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Fraction Wheel Instruction, Classroom Participation and Achievement in Third-Grade Mathematics

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ABSTRACT. This study examines the classroom implementation of fraction wheel media and the accompanying patterns of participation and achievement among third-grade students at MI Muhammadiyah 1 Kota Probolinggo, Indonesia. A descriptive classroom implementation approach combines observations, teacher and student interviews, instructional documentation, and achievement summaries from a pre-test and two instructional cycles. The intervention followed preliminary, core, and closing activities, incorporating teacher demonstrations, wheel manipulation, discussion in four groups, and individual assessment. Mean achievement scores increased from 63 at pre-test to 75 in Cycle I and 86 in Cycle II. Mastery percentages followed a different trajectory, decreasing from 39.13% to 30.43% before reaching 91.30%. The final increase therefore represents improvement relative to baseline, rather than uninterrupted improvement across all stages. Available observations recorded 100% participation in answering questions and 95.7% in operating the medium during Cycle II, although incomplete paired observations prevent calculation of gains for every participation indicator. The findings suggest that the fraction wheel can support accessible representations and opportunities for mathematical interaction when combined with purposeful questions and feedback. However, the absence of a comparison group, individual score distributions, and fully specified assessment criteria limits causal interpretation. The study contributes a context-sensitive account of classroom practice and identifies conditions for strengthening conceptual learning, inclusive participation, and the evaluation of manipulative-based fraction instruction.

Keywords: *fraction wheel, equivalent fractions, classroom participation, learning mastery, primary mathematics*

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INTRODUCTION

Fractions mark an important transition in elementary mathematics because learners must coordinate quantities, units, and symbolic relationships that cannot be understood by simply extending whole-number counting. A fraction describes a relationship between a selected quantity and a reference unit; its meaning depends on how that unit is partitioned and interpreted. Numerical development research emphasizes the importance of understanding magnitudes across number systems, rather than treating each notation as an isolated school topic (Siegler & Braithwaite, 2017). Consequently, early fraction instruction should help children

interpret what symbols represent, compare quantities meaningfully, and explain why a representation matches a mathematical expression.

The difficulty is partly conceptual. Children may assume that a larger denominator necessarily means a larger quantity, even when the same whole is being considered. They may also treat the numerator and denominator as unrelated whole numbers rather than coordinated components of one value. Research on whole-number bias shows that inappropriate whole-number reasoning changes with development and task demands, making it unsuitable to describe every error as simple carelessness (Braithwaite & Siegler, 2018b). A classroom response should therefore expose the relationship between the number of equal parts and the size of each part, while inviting students to justify their comparisons.

These demands have consequences beyond the immediate fraction lesson. Rational-number arithmetic involves several interacting sources of difficulty, including conceptual distinctions, procedures, and patterns of instructional experience (Siegler & Lortie-Forgues, 2017). Reviews of learning among children with mathematics difficulties likewise emphasize the need to understand fraction magnitude and to provide carefully structured instruction (Tian & Siegler, 2017). For beginning learners, an answer obtained by counting colored sections may conceal an incomplete understanding of the whole. Teachers need tasks that reveal whether children can identify the unit, recognize equal partitioning, and interpret the numerator and denominator together.

Indonesian research provides a relevant context for this problem. In a study of fraction multiplication, elementary students demonstrated difficulties interpreting contextual situations and the meaning of a fraction of a quantity, with procedural knowledge more prominent than conceptual understanding (Purnomo et al., 2022). Research on whole, half, and quarter concepts also documented problems with equal partitioning and abstraction among young primary learners (Sümen, 2019). These studies address different ages and tasks, but both indicate that familiar fraction symbols do not guarantee secure meanings. Instructional media are therefore valuable only when their use directs attention to the mathematical relationships that students need to construct.

