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Evaluation of Junior High School Students' Representation Skills in Differentiated Learning

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Abstract

Developing junior high school students' conceptual understanding through coherent mathematical representations remains a persistent challenge, as conventional assessments tend to prioritize procedural accuracy while neglecting how students construct, connect, and integrate symbolic, visual, and verbal forms. Differentiated learning is designed to address learner diversity, yet its role in fostering representational competence and providing diagnostic insight is still insufficiently examined. This study evaluates students' mathematical representation skills within differentiated learning environments by identifying representational patterns, variations across readiness levels, and the diagnostic value of representation-focused assessment. Using a qualitative approach, data were collected through analysis of students' written work and semi-structured interviews in classrooms implementing differentiated mathematics tasks. Participants were categorized into high, moderate, and low representational readiness levels. The findings reveal substantial variability in representational quality and integration. High-readiness students demonstrated flexible coordination across multiple representations, while moderate- and low-readiness students tended to rely on single or fragmented forms. Although differentiated tasks increased engagement and learner choice, effective representational coherence required explicit and targeted scaffolding. Importantly, representation-focused assessment uncovered learning gaps, misconceptions, and conceptual weaknesses that were often overlooked by procedural evaluations. The study concludes that differentiated learning can support the development of representational competence, but its effectiveness depends on intentional scaffolding and diagnostic assessment practices that promote deeper, more equitable conceptual understanding in mathematics.

***Keywords:** Mathematical Representation; Differentiated Learning; Representational Competence; Diagnostic Assessment; Junior High Mathematics*

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INTRODUCTION

The COVID-19 pandemic has brought sustained disruption to mathematics education worldwide, with consequences that extend beyond immediate learning loss to deeper dimensions of students' mathematical understanding. Research across diverse educational contexts has a documented declines in achievement, stagnation in cognitive development, and difficulties in rebuilding conceptual coherence following prolonged periods of remote instruction (Magableh & Abdullah, 2020; Fischer et al., 2024). These challenges are particularly salient in mathematics, a discipline in which learning depends not only on procedural fluency but also on students' ability to construct, interpret, and connect meanings across representations.

Within mathematics education research, mathematical representation is widely recognized as a central component of conceptual understanding and mathematical thinking. Representations: symbolic, visual, graphical, tabular, and verbal, serve as tools through which learners organize mathematical ideas, reason about relationships, and communicate meaning (Fatqurhohman et al., 2020; Vizha et al., 2025). Competence in representation involves more than the use of multiple forms; it includes the ability to select appropriate representations, translate between them, and use them productively in problem solving and explanation. Empirical studies consistently show that students' difficulties in mathematics often emerge at the representational level, even when procedural performance appears adequate (Fatqurhohman & Susetyo, 2022; Permatasari et al., 2025).\

The junior high school level represents a particularly critical stage for the development of representational competence. At this level, students transition from concrete reasoning toward more abstract mathematical structures, encountering formal symbolism, relational reasoning, and early algebraic thinking. Research indicates that many students struggle to coordinate different representations during this transition, leading to fragmented understanding and persistent misconceptions (Hackenberg et al., 2021; Marks et al., 2021). These difficulties are exacerbated when instructional practices prioritize uniform procedures over opportunities to explore mathematical ideas through varied representational pathways.

In the Indonesian context, the challenges associated with mathematical representation have been intensified by pandemic-era instructional conditions. Studies examining post-pandemic classrooms report that mathematics instruction during remote learning often emphasized task completion and algorithmic procedures, while opportunities for discussion, visual exploration, and representational translation were limited (Gusteti & Neviyarni, 2022; Wahyuningsari et al., 2022). As a result, many students demonstrate surface-level procedural competence but lack the representational flexibility needed to explain reasoning, justify solutions, or connect mathematical concepts meaningfully (Wahyuni, 2022; Yuniarti et al., 2025).

In response to these challenges, recent educational reforms have emphasized instructional approaches that recognize learner diversity and promote adaptive teaching practices. Within this broader landscape, differentiated learning has gained increasing attention as a pedagogical approach that seeks to accommodate variations in students' readiness, interests, and learning profiles (Eikeland & Ohna, 2022; Tomlinson & Imbeau, 2023). Rather than prescribing uniform learning trajectories, differentiated instruction encourages multiple pathways to understanding, allowing students to engage with mathematical ideas in ways that align with their cognitive resources.

