JOURNAL OF INTERDISCIPLINARY PERSPECTIVES

ISSN Print: 2984-8288, ISSN Online: 2984-8385
Vol. 4 No. 4, pp. 265-270, April 2026

Original Article

Effects of the Concrete–Representational–Abstract (CRA) Approach on Grade 6 Students' Fraction Achievement and Attitudes

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Article History:

Date received: February 19, 2026
Date revised: March 16, 2026
Date accepted: March 25, 2026

Recommended citation:

Jimenez, E.J. (2026). Effects of the Concrete–Representational–Abstract (CRA) approach on Grade 6 students' fraction achievement and attitudes. *Journal of Interdisciplinary Perspectives*, 4(4), 265-270. https://doi.org/10.69569/jip.2026.081

Abstract. This study addressed the persistent difficulty elementary learners experience with fractions and the limited classroom-based evidence on short Concrete–Representational–Abstract (CRA) interventions in Philippine public schools. This study aimed to determine the effects of a five-week CRA intervention on Grade 6 students' achievement in fractions and attitudes toward learning fractions. Using a quasi-experimental one-group pretest–posttest design, the study involved one intact Grade 6 class (N = 45). Matched pretest–posttest data were available for 39 students on the researcher-assembled fraction achievement test based on released TIMSS-style items (35 points) and for 40 students on the adapted Mathematics Attitude Scale. Lessons progressed from hands-on fraction models to drawings and then to symbols and procedures, with explicit bridging across stages. Achievement scores increased from M = 5.92 (SD = 4.03) to M = 13.18 (SD = 6.05), $t(38) = 12.63$, $p < .001$, dz = 2.02. Attitude ratings improved from M = 3.52 (SD = 0.62) to M = 3.88 (SD = 0.40), $t(39) = 5.49$, $p < .001$, dz = 0.87. The CRA approach was effective in improving both fraction achievement and class attitudes, indicating that sequenced and connected representations can support conceptual understanding and learner confidence. These findings highlight CRA as a practical, classroom-feasible instructional strategy for elementary mathematics instruction.

Keywords: *Concrete-Representational-Abstract; Elementary mathematics instruction; Fractions; Mathematics achievement; Student attitudes.*

Fractions are a persistent source of difficulty for many learners because they require students to coordinate part–whole relationships, unitizing, and magnitude reasoning in ways that differ from whole-number thinking (Jordan et al., 2024; Xu et al., 2024). In many Grade 6 classrooms, this becomes an instructional problem when learners are expected to perform fraction procedures before they have developed a stable understanding of models and visual representations. As a result, students may rely on procedures without strong conceptual understanding and may develop low confidence when working with fractions (Xu et al., 2024). Instruction that uses models and visual representations can help address these difficulties by making relationships among fractions more visible and supporting magnitude-based reasoning (Jordan et al., 2024; Schwarzmeier et al., 2024).

One widely used instructional framework for strengthening these connections is the Concrete–Representational–Abstract (CRA) approach, also described as the Concrete–Pictorial–Abstract sequence. CRA organizes instruction so that students first act on ideas with manipulatives, then represent the same ideas with drawings or diagrams, and finally work with mathematical symbols, while teachers make the links across stages explicit (Bruner, 1966; Witzel, 2005; Flores et al., 2024). Recent studies report positive effects of CRA/CPA-oriented instruction and related fraction interventions on students' fraction performance, including learners with mathematics difficulties, particularly when lessons emphasize conceptual understanding and structured practice with representations (Morano et al., 2020; Vessonen et al., 2021; Zhang et al., 2022; Iyamuremye & Burns, 2025).