The fraction wheel offers a potentially accessible representation for this purpose. A circular whole divided into equal sectors makes the relationship between a unit and its parts visible, while a rotating mechanism can organize selection, comparison, and discussion. However, the rotating action and the fraction representation perform different functions. Rotation may organize participation or introduce variation, whereas partitioning and labeling carry the mathematical content. Research on concreteness fading argues that successful instruction must clarify connections among concrete, representational, and abstract forms instead of assuming that handling objects automatically produces transferable knowledge (Fyfe & Nathan, 2019).

Evidence concerning manipulatives supports a conditional rather than universal expectation of benefit. A review of fraction interventions for struggling elementary learners found that instructional packages commonly combined representations with additional teaching components; effects on broader outcomes were less consistent than effects on closely aligned measures (Roesslein & Codding, 2019). A meta-analysis of single-case studies also reported benefits from manipulative-based mathematics interventions for learners at risk or identified with disabilities, while documenting variation across studies (Peltier et al., 2020). These findings justify investigating a fraction wheel within its teaching sequence, including explanation, practice, feedback, and assessment, rather than evaluating the object independently of classroom activity.

Digital fraction studies provide complementary insights without making a physical wheel equivalent to software. An intervention using digital manipulatives, adaptive activities, and feedback supported fraction learning, but the contribution of each component could not simply be transferred to a different classroom medium (Bush, 2021). Research comparing fraction

instruction with and without educational technology similarly highlights the relevance of instructional design and learners' prior achievement (Reinhold, Hoch, et al., 2020). For schools using inexpensive physical materials, the practical question is which instructional functions can be achieved through teacher guidance and peer interaction, even when automated feedback or adaptation is unavailable.

Student participation is another important dimension of implementation. A wheel can create visible opportunities to take turns, answer questions, and work with classmates, but these behaviors do not all represent the same depth of engagement. Broader engagement research distinguishes behavioral, emotional, and cognitive dimensions, although evidence from higher education cannot be directly generalized to elementary classrooms (Bond et al., 2020). In the present study, learning activeness is used in the narrower sense of observable classroom participation. Claims about motivation, confidence, or deep reasoning require additional evidence beyond the frequency of speaking or manipulating materials.

A further concern is the relationship between concepts and procedures. Understanding why two fraction representations are equivalent and successfully answering an exercise may develop together, but one cannot be inferred automatically from the other. Research describes conceptual and procedural knowledge as potentially reciprocal, with comparison, explanation, and exploration supporting their development (Rittle-Johnson, 2017). The sequencing of rational-number instruction also matters because different notations impose different conceptual demands (Tian & Siegler, 2018). A useful implementation study should therefore report both the learning opportunities offered and the limits of the evidence used to describe achievement.

The present study examines fraction wheel use in a third-grade classroom at MI Muhammadiyah 1 Kota Probolinggo. Its contribution is a detailed account of implementation alongside separately interpreted participation and achievement summaries. It does not claim that circular manipulatives are new or that one classroom establishes their effectiveness. Three questions guide the analysis: how was the medium incorporated into classroom instruction; what patterns of observable participation were reported across the two cycles; and how did mean scores and mastery percentages change across assessment stages? Addressing these questions together supports a proportionate interpretation of the reported improvements and their instructional implications.

METHOD

The study is reported as a descriptive classroom implementation study with qualitative observations and descriptive quantitative assessment summaries. This design integrates the description of classroom experiences with performance summaries from the pre-test and two instructional cycles. The cycles provide a temporal structure for describing implementation and outcomes; they do not establish an experimental comparison. The study documentation does not document the complete planning and reflection procedures needed to reconstruct a formal action-research protocol. Accordingly, the analysis focuses on classroom processes and descriptive outcome patterns, with interpretation bounded by the scope of the available evidence.

The setting was the third-grade mathematics classroom at MI Muhammadiyah 1 Kota Probolinggo. Students participated in fraction lessons, and the teacher facilitated demonstrations, group discussion, and evaluation. The study documentation identifies four learning groups but does not provide a class roster, participant flow, age distribution, or instructional dosage. These details are not reconstructed from rounded percentages. Transparent reporting of participants, context, researcher roles, and evidence is central to evaluating qualitative and mixed evidence reports (Levitt et al., 2018). Their incomplete specification therefore informs the scope of the conclusions rather than being concealed by an apparently precise sample description.

