Pretest	11.5	4.42			
Posttest	21.64	4.77	10.69	1.77	Significant

$*significant\ at\ \alpha = 0.05$

Table 4 presents the comparison between the pretest and posttest scores of the learners. The result showed that the mean score of the learners increased from 11.5 in pre- test to 21.64 in the post – test. This indicates a substantial gain in participants' knowledge or skills after the use of the math manipulative instructional material. This further suggests that the math manipulative instructional material was effective. Thus, most of the students improved as indicated in the large mean gain difference between the pre-test and post-test scores. However, it should be noted that the improvement was not equal or true for every learner; this is evident in the higher standard deviation in the post-test, which suggests that the learner scores became more varied after the use of the math manipulative instructional material. However, this means that the performance of the learners may have improved a lot while others improved little, creating a more spread score.

Beyond the overall improvement in scores, the study observed a decrease in the standard deviation, moving from 4.77 in the pre-test to 4.42 in the post-test. In statistical terms, a lower standard deviation in the post-test indicates that the participants' scores became more clustered around the mean.

A paired t-test was conducted to further test if there is a significant difference in the scores of the learners before and after the use of the math manipulative instructional material. Results showed that there is a significant difference in the pre – test and post–test scores with $t_{computed}$ = 10.69, which is greater than the t_{crit} = 1.77 at 0.05 level of significance. This means that the developed math manipulative instructional material has contributed to the improvement in scores of Grades 5 learners.

This finding aligns with the Pre-test/Post-test Design Theory established by Campbell and Stanley (1963), which posits that a significant shift in mean scores between two points in time is a primary indicator of "treatment effect" or the impact of a specific educational stimulus.

Furthermore, research by Cramer and Mahoney (1993) and Muthukumar et al. supports the use of pre-posttest models as a reliable means of evaluating cognitive structure improvement. The 10.14-point gain observed in this study reflects what Kraft (2020) categorizes as a significant instructional impact, as it demonstrates a clear shift from the baseline "entry-level" knowledge to a higher level of mastery post-intervention. This reduction in variability is a critical finding. According to Algen Cortez (2023), a reduced standard deviation following an intervention suggests "enhanced comprehension and consistency among learners." It implies that the intervention was not only effective for the high-achieving students but also successful in "narrowing the gap" for those who initially struggled. As noted in the Mastery Learning Framework (Bloom,1968) , successful instructional interventions should result in more uniform performance, as the methodology helps the group reach a shared level of proficiency.

CONCLUSIONS

Based on the findings of the study, the Grade 5 mathematics competencies that required the use of manipulatives included performing three or more operations using the GMDAS rule, multiplying fractions, solving multi-step problems involving multiplication of fractions with addition or subtraction, and finding the area of parallelograms, triangles, and trapezoids using formulas in both problem-solving and illustrative forms. These competencies served as the basis for the development of the Math Manipulative Instructional Material, particularly in the areas of rational number operations and spatial measurement. Through the use of concrete learning tools such as Multiplication Dots and Division Strategy Boards, learners were able to bridge the gap between abstract mathematical concepts and concrete understanding, making complex mathematical processes more meaningful and easier to comprehend.

Furthermore, the developed instructional material obtained a “Very Satisfactory” rating from expert evaluators and successfully met the established criteria for quality, relevance, usability, and instructional value. This indicates that the material is appropriate and effective for classroom utilization in teaching Grade 5 Mathematics competencies.

The findings also revealed a significant difference between the pretest and posttest scores of the learners after the utilization of the Math Manipulative Instructional Material. The increase in the mean score from 11.50 to 21.64, supported by the computed t-value of 10.69 which exceeded the critical value of 1.77, confirms that the improvement in learners’ performance was statistically significant. Hence, the study concludes that the use of math manipulatives positively influences the academic achievement of Grade 5 learners in Mathematics.

The study further implies that the integration of manipulative-based instructional materials can enhance learners’ conceptual understanding, engagement, and problem-solving skills in Mathematics. It also highlights the importance of using concrete and interactive learning resources in elementary mathematics instruction to address least-mastered competencies and improve learning outcomes. Moreover, the findings may encourage teachers, school administrators, and curriculum developers to design and utilize more contextualized and learner-centered manipulative materials to strengthen mathematics instruction in elementary schools.