Improving fraction achievement and attitudes is important because fraction knowledge underpins later rational-number learning and more advanced mathematical thinking. Recent research shows that students' understanding of fractions is associated with later algebraic thinking, mathematical problem-solving, and the development of more connected mathematical knowledge (Ching & Li, 2024; Syed Ismail et al., 2024; Xu et al., 2024). When misconceptions persist, learners may struggle not only with current Grade 6 competencies but also with later mathematics learning that depends on interpreting quantities and relationships. Instruction that deliberately connects concrete models, drawings, and symbols may help address these difficulties by making fraction relationships more visible, meaningful, and discussable for learners (Tossavainen & Helenius, 2024).

Representation-based instruction, such as CRA, is intended to build representational fluency—the ability to move flexibly between concrete models, visual representations, and symbolic notation. When teachers explicitly bridge each stage, learners can use models to justify procedures (e.g., why common denominators are needed) rather than memorizing steps. This emphasis on connected representations aligns with CRA's theoretical roots and is reflected in intervention research, which reports stronger conceptual understanding when concrete and pictorial work precedes symbolic practice (Bruner, 1966; Flores, 2020; Morano et al., 2020).

Beyond performance, students' attitudes toward mathematics are linked to engagement and achievement, making affective outcomes relevant when evaluating instructional approaches (Hwang & Son, 2021; Wen & Dubé, 2022). In this study, CRA was implemented for five weeks to address Grade 6 fraction competencies aligned with the Most Essential Learning Competencies (Department of Education, 2020a, 2020b). In the Philippine public-school context, mathematics instruction is guided by the Most Essential Learning Competencies (MELCs). However, teachers often work within limited time, uneven resources, and varied learner readiness, which can make sustained concept-building difficult (Department of Education, 2020a, 2020b; Bernardo et al., 2022). Evidence from short, classroom-feasible CRA sequences can therefore be useful for informing everyday lesson planning in public elementary schools and for supporting learners who need structured scaffolds within regular class periods.

Although CRA and other representation-based approaches have shown promise in prior research, empirical evidence on the effectiveness of short-term CRA interventions in regular Philippine public-school classrooms remains limited. Local work on fraction instruction has likewise emphasized the importance of connecting representations and addressing misconceptions in classroom lessons (Morillo et al., 2023). This gap prompted the present study, which examined whether a short CRA sequence could improve both fraction performance and students' attitudes under ordinary classroom conditions, while also offering practical guidance for teachers and school-based professional development.

This study aimed to determine the effects of a five-week Concrete–Representational–Abstract (CRA) classroom intervention on Grade 6 learners' achievement in fractions and attitudes toward learning fractions. The study contributes classroom-based evidence on a structured, representation-based approach to teaching key fraction competencies in a Philippine public school setting. Specifically, it asked: (1) Do students' fraction achievement change after the intervention? (2) Do students' attitudes toward learning fractions change after the intervention?

Methodology

Research Design

This study used a quasi-experimental one-group pretest–posttest design to examine changes in Grade 6 students' fraction achievement and attitudes before and after a five-week Concrete–Representational–Abstract (CRA) classroom intervention. The design was appropriate because the same intact class was observed under regular classroom conditions before and after the intervention. Because no comparison group was included, potential threats such as history, maturation, testing, and attendance-related differences could not be fully controlled. To reduce these threats, the same teacher-researcher implemented the full lesson sequence, and similar testing conditions and scoring procedures were used at pretest and posttest; only matched pretest–posttest data were included in paired analyses. Findings were therefore interpreted as within-class changes rather than proof of causation.

Participants and Sampling Technique

The participants were drawn from the accessible population of one intact Grade 6 class (N = 45) enrolled at Langtad Elementary School in the City of Naga, Cebu, during the 2025–2026 school year. Purposive intact-group sampling was used because the section was selected based on accessibility, scheduling, and school permission. All 45 students received the CRA-based lessons as part of classroom implementation. Inclusion criteria for the research dataset were enrollment in the selected class, participation in the five-week intervention, and parent/guardian consent plus student assent for use of the data. Students with incomplete pretest–posttest data for a given measure were excluded only from the paired analysis for that measure. Thus, matched data were available for fraction achievement (n = 39) and attitudes toward learning fractions (n = 40); the difference resulted from absences or incomplete responses during one of the test administrations.