Instruction was organized into preliminary, core, and closing activities. Preliminary

activities included stating objectives, checking attendance, and preparing students to participate. During the core activities, the teacher introduced the fraction wheel, explained how it represented fractions, and organized students into four groups. Students rotated the wheel, identified selected fractions, discussed fraction problems, compared representations, and presented responses. Closing activities included summarizing the lesson, giving feedback, and completing evaluations. These activities formed the reported classroom instructional sequence; particular wheel dimensions, construction materials, time allocations, and scripted teacher questions are not specified because the classroom account does not document them.

The wheel was considered one component of an instructional arrangement that also included explanation, peer interaction, and individual work. This distinction matters because students could improve through several concurrent experiences. The analysis therefore separates the medium's representational function from its role in organizing turns and interaction. It also distinguishes opportunities for conceptual learning from evidence that such learning occurred. For example, comparing equivalent sectors offers an opportunity to examine equivalence, but confirmation of understanding would require students' explanations or responses to tasks beyond the practiced representation. Interpretations consequently remain bounded by the classroom evidence reported here.

The reported evidence sources comprised classroom observations, interviews with the teacher and selected students, instructional documentation, and learning assessments. Observations addressed five participation indicators: attending to explanations, asking questions, answering questions, solving problems, and operating the medium. Interviews and documents provided contextual descriptions of implementation. However, interview transcripts, selection criteria, complete observation sheets, and examples of student work were not available in the reported dataset. Consequently, the qualitative account is presented as summarized classroom evidence, at the level supported by these records. Individual experiences and the prevalence of particular views cannot be established from summarized evidence alone.

Qualitative analysis was described through selecting relevant information, organizing descriptions, displaying findings, and drawing conclusions by comparing sources. In this analysis, descriptions are organized around implementation, observable participation, and interpretation of achievement. The use of multiple sources can support credibility, but triangulation is not treated as automatic proof of validity. Guidance on trustworthy thematic analysis emphasizes an explicit decision trail and traceable links between interpretations and evidence (Nowell et al., 2017). Because detailed coding records and observer agreement are not reported, the analysis does not claim a new validated coding framework or retrospectively calculated reliability coefficient.

Quantitative analysis uses the reported mean scores and mastery percentages at pre-test, Cycle I, and Cycle II. Differences between means are expressed in score points, while differences between percentages are expressed in percentage points. The mastery criterion and score distributions are not specified, so mastery counts, standardized effect sizes, and significance tests are not reconstructed. In addition, aggregate means cannot reveal which students improved or whether assessment difficulty remained constant. Tables preserve all available values, and unavailable observations are labeled explicitly. This approach prevents qualitative descriptors from being converted into numerical estimates and avoids treating incomplete indicators as a complete repeated-measures dataset.

Integration occurs at the level of interpretation: descriptions of classroom activity are considered alongside aggregate outcome patterns without testing a causal pathway between them. Agreement between enthusiastic participation and higher scores is treated as a plausible instructional pattern, not as mediation evidence. Discrepancies, particularly the initial decline in mastery, receive explicit attention. Student identities are not reported, and the article contains no identifiable interview quotations or photographs. Approval and consent procedures are not

specified in the available study documentation. This omission limits the transparency of reporting on the involvement of children and remains an important methodological limitation requiring clarification from the research records.

RESULTS AND DISCUSSION

Classroom implementation

The reported implementation followed a consistent three-stage lesson structure. At the beginning, the teacher communicated the lesson objectives and prepared students for participation. During the core stage, students encountered fractions through teacher explanation, wheel manipulation, group problem solving, and presentation. At the end, reflection and evaluation returned attention to the intended concepts. This sequence shows that the wheel was incorporated into a broader lesson rather than used only as a recreational activity. Table 1 separates the recorded classroom actions from the instructional functions inferred from them, helping distinguish implementation evidence from interpretation.