Research on differentiated instruction suggests that such approaches can enhance student engagement, learning satisfaction, and academic outcomes across subject areas (Godor, 2021; Liou et al., 2023; Fajaryati et al., 2023). In mathematics classrooms, differentiated learning has been associated with increased opportunities for students to employ diverse strategies and representations when solving problems (Hackenberg et al., 2021; Marks et al., 2021). These findings point to a strong conceptual alignment between differentiated instruction and the development of mathematical representation skills.

However, the effectiveness of differentiated learning depends not only on instructional design but also on the nature of evaluation practices that accompany it. A recurring concern in the literature is the misalignment between differentiated instruction and assessment systems that remain standardized and procedure-oriented (Puzio et al., 2020; Smets et al., 2022). When assessments privilege uniform answers and fixed solution methods, they fail to capture the diversity of students' representational thinking and obscure important differences in conceptual understanding.

From the perspective of mathematics education, evaluation plays a critical role in shaping students' opportunities to learn. Assessment practices influence what counts as mathematical knowledge, which forms of reasoning are valued, and how students engage with representations (Fischer et al., 2024). Yet, many existing assessment instruments are insufficiently sensitive to representational processes, focusing instead on final answers rather than the ways students construct and coordinate meaning across representations (Fatqurhohman & Firdaus, 2024; Wahyuni, 2022).

Despite growing interest in differentiated instruction, relatively few studies have examined how students' mathematical representation skills are evaluated within differentiated learning environments, particularly at the junior high school level. Existing research tends to focus on implementation issues, teacher beliefs, or general learning outcomes (Van den Kieboom & Groleau, 2022; Langelaan et al., 2024), while studies on representation often treat instructional context as a secondary consideration. This separation leaves a gap in understanding how differentiated instructional contexts shape students' representational activity and how evaluation can be designed to capture such activity meaningfully.

Addressing this gap is especially important in the context of post-pandemic learning recovery, where classrooms are characterized by heightened heterogeneity in students' prior knowledge and representational competence. Without evaluation frameworks that attend to representational diversity, differentiated instruction risks becoming a rhetorical commitment rather than a substantive pedagogical practice. Evaluation that foregrounds representation has the potential to function diagnostically, revealing students' conceptual resources and guiding instructional decision-making in differentiated classrooms (Smets et al., 2022; Fischer et al., 2024).

Accordingly, the purpose of this study is to evaluate junior high school students' mathematical representation skills within a differentiated learning context. The study examines how students with varying learning characteristics construct and use multiple representations when engaging with mathematical concepts, and how evaluation practices can systematically capture these differences. Rather than focusing on curriculum policy or measuring pandemic-related learning loss, this study positions differentiated learning as the instructional context within which representational competence is examined.

The contribution of this study lies in its integration of evaluation, representation, and differentiated learning within a single analytical framework. By foregrounding mathematical representation as the object of evaluation, this research advances discussions in mathematics education concerning how assessment can support conceptual understanding and meaning-making. The findings are expected to inform both theory and practice by offering insights into the design of evaluation approaches that align with differentiated instruction and attend to the representational foundations of mathematical learning at the junior high school level.

METHOD

1. Research Design

This study employed a qualitative multiple-case study design to empirically investigate junior high school students' mathematical representation skills in a differentiated learning environment. The design was chosen to allow systematic examination of students' representational processes as they naturally occurred during classroom instruction, rather than as isolated test performances. Each case consisted of an individual student whose written work and verbal explanations were analyzed to capture how mathematical ideas were represented, coordinated, and transformed across different representational forms. The study was conducted over four consecutive mathematics lessons, ensuring that students' representational activity was observed across multiple tasks and instructional moments.

2. Research Context and Participants

Data were collected using three open-ended mathematical tasks designed to elicit multiple representations, including symbolic, visual, and verbal forms. Tasks were administered during regular lessons and completed individually. Students' written responses constituted the primary data source. In addition, task-based semi-structured interviews were conducted with each focal student immediately after task completion. Interviews focused on students' reasoning, representational choices, and difficulties encountered during problem solving. All interviews were audio-recorded and transcribed verbatim.

3. Data Analysis

Data analysis followed a two-stage qualitative procedure. First, a within-case analysis was conducted to identify the types of representations used by each student and the accuracy and coherence of their use. Second, a cross-case analysis was carried out to compare representational patterns across students with different learning profiles. Representations were coded into symbolic, visual, and verbal categories. Transitions and inconsistencies between representations were treated as critical analytical units. Coding was conducted iteratively, with categories refined based on emerging patterns in the data.

