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CORE Model in Improving Students' Mathematical Representation Ability Based on Cognitive Style

Asa Raila Salam[1], Hikmatul Khusna[2*]
[1]Mathematics Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Prof. Dr. HAMKA – Address: Jakarta, Indonesia, 13710
[2]Mathematics Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Prof. Dr. HAMKA – Address: Jakarta, Indonesia, 13710
*Corresponding author's email: hikmatulhusna@uhamka.ac.id

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Abstract

This study analyzes the effects of the CORE learning model on the mathematical representation abilities of junior high school students based on Field Independent (FI) and Field Dependent (FD) cognitive styles. Using a quasi-experimental methodology, this study involved 68 eighth-grade students from SMPN 169 Jakarta, divided into an experimental group using the CORE model and a control group with conventional learning. Study instruments included GEFT and mathematical representation ability tests. ANOVA analysis results indicate significant differences (F=48.655; p<0.05) between these groups, with the highest mean values in the FD experimental group (8.53), followed by the FI experimental group (7.84), FD control group (6.31), and FI control group (4.44). This study proves that the CORE learning model provides a significant effects in improving students' mathematical representation abilities, especially when combined with their cognitive styles.

Keywords: *mathematical representation ability; cognitive style; CORE learning model*

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INTRODUCTION

Higher Order Thinking Skills (HOTS) have become essential in 21st century mathematics education, providing students with various mathematical abilities including problem-solving, mathematical reasoning, critical and creative thinking, concept connection, communication, analysis, and presentation skills (Hadi & Faradillah, 2019). These interconnected abilities require effective supporting tools for development, with mathematical representation serving as a crucial medium to visualize and understand concepts (Nisa & Zaenal, 2023). Mathematical representation helps students bridge abstract concepts into concrete forms like diagrams and graphs, enabling them to not only understand material but also apply it in various real-world situations (Escarez Jr. & Ching, 2022).

Mathematical representation refers to the skill students have in displaying mathematical concepts in multiple ways, which functions as a method for communicating mathematical answers or insights (Vasquez-Plaza et al., 2023). Mathematical representation is when students process and represent mathematical ideas in many different ways, and it also helps them solve math problems (Chen, 2016). This ability requires deep mental engagement, not just remembering rules and definitions. Thus, learning does not stop at students' basic understanding of the material, but encourages students to apply the knowledge gained in various different situations and conditions.

Mathematical representation ability can be classified into three main categories, as supported by extensive research in mathematics education (Supriadi et al., 2024). First, verbal representation is the capacity to convey ideas and concepts, as well as process information in oral or written form. Second, symbolic representation is the proficiency in utilizing mathematical symbols to describe more complex concepts or objects. Third, visual representation is the ability to understand and interpret information displayed through pictures, diagrams, graphs, or other visual media. Understanding these three forms of representation is very important because according to Hanifah et al. (2020), solving mathematical problems through representation can provide significant advantages in mathematics learning, including visualizing concepts with the real world, defining problems clearly, conveying mathematical understanding accurately, and supporting students' independent learning.

Mathematical representation ability is not only crucial for a deeper understanding of mathematical concepts but also lays the groundwork for developing higher-order thinking skills, which are essential in today's globalized world. However, data from various studies and national and international assessments indicate that Indonesian students' mathematical representation ability remains low. This problem stems from several interconnected factors that hinder the effective implementation of mathematical representation in learning. According to Hidayat et al. (2023), key obstacles include teachers' insufficient understanding of how to effectively integrate representational approaches into their instruction, inadequate professional development opportunities, and limited research on the effectiveness of representational strategies in mathematics education. Consequently, students frequently struggle to develop and utilize mathematical representation skills, perpetuating the cycle of poor representational competency.

When developing effective learning strategies for mathematical representation, it's crucial to consider students' cognitive styles, particularly field independent (FI) and field dependent (FD) characteristics that significantly influence how they process and interpret mathematical information solving (Agustiningtyas et al., 2023; Konita et al., 2017; Nugroho et al., 2020; Son et al., 2020). FI learners are characterized by their analytical, structured thinking and preference for independent learning, enabling them to excel at transforming between various mathematical representations, while FD learners adopt a holistic perspective, rely on external prompts, and prefer group activities but tend to struggle with switching between different representational forms. These fundamental differences in information processing between FI and FD students have broad implications for mathematics learning, highlighting the need for teachers to consider cognitive style diversity when designing effective teaching strategies to develop students' mathematical representation skills.