Research Instrument

Fraction achievement was measured using a researcher-assembled, adapted 35-point test based on selected released TIMSS-style fraction items (Mullis & Martin, 2017) and aligned with the targeted Grade 6 MELC competencies. Items were reviewed and adjusted for grade-level appropriateness, classroom language, and the specific competencies covered in the five-week intervention. The test used partial-credit scoring (Items 1–5 scored 0–1 point each; Items 6–20 scored 0–2 points each). Attitudes were measured using an adapted Mathematics Attitude Scale (20 items; 5-point Likert; Lim & Chapman, 2013). Both instruments underwent content validation by three expert validators, and revisions were made based on their comments on clarity, alignment, and suitability for Grade 6 learners. Pilot testing was conducted under face-to-face classroom conditions with 32 Grade 6 students from a different class. Internal consistency reliability was α = 0.703 for the achievement test, which is acceptable, and α = 0.835 for the attitude scale, which indicates good reliability.

Data Gathering Procedure

During Week 1, the teacher-researcher administered the pretest achievement test and the attitude scale under regular classroom conditions. The CRA intervention was then implemented across five weeks during a school-scheduled afternoon intervention period so that regular classes were not interrupted. Lessons progressed from concrete models (e.g., fraction strips/tiles and paper-folding) to representational drawings (e.g., fraction bars and area models) and then to abstract notation and procedures, with explicit teacher prompts linking each stage (Bruner, 1966; Witzel, 2005; Flores et al., 2024). Throughout the intervention, instruction addressed MELC-aligned Grade 6 fraction competencies, including understanding fractions as part of a whole, equivalent fractions, comparing and ordering, simplifying, and introductory operations and problem-solving. At the end of Week 5, the same teacher-researcher administered the posttest achievement test and attitude scale. Attendance was monitored each session through the class attendance record and lesson logs; students who were absent during an assessment or had incomplete paired data were excluded only from the corresponding paired analysis.

Data Analysis Procedure

Descriptive statistics (*M, SD*) summarized pretest and posttest scores. Paired-samples t-tests were used because the study compared pretest and posttest mean scores from the same participants on each outcome. Analyses were completed using Microsoft Excel, with α = 0.05 as the level of significance. Effect sizes were computed using Cohen's d (dz) for dependent samples to describe the magnitude of change. Prior to inferential analysis, difference scores were checked for missing data, extreme outliers, and approximate normality by inspecting the paired-score distributions.

Ethical Considerations

This study formed part of the researcher's master's thesis and received approval through the institutional ethics review process prior to implementation. Administrative permission to conduct the study was also obtained through the Schools Division Superintendent and the School Head of the participating public elementary school. Written informed consent from a parent or guardian and student assent were obtained prior to data collection.

Participation in the research component was voluntary, and refusal or withdrawal did not affect grades, class standing, or access to regular instruction. Data were coded, reported in aggregate form, and stored securely to protect confidentiality. Teacher-researcher field notes used to document classroom implementation did not include student names or identifying information.

Results and Discussion

Table 1 and Table 2 summarize students' pretest–posttest performance on fraction achievement and attitudes toward learning fractions after the five-week CRA intervention. Descriptive statistics (*M, SD*), paired-*samples t-tests*, and Cohen's *d (dz)* were used to examine the direction, statistical significance, and magnitude of change. The discussion below interprets these results in terms of both statistical and educational significance.

Fraction Achievement

Students' achievement in fractions improved after the CRA intervention (Table 1). Mean scores increased from *M* = 5.92 (*SD* = 4.03) to M = 13.18 (*SD* = 6.05), a mean gain of 7.26 points. This change was statistically significant, $t(38) = 12.63$, $p < .001$, and the effect size was very large ($dz = 2.02$). In practical terms, the class gained about 20.74% of the total 35-point test score within only five weeks. Although the posttest mean does not indicate full mastery, it suggests movement from very limited initial performance toward a stronger understanding of core fraction competencies such as equivalence, comparison, and introductory operations.