RESULT AND DISCUSSION

1. Patterns of Students' Mathematical Representations in Differentiated Learning

The analysis of students' work and interviews revealed distinct patterns in how junior high school students employed mathematical representations within a differentiated learning environment. While most students engaged with multiple representational modes: symbolic, visual, and verbal, their ability to coordinate these representations varied systematically with their level of representational readiness. High-readiness students demonstrated coherent integration across forms, translating between symbolic expressions, diagrams, and verbal explanations, which facilitated deeper conceptual understanding (Fatqurhohman et al., 2020; Permatasari et al., 2025; Smets et al., 2022). Students with moderate readiness often relied on a dominant representation, typically visual or verbal, producing partially aligned symbolic work that reflected emerging but unstable conceptual knowledge (Fatqurhohman & Susetyo, 2022; Yuniarti et al., 2025). In contrast, students with low readiness primarily employed concrete or verbal representations, with minimal translation into formal symbols, indicating that participation increased under differentiated tasks but conceptual integration remained limited (Hackenberg et al., 2021; Marks et al., 2021).

These observations suggest that differentiated learning can elicit a diversity of representational expressions; however, representational quality, coherence, and flexibility are not automatically ensured. To clarify the relationships between students' readiness, representational patterns, and pedagogical implications, Table 1 summarizes the observed trends, highlighting coordination, flexibility, and practical insights for instructional scaffolding. By structuring the data in this manner, the table provides a concise and theoretically meaningful overview that complements the narrative analysis and supports targeted interpretation of representational competence in differentiated mathematics learning.

Table 1. Patterns of Students' Mathematical Representations in Differentiated Learning

Readiness Level	Representation Pattern	Pedagogical Implication
High	▪ Uses symbolic, visual, and verbal representations ▪ Integrates multiple modes coherently ▪ Translates flexibly between modes	▪ Supports multi-modal reasoning ▪ Example: student verified symbolic solution with diagram and explained verbally ▪ Indicates strong conceptual understanding
Moderate	▪ Dominant use of one mode (visual or verbal) ▪ Symbolic representations often partial or procedural ▪ Limited translation across modes	▪ Requires scaffolding for alignment ▪ Example: diagram accurate but symbolic steps incomplete ▪ Verbal reasoning alone insufficient
Low	▪ Relies on verbal descriptions or concrete visual cues ▪ Rarely formalizes reasoning symbolically ▪ Minimal coordination between modes	▪ Needs guided support for symbolic formalization ▪ Example: student used drawing or verbal explanation only ▪ Differentiation increased engagement but not integration

Table 1 reveal that differentiated learning elicits diverse mathematical representations, yet the quality and coherence of these representations are strongly mediated by students' representational readiness. High-readiness students consistently integrated symbolic, visual, and verbal forms, demonstrating flexible translation across modalities. This pattern indicates not merely procedural competence but deep conceptual understanding, consistent with prior findings that representational integration reflects sophisticated mathematical reasoning (Fatqurhohman et al., 2020; Permatasari et al., 2025). In contrast, moderate-readiness students exhibited partial coordination, often producing correct visual or verbal forms that were misaligned with symbolic expressions, reflecting unstable conceptual schemas (Fatqurhohman & Susetyo, 2022; Yuniarti et al., 2025). Low-readiness students predominantly relied on concrete or verbal modes, with minimal symbolic formalization, suggesting that differentiation alone is insufficient to promote integrative reasoning (Hackenberg et al., 2021; Marks et al., 2021).

These findings underscore that differentiated learning functions as an enabling condition rather than a self-sufficient strategy. While providing choice in representational modes increased engagement and participation, it did not automatically foster integration or conceptual depth. This aligns with theoretical perspectives emphasizing that representational competence develops through explicit scaffolding and guided translation between modes, rather than through exposure to multiple representations alone (Smets et al., 2022; Langelaan et al., 2024; Van den Kieboom & Groleau, 2022). Moreover, the observed patterns highlight the diagnostic value of representation-focused evaluation: examining how students coordinate and translate representations offers richer insights into conceptual understanding than conventional procedural assessments.

Practically, these results suggest that mathematics instruction at the junior high level should pair differentiated tasks with structured opportunities for representational translation and alignment. Such scaffolding can help stabilize emerging conceptual knowledge, particularly for moderate- and low-readiness students, while allowing high-readiness students to extend flexible, integrated reasoning. Consequently, the findings provide a theoretically grounded and actionable framework for leveraging differentiated learning to strengthen both conceptual understanding and representational competence in heterogeneous classrooms.