Table 1. Reported instructional sequence and its interpretation

Stage	Reported activities	Instructional function
Preliminary	Objectives, attendance, and preparation	Orient students to the lesson and participation.
Core	Demonstration, wheel use, four groups, and discussion	Connect representations with symbols and provide interaction.
Closing	Summary, feedback, and evaluation	Consolidate ideas and examine individual performance.

Note. Activities summarize the original report. Instructional functions are interpretations, not independently measured effects.

The organization into four groups created a setting in which students could discuss responses before presenting them. The classroom account describes participation in rotating the wheel, identifying fraction values, and working on shared tasks. It does not specify whether every learner received equal turns, how groups were formed, or how responsibilities were distributed. Group work can therefore be reported as an implemented arrangement, but equitable participation cannot be assumed from the existence of groups. The distinction is particularly important when a visually engaging activity might allow a small number of confident students to dominate the materials or discussion.

The closing activities included feedback, lesson summaries, and evaluation. These components are relevant because they provide opportunities to connect actions with explicit mathematical meanings. Nevertheless, the classroom report does not identify the misconceptions addressed, the wording of corrective feedback, or the types of questions used to check transfer. The implementation evidence supports a description of the sequence and the opportunities it offered. It does not establish that all students moved successfully from concrete manipulation to independent symbolic reasoning. That stronger conclusion would require examples of explanations, written reasoning, or appropriately designed assessment items.

Observable student participation

The observation account described students as initially unfamiliar with the procedures and hesitant in some classroom exchanges. It also reported greater participation as students became accustomed to manipulating the wheel and discussing problems. These descriptions indicate a

perceived change in classroom interaction, but they are not accompanied by complete numerical observations for every indicator. In Cycle I, attending to the teacher's explanation was reported at 56.5%. In Cycle II, answering questions reached 100%, and operating the medium reached 95.7%. Table 2 retains these values while making the missing comparisons visible.

Table 2. Available participation observations across cycles

Indicator	Cycle I	Cycle II
Attending to explanations	56.5%	Qualitative increase only
Asking questions	Not reported	Not reported
Answering questions	Qualitative descriptor only	100%
Solving problems	Not reported	Not reported
Operating the medium	Qualitative descriptor only	95.7%

Note. Missing percentages are not zero. Different indicators cannot be combined into a valid gain score from these summaries.

The two high Cycle II percentages describe different behaviors. Answering questions concerns verbal participation, whereas operating the medium concerns interaction with the learning resource. Neither percentage establishes answer accuracy, explanatory quality, or independent problem solving. Moreover, the Cycle I descriptors for these indicators were qualitative, so a numerical increase cannot be calculated. The available record is compatible with stronger participation by the second cycle, but it does not support a precise gain score or an inferential significance claim. Asking questions and solving problems remain part of the observation framework without complete reported percentages.

Attention also requires careful interpretation. The Cycle I attention percentage cannot be compared numerically with the later answering or operating percentages because they measure different behaviors. A student may attend carefully without speaking, or manipulate the wheel without explaining the fraction represented. The results therefore support a differentiated account of participation rather than a single composite activeness score. This differentiation also prevents the strongest available values from being used to characterize all dimensions of student engagement. Further observation would be necessary to determine whether participation was sustained and accompanied by increasingly accurate mathematical explanations.

Achievement and mastery across stages

The achievement summaries show a steady rise in mean scores: 63 at pre-test, 75 in Cycle I, and 86 in Cycle II. The corresponding increases were 12 points and 11 points, producing a total difference of 23 points between baseline and the final assessment. These are descriptive changes in the reported class averages. Without individual scores, variation, and comparable assessment specifications, they cannot be translated into standardized effects or attributed exclusively to the wheel. Table 3 presents the mean and mastery results together because they describe complementary aspects of performance.

Table 3. Achievement summaries and descriptive changes

Assessment stage	Mean score	Mastery	Change in mean	Change in mastery
Pre-test	63	39.13%	Baseline	Baseline
Cycle I	75	30.43%	+12 points	−8.70 pp
Cycle II	86	91.30%	+11 points	+60.87 pp

Note. Changes compare each stage with the preceding stage. The overall changes are +23 score points and +52.17 percentage points (pp). Values reproduce the source table; no student counts are inferred.