REFERENCES

Rahmawati, F., & Surya, E. (2019). The effectiveness of using mathematics manipulatives in improving student engagement in Indonesia. *International Journal of Education in Mathematics, Science and Technology, 7*(4). International Journal of Education in Mathematics, Science and Technology

Abdullah, A. H., Zakaria, E., & Halim, N. (2017). Enhancing primary pupils' attitudes toward mathematics through manipulative-based learning in Malaysia. *Malaysian Journal of Learning and Instruction*. Malaysian Journal of Learning and Instruction

Sirin, P., & Chansaeng, S. (2018). Effects of manipulative tools on mathematics achievement of Grade 5 students in Thailand. *Journal of Education and Practice, 9*(12), 110–116. Journal of Education and Practice

Sharma, R., & Gupta, M. (2020). Impact of hands-on learning materials on academic achievement in mathematics among Indian upper-primary learners. *Asian Journal of Education and Training, 6*(1), 56–62. Asian Journal of Education and Training

Department of Education. (2019). *National achievement test results*. Department of Education

Cruz, R. J., & de Guzman, A. B. (2021). Effects of manipulative materials on fraction learning among Filipino Grade 5 pupils. *Philippine Journal of Education and Human Development, 9*(1), 33–40. Philippine E-Journals

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching algebra to students with learning difficulties: A systematic approach. *Focus on Exceptional Children, 35*(4), 1–16. ERIC

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. National Council of Teachers of Mathematics

Jerome S. Bruner. (1966). *Toward a theory of instruction*. Harvard University Press. Google Books

Jean Piaget. (1950). *The psychology of intelligence*. Routledge. Google Books

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research & Practice, 18*(2), 121–131. Wiley Online Library

Carbonneau, K. J., Marley, S. C., & Selig, J. P. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. *Journal of Educational Psychology, 105*(2), 380–400. APA PsycNet

Flores, M. M. (2010). Using the concrete-representational-abstract sequence to teach subtraction with regrouping to students at risk for failure. *Remedial and Special Education, 31*(3), 195–207. SAGE Journals

Albert Bandura. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215. ScienceDirect

Pajares, F., & Graham, L. (1999). Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary Educational Psychology, 24*(2), 124–139. APA PsycNet

Benjamin S. Bloom. (1968). *Learning for mastery*. Instruction and Curriculum. University of Kentucky

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Rand McNally. Google Books

Kraft, M. A. (2020). Interpreting effect sizes of education interventions. *Educational Researcher*. SAGE Journals

Malti, T., et al. (2016). Evaluating intervention programs with a pretest-posttest design. *Journal of Educational Psychology*. APA PsycNet

Department of Education. (n.d.). *LR evaluation tools*. Google Sites. LR Evaluation Tools

Rahmawati, F., & Surya, E. (2019). The effectiveness of using mathematics manipulatives in improving student engagement in Indonesia. *International Journal of Education in Mathematics, Science and Technology, 7*(4). International Journal of Education in Mathematics, Science and Technology

Abdullah, A. H., Zakaria, E., & Halim, N. (2017). Enhancing primary pupils' attitudes toward mathematics through manipulative-based learning in Malaysia. *Malaysian Journal of Learning and Instruction*. Malaysian Journal of Learning and Instruction

Sirin, P., & Chansaeng, S. (2018). Effects of manipulative tools on mathematics achievement of Grade 5 students in Thailand. *Journal of Education and Practice, 9*(12), 110–116. Journal of Education and Practice

Sharma, R., & Gupta, M. (2020). Impact of hands-on learning materials on academic achievement in mathematics among Indian upper-primary learners. *Asian Journal of Education and Training, 6*(1), 56–62. Asian Journal of Education and Training

Department of Education. (2019). *National achievement test results*. Department of Education

Cruz, R. J., & de Guzman, A. B. (2021). Effects of manipulative materials on fraction learning among Filipino Grade 5 pupils. *Philippine Journal of Education and Human Development, 9*(1), 33–40. Philippine E-Journals

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching algebra to students with learning difficulties: A systematic approach. *Focus on Exceptional Children, 35*(4), 1–16. ERIC

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. National Council of Teachers of Mathematics

Jerome S. Bruner. (1966). *Toward a theory of instruction*. Harvard University Press. Google Books

Jean Piaget. (1950). *The psychology of intelligence*. Routledge. Google Books

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research & Practice, 18*(2), 121–131. Wiley Online Library

Carbonneau, K. J., Marley, S. C., & Selig, J. P. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. *Journal of Educational Psychology, 105*(2), 380–400. APA PsycNet

Flores, M. M. (2010). Using the concrete-representational-abstract sequence to teach subtraction with regrouping to students at risk for failure. *Remedial and Special Education, 31*(3), 195–207. SAGE Journals

Albert Bandura. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215. ScienceDirect

Pajares, F., & Graham, L. (1999). Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary Educational Psychology, 24*(2), 124–139. APA PsycNet

Benjamin S. Bloom. (1968). *Learning for mastery*. Instruction and Curriculum. University of Kentucky

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Rand McNally. Google Books

Kraft, M. A. (2020). Interpreting effect sizes of education interventions. *Educational Researcher*. SAGE Journals

Malti, T., et al. (2016). Evaluating intervention programs with a pretest-posttest design. *Journal of Educational Psychology*. APA PsycNet

Department of Education. (n.d.). *LR evaluation tools*. Google Sites. LR Evaluation Tools