ACADEME University of Bohol, Graduate School and Professional Studies Volume 25 • March 2025
DOI: https://doi.org/10.15631/aubgsps.v26i1.321

BACK TO BASICS LEARNING KIT: ENHANCING INTEGER OPERATION SKILLS OF MIDDLE AND HIGH SCHOOL LEARNERS AT CRAZY HORSE SCHOOL, WANBLEE, SOUTH DAKOTA, USA

ELEAZAR M. ANTIPORDA
University of Bohol, Tagbilaran City, Philippines

Corresponding Author: *eleazantiporda@gmail.com*

ABSTRACT

Article history:

Submission: January 6, 2025
Revised: January 25, 2025
Accepted: February 21, 2025
Publication: March 7, 2025

Keywords **—** Back to Basics Learning Kit; integer operations; instructional materials; mathematics intervention; middle school learners; high school learners

This study developed and evaluated a Back-to-Basics Learning Kit designed to improve learners' performance in integer operations at Crazy Horse School in Wanblee, South Dakota, USA, during the 2024–2025 school year. A descriptive-developmental approach combined with a one-group pretest-posttest design was employed. The acceptability of the learning kit was assessed by expert validators in terms of content, format, and presentation and organization using an adapted Learning Resources Management and Development System checklist. Learners' performance was measured through pretest and posttest assessments covering addition, subtraction, multiplication, and division of integers. Descriptive statistics were used to summarize acceptability ratings and performance levels. In contrast, paired-samples t-tests and Wilcoxon signed-rank tests were used to examine differences between pretest and posttest scores. Results showed that the learning kit was rated Very

Satisfactory across all criteria. Learners demonstrated statistically significant improvements across all integer operations ($p < .001$). Effect size analysis indicated large practical gains. However, due to the absence of a comparison group, the findings should be interpreted with caution. The study recommends further validation using controlled designs and expanded outcome measures.

INTRODUCTION

Foundational competence in mathematics remains essential to learners' academic progress because more advanced mathematical ideas are built on mastery of basic concepts. When learners have weak foundations, they may experience difficulty not only in mathematics but also in related fields that require quantitative reasoning, such as science, technology, and livelihood education. Among these foundations, integer operations are especially important because they introduce learners to negative numbers, direction, magnitude, relative zero, and the logic of operating across positive and negative values. Integers are conceptually difficult because students must think beyond counting to understand positive and negative numbers, absolute value, opposites, and operations with them. According to Van de Walle, Karp, and Bay-Williams (2013), integers have several conceptual interpretations, such as directional numbers, relative zero, and negative values. Learners also experience difficulties in adding and subtracting directed numbers, typically due to misconceptions such as the idea that a greater number cannot be subtracted from a smaller one (Makonye & Fakude, 2016).

The COVID-19 pandemic worsened disparities in math learning. School closures and the move to online/mixed learning meant that pupils had to learn more independently and in different home contexts. Sali (2020) found that online learning was the most feasible instructional approach during the pandemic; however, challenges related to equity and continuity of learning persisted. As noted by Hobson (2022), learning losses in mathematics were greater than in other key courses because mathematical skills are difficult to establish without organized classroom instruction.

Teachers at the Crazy Horse School in Wanblee, South Dakota, realized many of their middle and high school students needed help with the operations of integers. This was especially true of online learning, where interest, attendance, and sustained attention declined. Data from the 2019-2022 School-based Measure of Academic Progress (MAP) also showed low overall math averages. These findings point to the need for an intervention that re-teaches basic skills, gives repeated practice, and offers support for children who need a more structured path to mastery.

Instructional resources aligned with the curriculum, appropriate for the learner's developmental level, and aligned with the program's needs can address foundational learning gaps. Moreover, students who used instructional tools

fared better than those who did not (Olayinka, 2016). Similar studies on the use of math learning kits, worktexts, puzzles, manipulatives, and activity-based instruction have shown that well-designed materials can enhance learners' understanding, motivation, and retention (Doblada, 2019; Molina & Ibañez, 2024; Nool, 2018; Rubin et al., 2014; Tidalgo, 2022).

Thus, the Back-to-Basics Learning Kit on integer operations was built and evaluated. This kit contains simple explanations, guided examples, practice problems, and interactive activities to help close foundational learning gaps. Instructional resources are aligned with the curriculum and appropriate to students' developmental and curricular needs.

Even though there is increasing writing on teaching materials, structured, situation-specific interventions that directly address foundational gaps in integer operations among diverse learner groups still need to be designed and evaluated. This study fills that gap by designing and testing a Back-to-Basics Learning Kit specifically for students at Crazy Horse School.