Mastery followed a non-monotonic pattern. The percentage fell from 39.13% at pre-test to 30.43% in Cycle I, a decline of 8.70 percentage points. It then increased to 91.30% in Cycle II, a rise of 60.87 percentage points from the preceding stage and 52.17 percentage points from baseline. The first-cycle decline is retained because the available record provides no verified correction. Figure 1 displays both trajectories separately, preventing the increase in mean scores from obscuring the different pattern in mastery. No interpolated values or estimated student counts are included.

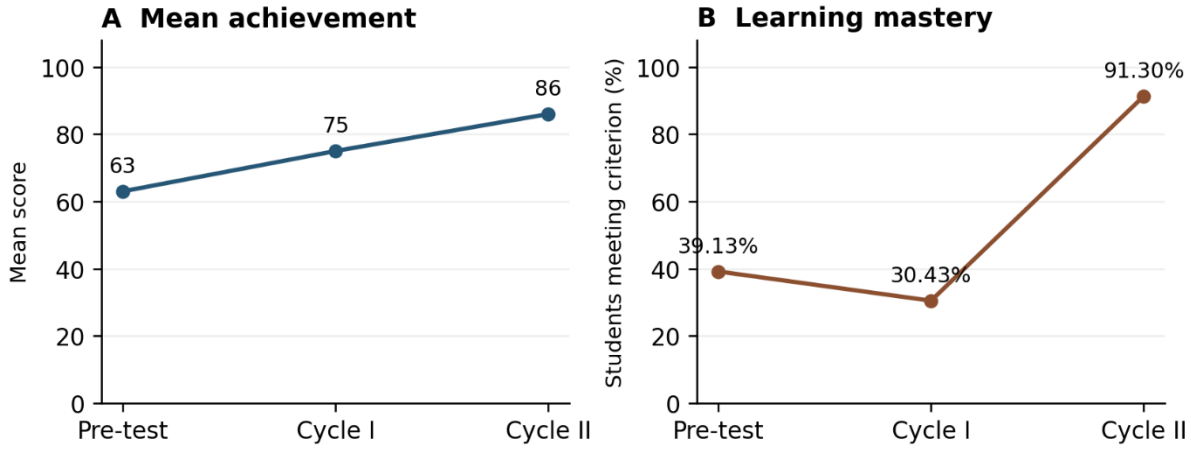


Figure 1. Mean achievement and mastery across assessment stages

Note. Panels use separate measures and reproduce the original values. The Cycle I mastery decline is retained; connecting lines show assessment order, not measurements between stages.

An increasing average and declining mastery percentage are not inherently incompatible. They can occur when improvement is concentrated among students who remain below a threshold, when some higher performers decline, or when assessment conditions differ. These are possible explanations, not findings about this class. The available summaries cannot distinguish them, and a transcription error also cannot be excluded without the original assessment records. Therefore, the first-cycle result should be examined against the scoring sheets and mastery criterion. Its presence weakens any statement that achievement improved uniformly for all learners throughout implementation.

By Cycle II, the reported average and mastery percentage both exceeded their baseline values. This is the clearest quantitative finding supported by the available summaries. At the same time, the final mastery result does not demonstrate complete class success, and it gives no information about retention after the instructional period. Taken together, the results show a

promising final performance pattern alongside incomplete observation coverage and an unresolved first-cycle discrepancy. The appropriate next step is explanatory discussion bounded by these conditions, rather than conversion of descriptive changes into a universal claim of instructional effectiveness.

DISCUSSION

Representations and the construction of fraction meaning

The educational value of the wheel depends first on how it represents the whole. Equal sectors can make the relation between partitioning and quantity accessible, but children must understand that equality of parts and consistency of the reference unit are essential. Rotating a pointer across fraction labels does not itself establish these relationships. The reported classroom activities offer plausible opportunities for connecting sectors, spoken fraction names, and symbols. However, the study did not separately assess these connections. The interpretation is therefore that the wheel supported access to meaningful representations, while the degree of conceptual change remains incompletely documented.