FI and FD cognitive styles are important because they significantly affect how students process information, understand material, and complete tasks in mathematics learning (Karaçam & Baran, 2015; Linawati et al., 2022; Son et al., 2020). FD students often leverage context and their environment to understand mathematical concepts and find success in group problem-solving through social interaction. On the other hand, the analytical nature of FI students allows them to extract information from context for deeper conceptual understanding, and they typically excel at solving problems systematically through independent work.

The different characteristics of these cognitive styles require varied learning approaches to optimize each student's learning potential according to their respective cognitive tendencies. However, Oktaviani et al. (2022) identified challenges exist in learning implementation, especially related to the limitations of learning models that accommodate differences in students' cognitive styles, which can affect the effectiveness of the learning process. Therefore, teachers need to design learning models that consider the balance between independent activities for FI students and collaborative learning for FD students, with cooperative learning being an effective solution to develop students' mathematical representation capacity while accommodating cognitive style diversity.

Cooperative learning is a learning model that emphasizes group learning activities, where students help each other in small groups to achieve shared success (Amin et al., 2020; Febriandi, 2020). One cooperative learning model that can be used to improve mathematical representation ability is the CORE (connecting, organizing, reflecting, extending) learning model (Darozatun et al., 2021; Ningsih et al., 2020; Yunita & Qoriah, 2024). The CORE learning model offers a promising approach to enhance students' mathematical representation abilities through a structured learning syntax that supports active learning processes.

This model consists of four interconnected phases that guide both teachers and students through a comprehensive learning experience (Aprilia & Diana, 2023). The first phase, Connecting, focuses on helping students establish meaningful links between new knowledge and their previous experiences, while the Organizing phase involves systematically grouping and structuring information using tools like concept maps and flowcharts. The Reflecting phase invites students to engage in metacognitive activities to assess their understanding, and the Extending phase challenges students to apply their knowledge in broader, real-world contexts.

With this syntax, CORE-based learning creates a more integrative, reflective, and applicable learning process. Implementation of the CORE model in mathematics learning requires careful planning to ensure a balance between conceptual and procedural development. The use of various media and learning resources can support the accommodation of differences in cognitive styles and the development of mathematical representation abilities. Learning activities need to be designed systematically to support the transition from concrete to abstract representation.

The CORE model permits adjustments at every phase, which serves the dual purpose of accommodating the distinct characteristics of FI and FD cognitive styles and enhancing students' capacity to represent mathematical ideas (Ningsih et al., 2020). By allowing adjustments at each stage to suit the differences between FI and FD cognitive styles, this model effectively supports the development of these skills. In the connecting stage, FI students connect new ideas with concepts already understood independently, while FD students need assistance to link new information with real contexts. In the organizing stage, FI students are more comfortable with analytical approaches, while FD students need guidance using visual aids. The reflecting and extending stages also consider differences in students' cognitive styles. Building on this background, this study aims to investigate the influence of the CORE learning model on junior high school students' mathematical representation abilities, considering their FI and FD cognitive styles.

RESEARCH METHODOLOGY

This study examines the impact of a CORE learning model adapted for FI and FD cognitive styles on Junior High School students' mathematical representation skills. The study was conducted at SMP Negeri 169 Jakarta. The study location was chosen because no study related to mathematical representation abilities had ever been conducted at that school before.

This study uses a quantitative quasi-experimental method to determine the effectiveness of the CORE learning model in improving the mathematical representation abilities of JHS students with different cognitive styles FI and FD. The quasi-experimental design was necessary because participants could not be randomly assigned to the experimental and control groups, but it still allows for examining the effects of the CORE model (treatment) on the measured outcomes of mathematical representation (Siregar et al., 2020; Yamah, 2022). This study applies the CORE learning model in the experimental class and conventional learning model in the control class. The teacher's role in the CORE model is multifaceted and requires a shift from traditional instructor-centered approaches to facilitating student-centered learning experiences. In this research implementation, the teacher functions as a learning facilitator, guide, and cognitive coach throughout each phase of the model.