2. Variations in Representational Coordination Across Learning Profiles

Analysis of students' representational coordination revealed systematic differences across learning profiles. While previous findings highlighted which representational modes students employed, this sub-section focuses on how effectively students coordinated these modes, and how this coordination varied with their readiness level. High-readiness students exhibited coherent, bidirectional integration across symbolic, visual, and verbal forms, translating between representations to validate solutions and articulate reasoning. Moderate-readiness students produced meaningful diagrams or verbal explanations, yet often failed to align these with symbolic expressions, indicating partial and unstable conceptual understanding. Low-readiness students predominantly relied on verbal or concrete visual cues, rarely achieving symbolic formalization. These patterns underscore that differentiated learning elicits diverse representational behaviors, but does not inherently guarantee integration or conceptual depth, emphasizing the importance of targeted scaffolding (Hackenberg et al., 2021; Fatqurhohman & Susetyo, 2022; Langelaan et al., 2024).

Table 2. Variations in Representational Coordination Across Learning Profiles

Readiness Level	Coordination Pattern	Integration Challenge	Instructional Implication
High	Fully coherent, bidirectional translation.	Minimal; representations mutually reinforce	Encourage multi-step reasoning and integration: e.g., student verified symbolic solution with diagram and explained verbally
Moderate	Partial coordination, dominant mode prevails.	Diagram often misaligned with symbolic expressions.	Provide scaffolding for translation between modes: e.g., diagram correct but symbolic steps incomplete, verbal explanation insufficient
Low	Isolated representations, minimal translation	Symbolic formalization absent	Guide translation across representations: e.g., relied on verbal explanation or concrete drawing only; differentiated tasks increased participation but not integration

Table 2 demonstrate that students' representational coordination varies systematically with readiness level. High-readiness students integrate multiple modes flexibly, using representations as mutually reinforcing tools for reasoning, validation, and explanation. Moderate-readiness students exhibit partial coordination: their representations may be accurate individually but fail to align structurally, indicating unstable conceptual understanding. Low-readiness students remain largely dependent on a single mode, rarely achieving symbolic formalization, despite engagement in differentiated tasks.

These findings reinforce the theoretical perspective that representational competence develops incrementally and requires explicit scaffolding to enable translation and alignment across symbolic, visual, and verbal forms (Smets et al., 2022; Langelaan et al., 2024; Van den Kieboom & Groleau, 2022). Pedagogically, teachers should pair differentiated tasks with structured opportunities for bidirectional translation, ensuring that representations are not used in isolation but as interconnected tools for conceptual understanding. Such an approach transforms differentiated learning from a strategy for engagement into a mechanism that enhances representational integration, diagnostic insight, and deep mathematical reasoning.

3. Differentiated Learning as an Enabling but Insufficient Condition

The analysis reveals that differentiated learning functioned as an enabling condition for students' mathematical representational activity, yet it was not sufficient to ensure representational coherence. Differentiated tasks allowed students to select modes aligned with their preferences, increasing engagement and reducing cognitive overload, particularly for low-readiness learners. For instance, students who began problem-solving with diagrams or verbal reasoning reported feeling "*more confident*" before formalizing their solutions symbolically. These findings corroborate previous studies indicating that differentiation enhances accessibility, participation, and learner agency in mathematics classrooms (Marks et al., 2021; Gusteti & Neviyarni, 2022).

However, the data indicate that when representational choices were entirely open, some students persisted in familiar but limited forms of representation. Without explicit scaffolding to guide translation and integration across modes, differentiation risked reinforcing representational silos rather than promoting meaningful conceptual connections. Moderate- and low-readiness students often produced accurate but isolated diagrams or verbal explanations that were disconnected from symbolic formalization. This pattern aligns with prior research emphasizing that differentiation alone is insufficient to develop robust representational competence; intentional instructional prompts are necessary to facilitate representational transitions and coherence (Smets et al., 2022; Langelaan et al., 2024).

Therefore, differentiated learning should be conceptualized not merely as variation in task format or pace, but as a strategic design that actively supports representational translation, alignment, and reflection. The findings extend the literature by demonstrating that representational growth depends critically on how differentiation is enacted at the level of representations, rather than solely at the level of content difficulty or learning speed. In practice, this implies that teachers should pair differentiated tasks with structured scaffolding and guided prompts, enabling students to move fluidly between symbolic, visual, and verbal forms, thus transforming differentiation from a tool for engagement into a mechanism for deep conceptual understanding.