Research using contextual learning trajectories helps explain how such opportunities might be developed. A rowing context supported the movement from informal situations toward addition and subtraction of fractions in Indonesian primary education (Nasution et al., 2018). Likewise, work on partitive fraction division highlighted the importance of units, partitioning, sequenced tasks, and graphical representations (Wahyu et al., 2020). Neither study establishes the effectiveness of the present wheel, and their content is not identical to introductory third-grade tasks. Their relevance lies in showing that a representation becomes instructionally useful through a carefully organized progression of meanings and problems.

A circular area model should also be connected to other representations. Fractions express numbers as well as parts of familiar objects, and a learner who recognizes shaded sectors may still struggle to compare magnitudes without a picture. A meta-analysis found an association between number-line estimation and broader mathematical competence, including evidence involving fractions (Schneider et al., 2018). This association does not prove that adding a number line would cause gains in this classroom. It nevertheless supports an instructional extension in which students relate a fraction shown on the wheel to a position between zero and one and explain the shared quantity.

The wheel also creates opportunities to challenge whole-number reasoning. For the same whole, increasing the denominator produces smaller equal parts, a relationship that can be inspected through carefully selected comparisons. Yet perceptual inspection should be accompanied by explanation, because an answer based only on color or orientation may not generalize. Research on fraction addition indicates that children's performance can reveal limitations in understanding the meaning of the operation (Braithwaite et al., 2018). Teachers should therefore use examples that require attention to the unit and the represented quantity, rather than rewarding a correct symbol without probing the reasoning behind it.

Task selection matters as much as representation. Studies of textbook learning demonstrate that children can acquire misleading associations from the distribution of fraction arithmetic problems (Braithwaite & Siegler, 2018a). Computational modeling also emphasizes how experiences and learning processes can generate systematic patterns of fraction performance (Braithwaite et al., 2017). Applied cautiously to the present setting, these findings suggest varying examples so that students cannot succeed through a single superficial cue. Such variation is a recommendation for strengthening instruction, not a claim that the reported lessons used a particular distribution of problems or eliminated biased reasoning.

From handling the medium to explaining mathematics

The distinction between action and reasoning is central to interpreting the participation findings. Operating the wheel may reduce the barrier to joining the lesson because it offers a clear, visible action. Mathematical understanding, however, requires students to explain what the selected fraction means and why an answer is reasonable. A meta-analysis of self-explanation prompts supports the instructional value of asking learners to generate conceptual connections (Bisra et al., 2018). In this classroom, follow-up questions about the whole, equal parts, and equivalence would provide stronger evidence of learning than operation alone, although the classroom report does not document systematic explanation prompts.

The movement toward symbolic reasoning should be gradual and purposeful. A teacher might first invite a student to identify a sector arrangement, then draw it, describe it verbally, and finally interpret a fraction without the wheel. These are suggested extensions, not reconstructed observations. The principle is to retain the meaningful relationship while reducing dependence on the material's incidental features. Students who can succeed only when the wheel is present may have acquired a useful local routine without a flexible concept. Assessments using alternative shapes, unfamiliar orientations, and written explanations would help distinguish those possibilities.

Individual differences make this transition especially important. Research on fraction arithmetic learning shows variation among learners rather than a single uniform developmental pathway (Braithwaite et al., 2019). Other work distinguishes adaptive expertise from routine performance in rational-number arithmetic (McMullen et al., 2020). These findings caution against reading the class mean as evidence that every student acquired the same competence. A rising average may coexist with persistent difficulties among particular learners. The wheel can therefore serve both as a shared classroom resource and as a starting point for targeted questions that reveal where individual students need additional support.