To obtain the study sample, cluster random sampling was employed. This sampling technique involves dividing the population into distinct groups (clusters) and subsequently randomly selecting these clusters. Miatun & Khusna (2020) note that this method is highly effective when dealing with populations that are geographically widespread and where achieving a fully representative sample from all members is difficult. In this study, eighth grade students at SMPN 169 Jakarta, comprising 6 classes with 212 students, were sampled using this cluster random sampling procedure. Data regarding the chosen participants are shown in Table 1.

Table 1. Participants

No	Name	Description	Amount
1.	Class	A	34
		E	34
2.	Age	12	13
		13	48
		14	7
3.	Gender	Female	33
		Male	35

The initial step in this study procedure is to conduct normality and homogeneity tests using students' mathematics scores. These scores were obtained from students in the experimental class and control class, which are presented in Table 2.

Table 2. Student Mathematics Score

No	Class	Experimental	Control
1.	Average	87	86
2.	Highest score	94	94
3.	Lowest score	80	79

After ensuring that the statistical assumptions are met, the next stage is to identify the characteristics of the students' cognitive styles. For this purpose, the researcher gave an initial test in the form of the Group Embedded Figures Test (GEFT) to all students in both classes to group them into the FD or FI category. The implementation stage of the research was carried out by applying the CORE learning model to the experimental class, while the control class used conventional learning methods, which lasted for seven meetings. At the end of the treatment, both groups were given a mathematical representation ability test to assess the extent to which the ability had improved after the intervention was carried out.

The instruments in this study are divided into two based on their roles. The first category is instruments that support the treatment process, namely teaching modules and student worksheets. The teaching module is specifically designed to implement the CORE learning model, taking into account the characteristics of FI and FD cognitive styles. This document contains a systematic guide to learning, including objectives, materials, methods, and evaluations that are tailored to improve mathematical representation. Meanwhile, student worksheets act as a practical guide that contains structured tasks according to the CORE stages, specifically designed to encourage mathematical representation skills through connecting, organizing, reflecting, and expanding understanding activities.

The second category of instruments focuses on data collection, with the main instrument being a mathematical representation test. This test is designed to assess students' ability to present mathematical concepts in various formats, including visual representations (such as graphs and diagrams), symbolic representations (through equations and formulas), and verbal representations (in the form of explanations). The preparation of the test is based on indicators of mathematical representation ability that are in accordance with the curriculum and cognitive level of junior high school students.

To ensure quality, this test instrument underwent a comprehensive validation process designed to confirm that it accurately measures the intended mathematical representation ability. The validation consisted of content validation conducted by lecturers and mathematics teachers as subject matter experts, along with construct validation involving junior high school students to verify alignment with mathematical representation theory. Data obtained through construct validation were analyzed using Winsteps software with Rasch Model analysis, while reliability tests were performed to determine the instrument's consistency and stability in measuring the same abilities across different times and conditions, typically using Cronbach's Alpha or test-retest reliability methods (Senjayawati & Kadarisma, 2020). Additionally, the instrument was equipped with systematic assessment grids and rubrics to enable objective and consistent evaluation processes, with detailed instrument specifications based on mathematical representation ability indicators presented in Table 3.

Table 3. Mathematical Representation Ability Instrument Blueprint

No	Ability Indicator	Test Indicator
1.	Visual representation is students' ability to understand and interpret information presented in the form of pictures, diagrams, graphs, or other visual forms.	Students are able to understand and interpret information presented in the form of graphs on plane figures.
2,	Symbolic representation is the ability to use symbols (whether numbers, letters, or other signs) to represent more complex concepts or objects	Students are able to use mathematical symbols to represent the concept of similarity from information presented in solving problems on plane figures.
3.	Verbal representation is the ability to use oral or written language to express ideas and concepts, as well as understand information conveyed in verbal form	Students are able to interpret information from mathematical situations presented using written language to determine the maximum number of products that can be made based on available materials, as well as identify limiting factors in the production process.