Table 3. Differentiated Learning as Enabling but Insufficient Condition

Function	Observation / Pattern	Pedagogical Implication
Enabling	▪ Increases engagement: students more willing to express mathematical ideas ▪ Reduces cognitive overload: learners start with preferred representation mode ▪ Supports diverse learning profiles: low-readiness students gain access to problem-solving	▪ Allow students to choose initial representational form (diagram, verbal, or concrete) ▪ Example: a student began with a diagram, then translated to symbolic solution; reported increased confidence and participation
Insufficient	▪ Representational silos: students confined to familiar modes ▪ Limited cross-modal translation: diagrams, verbal, and symbolic representations often disconnected ▪ Partial conceptual integration: symbolic formalization missing or inaccurate	▪ Provide explicit scaffolding to guide translation and alignment between representations ▪ Example: moderate-readiness student drew correct diagram but symbolic procedure incomplete; teacher intervention prompted mapping across modes

Table 3 demonstrate that while differentiated learning enables engagement and access, it does not automatically produce representational coherence. Students' choices of preferred modes increased confidence and reduced cognitive load, particularly for low-readiness learners, confirming differentiation's role as an enabling condition (Marks et al., 2021). However, when left unguided, representational silos persisted, and cross-modal integration remained limited, indicating that differentiation alone is insufficient to foster conceptual connections. These findings emphasize that differentiation must be strategically coupled with scaffolding and explicit prompts to support representational translation and integration, ensuring deeper conceptual understanding.

4. Representation as a Diagnostic Lens for Learning Gaps

A central contribution of this study lies in demonstrating the diagnostic potential of analyzing students' mathematical representations within differentiated learning contexts. Analysis of students' written products and verbal explanations revealed learning gaps that would often remain undetected through conventional procedural assessments. Several students, for example, produced correct numerical answers while employing inconsistent or inaccurate representations, highlighting fragile conceptual understanding. Conversely, some students who committed minor procedural errors exhibited coherent multi-modal reasoning, indicating stronger conceptual foundations despite incorrect final answers. These findings support prior critiques of traditional assessment practices that privilege final answers over representational reasoning (Puzio et al., 2020; Fischer et al., 2024).

By focusing on representation, the study captured a more nuanced picture of students' cognitive processes, including misconceptions, partial understandings, and emerging conceptual structures. This is particularly salient in post-pandemic contexts, where learning loss often manifests as fragmented understanding rather than complete absence of knowledge (Yuniarti et al., 2025). The representational lens therefore functions not only as a measure of achievement but also as a diagnostic tool, providing actionable insights into students' readiness, conceptual gaps, and specific areas requiring scaffolding.

Furthermore, representation-focused evaluation allowed differentiated learning to function diagnostically. Teachers could make informed decisions about when to prompt representational translation, when to provide guided scaffolding, and when to introduce formal symbolic procedures. This integration of assessment and instruction reinforces the argument that effective differentiated learning requires alignment between representational analysis and pedagogical interventions (Tomlinson & Imbeau, 2023; Van den Kieboom & Groleau, 2022). Overall, evaluating students' mathematical representations enables teachers to move beyond procedural accuracy, cultivating deeper conceptual understanding while tailoring instruction to individual learning profiles.

Table 4. Representation as a Diagnostic Lens for Learning Gaps

Observation / Pattern	Diagnostic Insight	Instructional Implication
Correct numerical answers, inconsistent representations	▪ Fragile conceptual understanding ▪ Procedural success masks gaps	▪ Provide targeted scaffolding to align representations with symbolic reasoning; ▪ e.g., student computed correct result but diagram contradicted the relationship
Minor procedural errors, coherent representations	Strong conceptual foundation despite mistakes	▪ Encourage formalization and symbolic generalization; ▪ e.g., student miscalculated but diagram and verbal reasoning consistent
Fragmented multi-modal use	Partial understanding, emerging structures	▪ Guide representational translation and integration; ▪ e.g., student used diagram and verbal mode separately, needed prompts to connect them

Table 4 illustrate that mathematical representations serve as a powerful diagnostic lens to identify learning gaps that procedural assessments often overlook. Students may arrive at correct numerical solutions while displaying fragmented or incorrect representations, indicating that procedural success does not necessarily equate to conceptual understanding. Conversely, students making minor computational errors sometimes exhibit coherent multi-modal reasoning, revealing emerging or robust conceptual structures despite incorrect outcomes.