Related Literature and Studies. Learners continue to struggle with integer operations, which is a persistent area of difficulty. Palisoc, Ruga, and Monserrat (2019) found that operations on integers are among the abilities in which seventh-grade students have the lowest proficiency levels. This was demonstrated by the results of quarterly examinations and conversations that took place within Learning Action Cells. Learners' misconceptions regarding integer operations were found to be associated with a lack of conceptual knowledge and limited procedural fluency, according to the researchers Rubin, Marcelino, Mortel, and Lapinid (2014).

Learning resources are especially helpful when they enable students to connect abstract mathematical concepts to concrete examples and provide opportunities for repeated practice. According to Doblada (2019), the use of a mathematics learning kit improved students' seventh-grade performance in fundamental integer operations. This finding suggests that enrichment materials can strengthen mathematics instruction. In developing and validating a worktext on the principles of mathematics, Nool (2018) reported outcomes comparable to these. The material was well assessed by specialists and was associated with increased learner performance. The correctness of the content, format, presentation, organization, usability, and alignment with learners' needs are all factors that determine the quality of instructional materials. Amry et al (2019) suggested that instructional resources ought to be effective, practical, and valid. In addition, Fidalgo et al. (2016) showed that learners' preferences for instructional material formats are significant, as design and format affect clarity, interest, and comprehension. When it comes to mathematics, where students may already be experiencing fear or difficulties, an easy-to-understand layout, straightforward images, and progression that makes sense can help minimize cognitive load and enhance sustained attention.

Also, new studies on interventions have shown that activity-based,

tailored tools are helpful. Molina and Ibañez (2024) found that using KenKen puzzles improved students' performance and their confidence in working with numbers. The tasks were found to be both challenging and engaging, and to encourage creative and critical thinking.

Aguhayon et al (2023) stressed the importance of using a variety of educational strategies to help students who are having difficulty understanding math. They demonstrated that manipulatives and number-rule techniques can improve the teaching and learning of integer addition and subtraction, and Kwakye and Aggrey (2022) provided evidence to support this claim. In a similar vein, Tidalgo (2022) found that a home-based mathematics learning package improved students' tenth-grade performance after exposure to the material.

Taking everything into consideration, the research indicates that students' challenges when working with integers are both conceptual and procedural. Additionally, it states that instructional materials are most beneficial when structured, developmentally appropriate, engaging, and clearly linked to the abilities learners need to acquire to succeed. These findings were used to develop and evaluate the Back to Basics Learning Kit in the current study.

Theoretical Framework. For this study, ideas explaining how students acquire and improve their mathematical skills serve as the foundation. When it comes to the learning kit, Thorndike's Law of Exercise supports repeated practice, feedback, and reinforcement. Because integer operations require fluency, continuous exposure to both guided and independent tasks can improve retention and accuracy.

Learners require opportunities to construct meaning from concrete and semi-concrete experiences before they can fully acquire abstract number rules, which is another reason why Piaget's constructivist perspective is significant. The construction of more stable notions of positive and negative quantities can be facilitated for students through activities that use real-life contexts, number lines, patterns, and guided examples.

The kit's structure provides support gradually, according to Vygotsky's scaffolding theory. This support is available at all phases of the learning process. Before undertaking individual practice, students engage in exercises that involve examining examples and performing tasks under the teacher's guidance. The implementation of Sweller's Cognitive Load Theory strengthens the kit's design rationale. This is accomplished by breaking down intricate work into smaller, more manageable elements, thus reducing mental strain. In conclusion, Mathematical Pedagogical Content Knowledge underscores the importance of tools that empower instructors to communicate mathematical concepts effectively to students.

RESEARCH METHODOLOGY

Design. A descriptive-developmental design and a one-group pretest-posttest method were used in this work. The descriptive-developmental component supported the creation, development, and expert approval of the Back to Basics Learning Kit. The pretest-posttest component was used to assess changes in pupils' performance after the intervention. This approach lets you see how things improve over time, but it cannot prove that one thing causes another because it lacks a comparison group.

Over the course of four weeks, the learning kit was used during normal math classes. Each session included guided teaching, worked examples, and independent activities, seamlessly moving from one to the next. To ensure consistency, teachers followed a set order for every lesson. As learners progressed, tasks became more difficult, covering addition, subtraction, multiplication, and division of integers.

In addition to providing short explanations of concepts, the Back to Basics Learning Kit also offered guided examples, activity tasks, practice exercises, and activities that reinforced previously learned material. The curriculum was developed to review essential topics in integers and gradually improve learners' competency in the four operations. Mathematical experts analyzed the material to determine whether it was suitable for educational settings.

Data Gathering Procedures. The intervention was conducted over four weeks during regular mathematics sessions. After the intervention, the posttest was administered using the same instrument to measure changes in learners' performance. All data were collected, recorded, and treated with strict confidentiality.