After data collection is complete, the next step is to test the research hypothesis that has been formulated in this study according to the focus of the study. The main hypothesis of this study is that there is a significant effect of the application of the CORE learning model on improving the mathematical representation ability of junior high school students compared to conventional learning models. In addition, the alternative hypothesis of this study is that there is a significant effect of the difference in mathematical representation ability based on the FI and FD cognitive styles between the experimental class and the control class in this study. The main hypothesis testing will be carried out using the T test, while the alternative hypothesis will be tested using one-way ANOVA.

RESULTS AND DISCUSSION

The purpose of this study is to investigate how the CORE learning model affects the mathematical representation abilities of junior high school students, while also examining the role of FI and FD cognitive styles. The focus of this study lies in a thorough analysis of mathematical representation ability as the main outcome variable. Based on the results of the research data analysis, the author can put forward several things, namely.

Prerequisite Test

The results of the normality tests, using either Kolmogorov-Smirnov, demonstrated that the data from both groups followed a normal distribution, as evidenced by significance values exceeding 0.05 ($p > 0.05$) (Ruslam et al., 2023), which implies the data is representative of the studied population. Similarly, Levene's Test for homogeneity of variance indicated that the variance between the groups was homogeneous, with significance values also above 0.05 (Aprilia & Diana, 2023). Meeting both the normality and homogeneity assumptions allows for the use of appropriate statistical analysis.

Identifying Students' Cognitive Styles

Before treatment was given, an initial test was conducted to identify students' cognitive styles using the Group Embedded Figures Test (GEFT) questionnaire. The grouping results revealed that students in both classes had relatively balanced distributions of cognitive styles. In the experimental class, 18 students were classified as Field Independent (FI) while 16 students were categorized as Field Dependent (FD). Similarly, the control class showed a comparable pattern with 19 students identified as Field Independent and 15 students as Field Dependent. This balanced distribution across both classes ensured that the cognitive style variable was adequately represented in the study, providing a solid foundation for analyzing the interaction effects between teaching methods and students' cognitive styles on learning outcomes.

Comparison of CORE Model and Conventional Model

The CORE learning model is superior, showing significantly different characteristics compared to conventional learning in the control group. After conducting study on the two different learning models, the studier documented the differences in student activities in the classroom. Documentation of both is presented in Figures 1 and 2.

Figure 1. Environment during Implementation of CORE Learning Model

Figure 1 shows the classroom after the implementation of the CORE model, indicating a significant shift from conventional learning to a student-centered approach. This visualization emphasizes the characteristics of collaborative learning, where students are actively involved in interactive group activities, supported by flexible seating arrangements for peer discussion and social knowledge construction. This visual documentation shows how the CORE model facilitates the development of mathematical representation skills through deeper engagement, structured group collaboration, and a holistic approach to conceptual understanding that integrates cognitive, social, and metacognitive aspects of mathematics learning.

Figure 2. Environment during Implementation of Conventional Learning Model

Figure 2 visualizes the classroom after implementation of the conventional learning model. Its characteristic is the standard room configuration with a whiteboard as the central element of learning at the front. The arrangement of student seating facing the front in an orderly linear row reflects a strict instructional order between the teacher and the learner within a common pedagogical framework. This visual documentation underlines the fundamental characteristics of the traditional learning model that emphasizes formal structure, classroom discipline, and individual focus in the process of acquiring mathematical knowledge. A systematic comparison between these two learning models is presented in more detail in Table 4.

This supports the findings of Febriandi (2020) showing that learning that activates reflective and social cognition significantly improves conceptual understanding and representation abilities. Students in conventional learning are often only exposed to one type of representation and are not given the opportunity to develop understanding in various forms. This makes it difficult for them to transfer mathematical knowledge to other forms of representation, unlike the CORE approach which designs activities for exploring multiple representations from the beginning (Salma & Sumartini, 2022; Son et al., 2020).