Table 1. *Summary of Pretest–Posttest Results for Fraction Achievement (n = 39)*

Measure	Pretest *M (SD)*	Posttest *M (SD)*	Mean diff	*t(df)*	*p*	Cohen's *dz*
Fraction Achievement (35 pts)	5.92 (4.03)	13.18 (6.05)	7.26	12.63 (38)	< .001	2.02

Note. *dz = Cohen's d for dependent samples.*

This pattern aligns with studies reporting that CRA/CPA-oriented instruction can strengthen understanding of fractions by helping learners connect part–whole relationships, equivalence, and magnitude across multiple representations (Morano et al., 2020; Vessonen et al., 2021; Zhang et al., 2022; Iyamuremye & Burns, 2025). In Philippine and similar classroom contexts, representation-based fraction lessons have likewise emphasized the importance of addressing misconceptions through connected visual and concrete models rather than isolated procedures (Morillo et al., 2023).

The improvement is also consistent with CRA's cognitive rationale. CRA supports representational fluency by helping learners move from concrete actions to drawings and then to symbols while preserving the same mathematical idea. This progression can deepen conceptual understanding because students are not asked to memorize procedures in isolation; instead, they interpret what numerators, denominators, equivalence, and operations mean across linked representations (Bruner, 1966; Flores, 2020; Flores et al., 2024). When the teacher explicitly bridges these stages, abstract procedures become easier to justify and less dependent on rote recall.

Notably, the posttest SD was larger than the pretest *SD*, suggesting that gains varied across learners. In Philippine public-school classrooms, such variation is expected because learners often begin with uneven prior knowledge and may need different amounts of scaffolding to benefit from multiple representations (Bernardo et al., 2022; Ennis & Losinski, 2019). Even so, the class-level gain indicates that the intervention was educationally meaningful under regular school conditions.

Attitudes Toward Learning Fractions

Students' attitudes toward learning fractions also improved after the CRA intervention (Table 2). Mean attitude ratings increased from *M* = 3.52 (*SD* = 0.62) to *M* = 3.88 (*SD* = 0.40), a mean gain of 0.36 points on the 5-point scale. The increase was statistically significant, t(39) = 5.49, $p < .001$, with a large effect ($dz = 0.87$). Educationally, this suggests that students ended the intervention with more positive and more consistent views of learning fractions, which may support participation and persistence during later mathematics lessons.

Table 2. *Summary of Pretest–Posttest Results for Attitudes Toward Learning Fractions (n = 40)*

Measure	Pretest *M (SD)*	Posttest *M (SD)*	Mean diff	*t(df)*	*p*	Cohen's *dz*
Attitude Rating (1–5)	3.52 (0.62)	3.88 (0.40)	0.36	5.49 (39)	< .001	0.87

Note. *Higher scores indicate more positive attitudes.*

These findings are consistent with research linking attitudes toward mathematics to achievement and engagement outcomes (Hwang & Son, 2021; Wen & Dubé, 2022). CRA-informed lessons may contribute to improved attitudes because students can see and explain fraction ideas through models and drawings before working with symbols. When learners experience clearer understanding and more frequent success during tasks, their confidence may increase and anxiety may decrease, which supports willingness to participate and persist on challenging problems (Prosser & Bismarck, 2023; Iyamuremye & Burns, 2025).

In addition, concrete and representational tasks allow misconceptions to be addressed earlier (e.g., unequal partitions, misinterpretation of numerators/denominators) before errors become entrenched at the symbolic level. Over time, this can reduce frustration and strengthen learners' perception that fractions are understandable rather than arbitrary rules. In a Philippine public-school setting, this is important because short intervention periods require approaches that can build understanding while also keeping learners engaged and confident.