These observations underscore the critical role of representation-focused assessment in post-pandemic learning contexts, where fragmented knowledge and partial conceptual understandings are prevalent (Yuniarti et al., 2025). By analyzing students' representations: symbolic, visual, and verbal, teachers can detect misconceptions, gaps, and inconsistencies, enabling targeted scaffolding and interventions. This aligns with the principles of differentiated instruction, emphasizing that assessment and teaching must be integrated to support individual learning trajectories (Tomlinson & Imbeau, 2023; Van den Kieboom & Groleau, 2022).

Importantly, the data suggest that differentiated learning alone does not guarantee conceptual coherence. Without explicit guidance to translate and align representations, students may rely on familiar modes, leaving gaps unaddressed. Therefore, teachers must design instructional prompts and scaffolds that encourage students to move fluidly between visual, symbolic, and verbal representations, ensuring that engagement translates into deep, transferable understanding. Overall, the representational lens not only provides diagnostic insight but also guides pedagogical decision-making, bridging assessment, differentiation, and conceptual development in mathematics classrooms.

5. Implications for Mathematics Instruction and Assessment

The results suggest several implications for mathematics instruction at the junior high school level. First, differentiated learning should explicitly incorporate representational goals, ensuring that students are not only allowed but also guided to engage with multiple representations. Second, assessment practices should move beyond uniform procedural tasks and include representation-rich activities that reveal students' conceptual structures. From a theoretical perspective, the findings contribute to mathematics education research by positioning representation as a central reminder mechanism linking differentiation and conceptual understanding. Rather than viewing representation as an auxiliary skill, this study supports its role as a core indicator of mathematical learning, particularly in heterogeneous classrooms (Van den Kieboom & Groleau, 2022).

Finally, this study addresses a gap in the literature by empirically examining how differentiated learning interacts with students' representational competence at the junior high school level. While prior research has explored differentiation broadly, few studies have focused on its representational consequences using fine-grained qualitative analysis. The findings thus extend existing frameworks and offer an empirically grounded basis for designing more inclusive and conceptually oriented mathematics instruction.

The findings extend existing research on differentiated learning by foregrounding mathematical representation as a central mechanism linking instructional adaptation and conceptual understanding. Rather than evaluating differentiation solely through engagement or achievement outcomes, this study demonstrates the importance of examining how students coordinate representations under differentiated conditions. Practically, the results suggest that mathematics instruction at the junior high school level should integrate explicit representational goals into differentiated task design and assessment. Teachers should not only allow representational diversity but also actively support representational translation and integration. Such an approach has the potential to enhance conceptual understanding and equity in heterogeneous classrooms, particularly in post-pandemic learning contexts where conceptual fragmentation remains a significant challenge.

In sum, this study demonstrates that differentiated learning creates meaningful opportunities for students to engage in mathematical representation, but its effectiveness depends on intentional instructional and evaluative design. By foregrounding representation as both a learning process and an assessment lens, the study offers a refined perspective on how differentiation can support deeper mathematical understanding. These findings provide practical and theoretical contributions to ongoing discussions on assessment, representation, and differentiated instruction in secondary mathematics education.

CONCLUSION

This study examined junior high school students' mathematical representation skills within a differentiated learning environment and revealed significant variation in how students constructed, coordinated, and translated symbolic, visual, and verbal representations. Differentiated learning increased students' engagement and accessibility to mathematical tasks;

however, it did not automatically lead to representational coherence. Students with higher representational readiness demonstrated flexible and meaningful coordination across representations, whereas students with lower readiness tended to rely on isolated or fragmented forms. These findings indicate that representational competence develops unevenly and requires intentional instructional support beyond task differentiation alone.

From a theoretical standpoint, this study contributes by positioning mathematical representation as a central analytical lens for evaluating differentiated instruction. It extends existing frameworks of differentiated learning by emphasizing representational alignment as a key mechanism linking instructional adaptation and conceptual understanding. Practically, the findings highlight the importance of assessment practices that foreground students' representational activity, as such evaluations provide diagnostic insights that are often overlooked in procedural assessments. The central takeaway is that differentiated learning becomes pedagogically effective when it is deliberately designed and evaluated to foster representational coherence, thereby supporting deeper and more equitable mathematical understanding in junior high school classrooms.

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