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Table 4. Comparison of Learning Processes between CORE Model and Conventional Learning

No	Aspect	CORE Model	Conventional Model
1.	Activity Structure	Interactive and collaborative, students active in groups	Predominantly passive sitting, limited discussion activity
2.	Seating Position & Involvement	Students standing and moving, showing high dynamics and collaboration	Sitting facing forward, indicating focus on the teacher
3.	Supported Learning Styles	Supports FD (field dependent) through cooperation and contextual understanding	Suitable for FI cognitive style that is independent and systematic
4.	Teacher's Role	As a facilitator who guides and directs the student learning process	As the center of information (teacher-centered)
5.	Social Interaction	Students participate in lively discussions within their groups while working on problems.	Students exhibit limited engagement with peers during the problem-solving process.
6.	Learning Environment	Flexible, dynamic, and encouraging active participation	Less flexible and static
7.	Learning Activities	Connecting concepts (connecting), organizing information (organizing), reflection, extending.	Listening to explanations and taking notes

Main Hypothesis Test

After the intervention phase concluded for both the experimental and control groups, students were given this test. The results of their mathematical representation ability are detailed in Table 5.

Table 5. Final Test Results

No	Class	Experimental	Control
1.	Average	90.51	60.53
2.	Highest score	100	78
3.	Lowest score	45	33

In this test, the T-test was specifically applied to Final test data for treatment in the form of questions to the indicators of mathematical representation ability to compare the two groups specifically, providing a more focused analysis of the mean difference between these groups at the final stage of the study. From the data of hypothesis 1 testing, the analysis was conducted in two systematic stages to compare groups on the final test. The first stage involved examining the descriptive statistics of the groups through the Group Statistics table which provides an initial overview of the differences in numerical characteristics between the experimental and control groups, and this overview is presented in Table 6.

Table 6. Group Statistics

No	Class	N	Mean	Std. Deviation	Std. Error Mean
1.	Experimental	34	8.15	1.077	.185
2.	Control	34	5.32	1.451	.249

Based on Table 5, the experimental group demonstrated a higher average score and a more consistent spread of data compared to the control group. To further validate these observations, an Independent Samples T-test was conducted, and the results are detailed in Table 6.

Table 6. Independent Samples Test

No	Equal variances	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
1.	assumed	12.516	.001	9.113	66	.000	2.824	.310
2.	not assumed			9.113	60.898	.000	2.824	.310

Based on Table 6, the t-test analysis revealed a very significant difference ($p < 0.001$) between the experimental and control groups. Levene's test indicated non-homogeneous variances ($F = 12.516$, $p = 0.001$), so the analysis continued with the assumption of unequal variances (Ruslam et al., 2023). The calculated t-statistic of 9.113 with 60.898 degrees of freedom, coupled with a significance level of 0.000, substantiates a noteworthy disparity between the groups. The experimental group's average was 2.824 points superior to the control group's. The standard error of the difference, recorded at 0.310, and the 95% confidence interval, spanning from 2.204 to 3.443 (excluding zero), provide additional evidence that this divergence is not attributable to random occurrence.

Ultimately, the data indicates that the experimental group benefited significantly from the learning intervention compared to the control group. The CORE learning model's systematic structure and its emphasis on reflection are key factors in its significant contribution to enhancing students' mathematical representation abilities. Additionally, this model supports the development of complex cognitive activities required in mathematical representation. This aligns with Darozatun et al. (2021), about the CORE model reflects this principle by providing learning stages that encourage active student participation. Furthermore, in accordance with the principles of representation in mathematics learning put forward by Khoirina & Rochmad (2022) and Yunita & Qoriah (2024), students' capacity for mathematical representation will flourish when they are trained to articulate mathematical concepts in visual, symbolic, and verbal modalities, all of which are overtly encouraged within the CORE learning framework.

Alternative Hypothesis Test

After the t-test confirmed significant differences between the experimental and control groups, One Way ANOVA analysis was conducted to identify in more detail which groups showed superior mathematical representation abilities, so that the data results could be generalized. Interpretation of the analysis results was carried out through five stages, starting with the first stage, namely descriptive analysis, which is presented in Table 7.

Table 7. Descriptive statistics

No	Group	N	Mean	Lower Bound	Upper Bound	Min.	Max.
1.	Experimental – FI	19	7.84	7.24	8.45	4	9
2.	Experimental – FD	15	8.53	8.28	8.89	7	9
3.	Control – FI	18	4.44	3.87	5.02	3	7
4.	Control – FD	16	6.31	5.74	6.89	4	7

Based on Table 7, the descriptive table presents summary statistics for four different groups. This descriptive table provides an initial overview of the distribution of values in each group before further analysis is carried out. After obtaining an overview of the data, the next step is to carry out the analysis prerequisite test to determine the appropriate statistical method for hypothesis testing. This second stage is a homogeneity test, the results of which are presented in Table 8.