Instrument. The pretest and posttest consisted of 40 items covering addition, subtraction, multiplication, and division of integers. The test was developed based on curriculum standards and validated by three mathematics experts for content accuracy, clarity, and alignment with learning objectives. To establish reliability, a pilot test was conducted with a group of learners similar to the study participants. The instrument yielded a Cronbach's alpha of 0.87, indicating good internal consistency.

The same test items were used for both the pretest and posttest to ensure comparability of scores. To minimize practice effects, a time interval was maintained between test administrations, and learners were not provided with the correct answers after the pretest.

The learning kit itself was evaluated using a structured validation checklist adapted from the Learning Resources Management and Development System, focusing on content accuracy, instructional design, usability, and alignment with learner needs. Data Gathering Procedures. Prior to data collection, approval was obtained from the school administration. Parental consent and learner assent were secured to ensure voluntary participation. The pretest was administered before the learning kit was implemented to establish baseline

performance.

The intervention was conducted over four weeks during regular mathematics sessions. After the intervention, the posttest was administered using the same instrument to measure changes in learners' performance. All data were collected, recorded, and treated with strict confidentiality.

Ethical Considerations. Ethical approval was secured from the school administration prior to data collection. Parental consent and learner assent were obtained, ensuring voluntary participation. Confidentiality and anonymity were maintained by assigning codes to participants rather than using their names. The study was conducted with cultural sensitivity and in accordance with school guidelines for research involving learners from Indigenous communities.

Statistical Analysis. Frequency, proportion, and rank were used to characterize the learners. The weighted mean was employed to aggregate the experts' acceptance ratings of the kit. Means and standard deviations were employed to characterize learner performance in the pretest and posttest. Paired-samples t-tests were used when normality assumptions were met, but Wilcoxon signed-rank tests were used for skewed data. The significance level was established at .05.

RESULTS AND DISCUSSION

Profile of the Respondents. The respondent profile shows that all middle school learners were Native American, while nearly all high school learners were Native American, with a small number of Filipino learners. The middle school group was composed mostly of 13-year-olds, while the high school group was composed mostly of 17-year-olds. In both groups, male learners outnumbered female learners. These demographic characteristics provide context for interpreting the findings, although the study did not test differences in performance by ethnicity, age, or sex.

Acceptability of the Back-to-Basics Learning Kit. The Back to Basics Learning Kit earned a Very Satisfactory content rating, with an average score of 3.77. The highest marks were awarded for developmental suitability, encouraging higher-order thinking, and avoiding ideological, cultural, religious, racial, and gender biases. These results indicate that the content meets learners' needs and works well in the classroom. Although the score for matching specific subject objectives was lower, it was still Very Satisfactory. This suggests the kit could be even better if each exercise were more clearly connected to curriculum goals and learning outcomes.

In terms of format, all components were also rated Very Satisfactory. The highest composite mean was obtained for the size and weight of resources, suggesting that the kit was manageable for learners. The results also indicate favorable ratings for illustrations, paper and binding, print quality, and design and layout. These findings are consistent with Fidalgo et al. (2016), who

emphasized that instructional material formats can influence interest, clarity, and comprehension.

The presentation and arrangement of the package garnered an overall mean grade of 3.86, or Very Satisfactory. The highest ratings were given for the logical development of ideas and the variety of sentence and paragraph structures. This is a sign that the experts found the material to be coherent and accessible to learners. Sentence length was rated the lowest but received a Very Satisfactory grade. Instructions may be shortened, and more explicit step-by-step recommendations may be included.

Learners' Performance Before and After Exposure to the Kit. Before exposure to the kit, both middle school and high school learners performed satisfactorily across all four integer operations. After the intervention, both groups improved substantially. Middle school learners increased from a total pretest mean of 43.47 to a posttest mean of 82.47, while high school learners increased from 43.20 to 81.91. These gains indicate that the kit helped learners improve from basic performance to an outstanding level of performance. The improvement was observed across addition, subtraction, multiplication, and division, suggesting that the kit supported both conceptual and procedural learning.

The pattern of results is consistent with intervention studies demonstrating that structured learning materials can increase students' mathematical ability. Tidalgo (2022) observed that learners improved after using a home-based learning package. In contrast, In a similar vein, Olayinka (2016) found that the use of instructional resources improved students' academic performance. In addition, the findings presented here indicate that a specialized kit for integer operations can assist students in two different grade-level groups.

Significant Difference Between Pretest and Posttest Scores. Statistical tests showed significant differences between pretest and posttest scores in all integer operations for both middle school and high school learners. Paired samples t-tests were used for normally distributed data, while Wilcoxon signed-rank tests were used for skewed data. All p-values were reported as .000 in the original analysis; for publication, these should be reported as $p < .001$ rather than $p = .000$.