Conceptual distinctions across rational-number notations provide another reason to assess transfer carefully. Research on decimal arithmetic shows that procedural success and conceptual knowledge may diverge even within closely related numerical content (Lortie-Forgues & Siegler, 2017). The present study does not investigate decimals, and its findings should not be generalized to them. The relevant implication is methodological: success on practiced fraction tasks cannot stand in for all forms of rational-number understanding. Transfer should be investigated with explicitly selected tasks, rather than inferred from the general attractiveness of a concrete learning medium or from a single aggregate score.

Participation and the organization of classroom interaction

The high Cycle II participation percentages are educationally encouraging because they suggest that students were willing to engage in visible classroom actions. Nonetheless, the distinction between behavioral involvement and mathematical reasoning must remain explicit. A student may answer a short recall question without coordinating fractional quantities, while another may reason productively before speaking. The findings therefore support the claim that the learning arrangement offered opportunities for participation. They do not establish that every participating learner experienced the same emotional response, invested equal cognitive effort, or benefited equally from group interaction.

The game-like quality of the wheel may help explain students' interest, but the study did not isolate this mechanism. A meta-analysis of gamification found that cognitive, motivational, and behavioral outcomes need separate consideration and that effects vary with design and context (Sailer & Homner, 2020). A rotating classroom wheel also differs from the diverse interventions included in that review. Its practical value is more defensibly linked to purposeful turn-taking and meaningful tasks than to novelty alone. If attention is directed mainly toward

spinning or winning, the activity could compete with the mathematical goals it is intended to support.

Inclusive implementation requires monitoring who receives opportunities to contribute. Four groups do not automatically ensure that quiet students, learners needing more time, and confident speakers participate comparably. Rotating responsibilities for manipulation, explanation, checking, and reporting would make participation more visible and distribute opportunities more deliberately. These roles are proposed improvements rather than features verified in the classroom account. Teachers can also invite students to prepare an explanation with a peer before addressing the class. The central objective is to make the mathematical contribution accessible, rather than using public participation as the sole indicator of successful engagement.

Cognitive demands should be managed alongside participation. Students may need to coordinate the wheel's movement, the selected fraction, a peer's explanation, and a written task at the same time. Cognitive load theory emphasizes the relationship between instructional design and the demands placed on limited processing resources (Sweller et al., 2019). Clear demonstrations, simple visual layouts, and pauses between selection and explanation are therefore reasonable design considerations. The present evidence does not measure cognitive load, but it supports examining whether the procedural excitement of the activity helps students focus on the relevant quantities or distracts from them.

Feedback and interpretation of achievement

Feedback is a plausible contributor to the observed final improvement because the reported sequence included teacher reinforcement and evaluation. Its presence alone does not specify its quality. A large meta-analysis showed that feedback effects vary and that different forms of feedback should not be treated as a uniform intervention (Wisniewski et al., 2020). For fraction learning, useful feedback would identify the conceptual issue in a response and guide the next step, such as reconsidering unequal parts or an inconsistent whole. The study cannot establish that this mechanism occurred consistently, but it indicates an important feature to document in subsequent implementation research.

Evidence from digital fraction instruction also draws attention to feedback and adaptation. Research with disadvantaged learners examined sustained learning under instructional conditions incorporating interactivity, adaptivity, and explanatory feedback (Reinhold, Hofer, et al., 2020). A physical wheel does not provide these functions automatically; they depend on teacher decisions and the organization of tasks. Broader research on digital mathematics and science instruction similarly identifies contextual factors, including teacher preparation, as relevant to outcomes (Hillmayr et al., 2020). These comparisons support investing in instructional planning rather than assuming that either a physical or digital medium independently guarantees better achievement.

The mean-score increase in the present study is compatible with learning during the instructional period, but several rival explanations remain possible. Students received repeated instruction, became familiar with classroom routines, and completed successive assessments. Without a comparison group or documented equivalence of tests, the separate contribution of the wheel cannot be identified. This limitation does not make the descriptive results meaningless. It changes the appropriate claim from demonstrated causal effectiveness to an observed improvement associated with a particular classroom arrangement. Such a claim is useful for local reflection while remaining open to further testing.