Table 8. Test of Homogeneity of Variance

No	Name	Levene Statistic	df1	df2	Sig.
1.	based on mean	1037	3	64	.382
2.	based on median	.326	3	64	.806
3.	based on median with adjusted df	.326	3	58.826	.806
4.	based on trimmed mean	.752	3	64	.525

Based on Table 8, the homogeneity of variance test shows that the significance value for all groups is greater than 0.05. According to the homogeneous criteria. The significance values above 0.05 confirm that the data variance is consistent across all four groups. This homogeneity of variance is a necessary condition for further analysis, allowing us to proceed to hypothesis testing with ANOVA to ascertain if significant differences exist between the groups under investigation. The outcomes of the ANOVA test are detailed in Table 9.

Table 9. ANOVA

No	Name	Sum of Squares	df	Mean Square	F	Sig.
1.	Between Groups	169.094	3	56.365	48.655	.000
2.	Within Groups	74.142	64	1.158		

Based on Table 9, the one-way ANOVA test provides strong statistical evidence (F = 48.655, $p < 0.005$) of significant differences in mathematical representation ability among the four groups of students (Waluyo et al., 2024). The order of average scores from highest to lowest is: Experimental–FD (8.53), Experimental–FI (7.84), Control–FD (6.31), and Control–FI (4.44). This implies that the effects of the CORE learning model is not separate from students' cognitive styles. For further analysis regarding differences between group pairs, the next stage is post-hoc analysis, the details of which can be seen in the Multiple Comparisons section in Table 10.

Table 10. Multiple Comparisons

No	Type	(I) Groups	(J) Groups	Sig.	Lower Bound	Upper Bound
1.	**Tukey HSD**	Control – FI	Control - FD	.000	-2.84	-.89
			Experimental - FI	.000	-4.33	-2.46
			Experimental - FD	.000	-5.08	-3.10
		Control – FD	Control - FI	.000	.89	2.84
			Experimental - FI	.000	-2.49	-.57
			Experimental - FD	.000	-3.24	-1.20
		Experimental – FI	Control - FI	.000	2.46	4.33
			Control - FD	.000	.57	2.49
			Experimental - FD	.256	-1.67	.29
		Experimental – FD	Control - FI	.000	3.10	5.08
			Control - FD	.000	1.20	3.24
			Experimental - FI	.256	-.29	1.67
2.	**LSD**	Control – FI	Control - FD	.000	-2.61	-1.13
			Experimental - FI	.000	-4.10	-2.69
			Experimental - FD	.000	-4.84	-3.34
		Control – FD	Control - FI	.000	1.13	2.61
			Experimental - FI	.000	-2.26	-.80
			Experimental - FD	.000	-2.99	-1.45
		Experimental - FI	Control - FI	.000	2.69	4.10
			Control - FD	.000	.80	2.26
			Experimental - FD	.068	-1.43	.05
		Experimental - FD	Control - FI	.000	3.34	4.84
			Control - FD	.000	1.45	2.99
			Experimental - FI	.068	-.05	1.43

Based on Table 10, the post-hoc analysis results show the results of statistical analysis using the Tukey HSD (Honest Significant Difference) test which compares several groups. The criterion used is if Sig. < 0.05, then there is a significant difference between the two groups, and if Sig. > 0.05, then there is no significant difference (Aprilia & Diana, 2023). From the comparison results, it was found that five group pairs (Control–FI vs Control–FD, Control–FI vs Experimental–FI, Control–FI vs Experimental–FD, Control–FD vs Experimental–FI, and Control–FD vs Experimental–FD) showed significant differences with Sig. values = 0.000 for all these pairs, while only one, namely Experimental–FI and Experimental–FD, did not show a significant difference with a Sig. value = 0.256 which is greater than 0.05.