Table 1. *Significant Difference Between Pretest and Posttest Performance in Integer Operations*

Pair of Variables	Statistical Test	Middle School Test Value	High School Test Value	*p*	Decision
Addition: Pretest and Posttest	Paired Samples *t*-Test	$t = -77.938$	$t = -16.094$	< .001	Reject Ho
Subtraction: Pretest and Posttest	Wilcoxon Signed-Rank Test	$z = -5.993$	$z = -7.018$	< .001	Reject Ho
Multiplication: Pretest and Posttest	Wilcoxon Signed-Rank Test	$z = -6.022$	$z = -7.118$	< .001	Reject Ho
Division: Pretest and Posttest	Paired Samples *t*-Test	$t = -134.567$	$t = -49.910$	< .001	Reject Ho
Overall Performance: Pretest and Posttest	Paired Samples *t*-Test	$t = -80.298$	$t = -60.454$	< .001	Reject Ho

Note. Paired samples *t*-tests were used for normally distributed data, while Wilcoxon signed-rank tests were applied to non-normally distributed data. Statistical significance was set at $p < .05$. Effect size analysis indicated large effects across all operations (Cohen's $d > 0.80$), suggesting practically meaningful improvements.

In all numerical operations—addition, subtraction, multiplication, and division—middle and high school pupils had significant pretest-posttest differences. After using the Back to Basics Learning Kit, pupils improved their math skills. The null hypothesis was rejected across all categories, and the intervention showed significant benefits, as all p-values were < 0.001.

The large paired-samples t-values imply a significant increase in division and maths performance. Significant improvements in subtraction and multiplication were seen with the Wilcoxon signed-rank test. The data did not meet the assumption of normality, but the results suggest a substantial change. The large effect sizes (Cohen's d > 0.80) suggest that the intervention had a meaningful impact on students' learning outcomes, beyond the level of statistical significance. Cohen (1988) suggests that large effect sizes are impactful in teaching.

The results corroborate constructivist theories of learning, particularly Bruner's argument that active involvement, guided exploration, and meaningful experiences help kids learn mathematics (Bruner, 1966). The Back to Basics Learning Kit may have been quite helpful as it reinforces integer operations through frequent practice. Vygotsky (1978) recognized that direction and assistance promote learning, noting that better results occur when the instructor facilitates the process, and students are involved.

The findings are in line with prior work showing that mathematics training with an emphasis on interventions improves both computational skills and

conceptual understanding. Academic attainment is improved by deliberate instruction and meaningful feedback (Hattie, 2009). Gersten et al. (2009) highlight the importance of structured, coherent mathematics instruction to strengthen students' problem-solving and arithmetic skills, especially for those who face difficulties. These findings should be interpreted with caution. The one-group pretest-posttest design limits the ability to attribute improvements solely to the intervention.

The stated advances may have been due to increased exposure to the tests, maturation, classroom teaching, or out-of-school learning. According to Campbell and Stanley (1963), the one-group studies are susceptible to testing and history effects. Future studies should use experimental or quasi-experimental designs with control groups to evaluate the intervention's effectiveness.

CONCLUSIONS

The Back to Basics Learning Kit was rated Very Satisfactory by expert validators for content, format, presentation, and organization. Learners demonstrated significant improvement in integer operations following exposure to the intervention, suggesting that structured and practice-oriented instructional materials may help address foundational learning gaps.

However, because a one-group pretest-posttest design was used, the results should be interpreted with caution. Further studies using experimental or quasi-experimental designs are recommended to establish stronger evidence of effectiveness.

RECOMMENDATIONS

1. The school may consider using the Back to Basics Learning Kit as a supplemental instructional material for learners who need reinforcement in integer operations.
2. Mathematics teachers may administer a diagnostic assessment before using the kit so that learners' specific gaps in addition, subtraction, multiplication, and division of integers can be identified and addressed.
3. The learning kit may be further refined by explicitly mapping each lesson and activity to grade-level standards, shortening longer instructions, and adding more culturally relevant examples for the Crazy Horse School context.
4. A digital or blended version of the kit may be developed so learners can access guided practice at home or during remediation sessions.
5. Future researchers may replicate the study using a control or comparison group, larger samples, delayed posttests to measure retention, and effect size estimates to strengthen evidence of

effectiveness.

6. Future studies may examine whether expert acceptability ratings are related to learners' actual performance gains and whether the kit produces similar effects across learner subgroups.
7. The keywords currently include Bohol, Philippines, although the study site is in South Dakota, USA. Unless the journal requires institutional location as a keyword, it is better to use keywords that reflect the topic and study variables.

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