Implementation Fidelity

Implementation fidelity was monitored descriptively by the teacher-researcher through session-by-session lesson logs and researcher field notes recorded in every intervention session during the five-week intervention. No external observer was used. The fidelity indicators were whether each lesson followed the intended CRA sequence (concrete → representational → abstract), whether explicit bridging prompts were used, and whether learners had opportunities to practice at each stage. The logs showed that these core elements were implemented in each lesson. Typical bridging prompts asked learners to model a fraction using tiles or folded paper, sketch the corresponding fraction bar/area model, and then write the matching symbolic fraction or equation.

The teacher-researcher field notes were summarized descriptively rather than statistically. They indicated that learners were generally more engaged during the concrete and representational tasks and were more able to explain fraction relationships when they could point to a model or diagram before working with procedures. Overall, the available implementation records suggest reasonable fidelity to the intended CRA sequence, although the absence of an external observer limited independent verification.

Limitations

Results are based on one intact class and a one-group pretest–posttest design; therefore, improvements cannot be attributed solely to CRA. Threats to internal validity (e.g., maturation, teacher effects, and test familiarity) may have contributed to gains over the five weeks. Because the sample came from one public elementary school, the findings should be generalized cautiously to other grade levels, schools, or instructional settings. The study also did not include a delayed posttest, so retention of learning could not be examined. In addition, implementation records were based on teacher-researcher field notes without an external observer, which limited independent verification of fidelity. Future studies should use experimental or stronger quasi-experimental designs with comparison groups, larger and more diverse samples, and follow-up assessments to examine long-term retention, transfer of learning, and the specific contribution of concrete, representational, and bridging components.

Conclusion

This study provides classroom-based evidence that a short CRA intervention can improve Grade 6 learners' achievement in fractions and attitudes in a Philippine public-school setting. Under regular school conditions, students showed statistically significant and educationally meaningful gains after five weeks of instruction that explicitly connected concrete models, drawings, and symbols. The findings provide empirical support for the use of CRA as a practical, representation-based approach to fraction teaching in real classrooms.

For classroom practice, the results support lesson designs that do not move immediately to symbolic procedures. Teachers may strengthen fraction learning by planning routines such as model–draw–explain–compute, using consistent visual representations, and prompting learners to explain how each representation shows the same idea. These practices may also inform school-based professional development and instructional planning for implementing DepEd mathematics, particularly in lessons targeting common misconceptions about fractions.

At the school and district levels, the findings may support evidence-based instructional decision-making, including the use of manipulatives, visual models, and explicit bridging prompts during intervention periods or regular mathematics classes. The study also suggests value in teacher support programs that help teachers design CRA-aligned lessons and monitor learners' progress across representations. Future research should examine CRA through experimental or quasi-experimental designs with comparison groups, broader student populations, and longer follow-up periods. Studies may also investigate retention, transfer of learning, and which components of CRA are most influential for different learners. Overall, representation-based instruction remains important for helping students build meaningful and durable understanding of fractions.

Contributions of Authors

The sole author was responsible for conceptualization, methodology, data gathering, data analysis, interpretation, and manuscript preparation.

Funding

This research received no external funding.

Conflict of Interests

The author is employed as a Math Specialist at Made for Math. However, the study was conducted independently as an academic requirement. Made for Math provided no funding or material support and had no role in the study design, data collection, analysis, interpretation, or reporting.

Acknowledgment

The author acknowledges the support of the participating school, learners, and families involved in the study, as well as the institutional support, encouragement, and moral support received throughout the research process. The author also acknowledges Made for Math for providing a professional environment that strengthened familiarity with structured, research-informed mathematics instruction, including the Concrete–Representational–Abstract (CRA) sequence, and helped inform the author's interest in examining CRA as an approach for supporting Grade 6 students' understanding of fractions.

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