Mastery requires equally careful interpretation because it is a threshold-based summary. An average represents the center of the score distribution, whereas mastery describes the proportion meeting a criterion. The initial divergence between these indicators demonstrates why both should be reported. Changing the Cycle I percentage merely to create a smoother trajectory

would remove potentially important information. Retaining the value instead exposes a question that can be resolved only through assessment records. Until the threshold, denominators, and individual scores are verified, the study should not assert continuous class-wide improvement or explain the decline through an unobserved learner characteristic.

A meta-analysis of rational-number interventions found that results depended in part on the type of outcome measure, with stronger effects on proximal than distal measures (Rojo et al., 2023). This distinction is directly relevant to the interpretation of the present assessments. If test items closely resemble the practiced wheel tasks, improved scores may indicate successful learning of those tasks without demonstrating broader competence. Future evaluation should include both curriculum-aligned questions and transfer items using unfamiliar representations. A delayed assessment would further distinguish immediate performance from retention, which the current two-cycle summary does not establish.

Implications and limitations

Assessment should also make the content of learning visible. Research on cognitively diagnostic fraction-subtraction assessment illustrates the value of specifying the knowledge attributes that a task requires (Akbay et al., 2018). The present study concerns younger learners and different instructional objectives, so that assessment framework cannot simply be adopted unchanged. Nevertheless, it suggests organizing evidence around identifiable competencies such as equal partitioning, naming fractions, comparing quantities, and explaining equivalence. Reporting performance by competency would make the mean score more interpretable and help teachers determine which aspects of fraction understanding remain difficult after instruction.

For classroom practice, the findings support treating the wheel as an entry point within a coherent sequence. Teachers can establish the whole, connect representations and symbols, invite explanations, offer feedback, and then check individual understanding without the medium. These recommendations are grounded in the relationship between the reported implementation and the wider literature; they are not all verified features of the original lessons. The approach also allows inexpensive resources to be used purposefully. What matters is whether the teaching sequence makes mathematical relationships accessible and provides evidence that learners can use those relationships independently.

For subsequent lessons, a brief individual exit task could complement the group activity. Students could identify the whole, explain one fraction representation, and solve a related question without rotating the wheel. Comparing these responses with classroom observations would help distinguish willingness to participate from independent understanding. The task should use the same intended competencies across assessment occasions, with scoring criteria established beforehand. This proposed procedure would make instructional decisions more transparent while avoiding the assumption that an enjoyable lesson necessarily produces secure mathematical knowledge for every learner.

The study's main limitations concern the descriptive design, incomplete methodological specification, partial participation observations, and aggregate achievement summaries. The classroom account does not provide the sample roster, full instruments, mastery threshold, score variability, or detailed interview evidence. It also does not support statistical significance testing, causal mediation, or claims about long-term retention. These limitations should guide future documentation: preserve individual assessment records, specify observational definitions, report instructional time and ethical procedures, and compare outcomes across equivalent tasks. A stronger subsequent study could then evaluate whether the promising final pattern is reproducible across classrooms and learners.

CONCLUSION

The fraction wheel was implemented through teacher preparation, guided manipulation,

discussion in four groups, and closing evaluation in a third-grade classroom at MI Muhammadiyah 1 Kota Probolinggo. The reported mean scores increased from 63 to 75 and then 86. Mastery decreased from 39.13% to 30.43% before increasing to 91.30%, so improvement was evident at the final stage but was not continuous across all indicators. Available Cycle II observations recorded high participation in answering questions and operating the medium, while missing paired percentages prevented a complete numerical analysis of participation gains.

These findings support the fraction wheel as a promising classroom resource when its representational features are connected to explanation, feedback, and individual assessment. They do not establish that the wheel alone caused the improvement or that all students achieved transferable conceptual understanding. The practical contribution lies in identifying how concrete representation and structured interaction can be combined, together with the evidence needed to evaluate that combination responsibly. Future research should verify the assessment records, specify the mastery criterion and participant information, document participation consistently, and include transfer and retention measures. Such evidence would strengthen the basis for decisions about broader implementation.

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