Table 10 also displays the results of analysis using the LSD (Least Significant Difference) method, which is known as a more sensitive and tends to be liberal statistical approach compared to Tukey HSD, although it provides similar results. With the same criteria, the following interpretation was obtained: the Control–FI group has the lowest average and is significantly different from all other groups; the Experimental–FD group has the highest average and differs significantly from Control–FI, Control–FD, and Experimental–FI; the Control–FD group shows significant differences with Control–FI, Experimental–FI, and Experimental–FD; while the Experimental–FI group differs significantly from Control–FI and Control–FD, but does not differ significantly from Experimental–FD. The difference between Experimental–FI and Experimental–FD is stated to be not significant with a *p*-value of 0.256.

This indicates that in a CORE-based learning environment, both FI and FD students show comparable improvement. This finding is reinforced by Konita et al. (2017) and Oktaviani et al. (2022), who state that a flexible and multimodal learning approach is able to accommodate various student learning and cognitive styles equally. To provide a clearer visualization of the differences in mean scores between the groups, a comparative chart of the mean scores between the control and experimental groups for both Field Independent (FI) and Field Dependent (FD) learners is presented. This graphical visualization facilitates the interpretation of the mean score differences that have been identified through the previous post-hoc test, as shown in Figure 3.

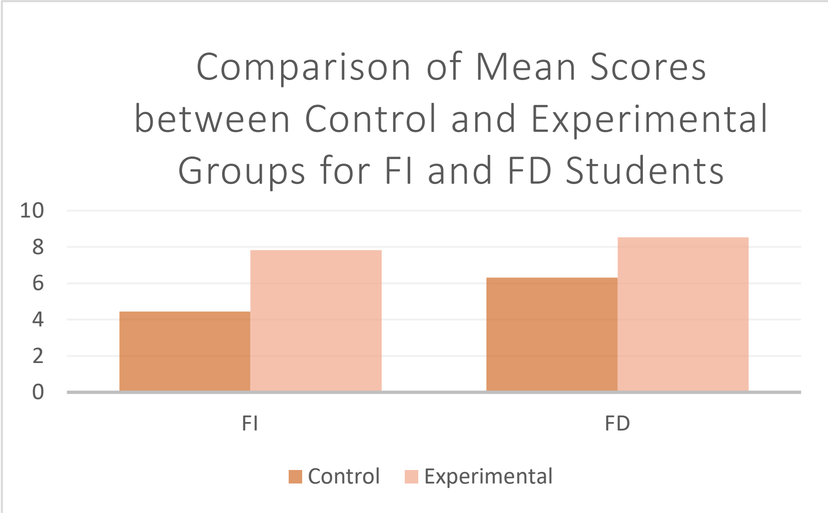

Figure 3. Comparison of Mean Scores between Control and Experimental Groups for FI and FD Students

As illustrated in Figure 3, the CORE learning model appears to be the most effective method for improving mathematical representation abilities, especially for FD students who achieved the highest scores. FI students in the experimental group also showed progress with CORE, though less so than FD students. Notably, conventional teaching resulted in only minor gains for FD students and no improvement whatsoever for FI students in the control group.

Comparison of Mathematical Representation Abilities between FD and FI Students in the Experimental Group

The results of the ANOVA test showed no significant difference between students with Field Independent (FI) and Field Dependent (FD) cognitive styles in the experimental class using the CORE learning model. This phenomenon is in line with the cognitive style theory of Pithers (2002)**,** which states that differences in information processing methods between FI and FD individuals do not always result in significant differences in academic achievement in certain learning contexts. This finding is supported by Sundari et al. (2020), who emphasized that the effectiveness of cognitive styles is highly dependent on the suitability of learning characteristics to task demands. The constructivist CORE learning model allows both types of cognitive styles to develop optimally. Vygotsky (1978)'s constructivism theory explains that learning with adequate scaffolding and social interaction can accommodate various student learning styles (Ningsih et al., 2020). In this context, the systematic CORE stages provide sufficient structure for FD students as well as flexibility for FI students to organize information independently. In addition, research by Nugroho et al. (2020) shows that in a well-designed and supportive learning environment, differences in cognitive styles tend not to have a significant impact on learning outcomes because each student can find strategies that suit their cognitive preferences within the same learning framework.

However, based on the average fi and fd there is a significant difference. Data analysis shows that FD students in the experimental group achieved the highest average score (8.53) in mathematical representation ability, exceeding FI students (7.84). This indicates that the CORE model is able to effectively support FD students in developing their mathematical representation abilities. This finding is consistent with the characteristics of FD students who tend to be more comfortable in collaborative and contextual learning environments. The CORE model, which emphasizes the connecting and reflecting stages, allows FD students to link abstract concepts with concrete experiences and group discussions, which significantly improves their representation skills (Auliya & Lestariningsih, 2020; Nurazizah et al., 2023; Rosa et al., 2021). Theoretical support is also provided by Karaçam & Baran (2015), who states that FD students tend to develop in socially-based learning, as they are more responsive to group interactions and contextual cues. CORE provides a learning environment that supports these preferences through interactive activities, shared reflection, and structured exploration of concept meanings.

Overall, the significance of the CORE model lies in its ability to not only significantly improve students' mathematical representation abilities but also to accommodate differences in students' cognitive styles, creating an adaptive and inclusive learning environment. This is very important in the context of modern education, where personalization of learning and strengthening higher-order thinking skills are the main focus.

Comparison of Mathematical Representation Abilities between FD and FI Students in the Control Group

Interesting results are seen in the control group with conventional learning, where FD students have better mathematical representation abilities (average 6.31) compared to FI students (average 4.44). Possibly, this is because conventional learning implicitly presents material with repetition and directness, providing a context that helps FD students. However, the low performance of FI students in conventional learning shows that their learning style, which tends to be independent, analytical, and less dependent on social context, is less facilitated by conventional methods that tend to be one-way. According to Rofi'i et al. (2023), FI students need space for independent exploration and logical reflection, which is not widely available in conventional approaches.

This finding is consistent with study by Auliya & Lestariningsih (2020) which revealed that individuals with FD cognitive styles have a tendency to see patterns as a whole and are more influenced by the social context around them. According to cognitive style theory proposed by Pithers (2002), differences in performance between FD and FI students are often determined by the match between the learning structure and students' cognitive preferences (Auliya & Lestariningsih, 2020; Son et al., 2020). Study by Ningsih et al. (2020) further explains that conventional approaches that are structured and guided often provide advantages for FD students who tend to rely on external structures. Linawati et al. (2022)'s longitudinal study reinforces this by finding that in learning environments with direct instruction, FD students show higher levels of adaptation compared to FI students who need autonomy and opportunities for independent concept discovery.

CONCLUSION AND SUGGESTIONS

Based on research results, the CORE learning model effectively improves junior high school students' mathematical representation skills, with experimental classes showing significant improvements over control classes. FI students gained 3.40 points (4.44 to 7.84) while FD students gained 2.02 points (6.31 to 8.33), demonstrating practically meaningful enhancements in expressing mathematical ideas through multiple representational formats.

Regarding cognitive styles, although ANOVA tests showed no significant difference between FI and FD students in experimental classes, FD students achieved higher mean performance (8.33) with more consistent results compared to FI students (7.84). This suggests the CORE model's structured, collaborative nature particularly benefits FD students while still accommodating both cognitive styles. These findings align with Aptitude-Treatment Interaction theory, emphasizing the importance of matching individual characteristics with appropriate learning methods.

The researchers acknowledged several methodological and practical limitations. The researchers acknowledged several methodological and practical limitations including the relatively short study duration which limited observation of long-term CORE model effects, insufficient control of external variables such as students' socioeconomic background and learning motivation, and limited generalizability due to focusing on only one or few schools with specific characteristics. Additionally, the study emphasized quantitative aspects without in-depth exploration of qualitative learning processes, lacked detailed analysis of student interactions and emotional responses across different cognitive styles, and was restricted to specific mathematics materials making effectiveness uncertain for other topics. Other important limitations include varying learning environment factors, potential researcher bias, Hawthorne effects, and practical implementation challenges that must be considered for future large-scale applications.

Future studies should employ longitudinal designs with longer durations and mixed methods approaches to comprehensively understand the CORE model's long-term effects, including qualitative analysis of student interactions and learning strategies. Research with larger, more diverse samples and multidimensional cognitive style instruments is needed to increase generalizability, along with comparative studies examining the CORE model against other innovative learning approaches.

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