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Fostering Mathematical Creative Thinking Through the DOCAR Instructional Model: An Embedded Mixed-Methods Investigation Across Mathematical Self-Efficacy Levels

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ABSTRACT: Developing students' mathematical creative thinking is essential for enabling them to generate original ideas and solve complex problems, yet mathematics instruction often emphasizes procedural knowledge. This study examined the effectiveness of the DOCAR instructional model in enhancing mathematical creative thinking, differences across mathematical self-efficacy levels, and students' learning processes during instruction. An embedded concurrent mixed-methods design was employed with quantitative data as the primary component. Sixty seventh-grade students from a junior secondary school in Surabaya, Indonesia, participated in a nonequivalent control group quasi-experiment. Mathematical creative thinking and self-efficacy were measured using validated instruments. Quantitative data were analyzed using Two-Way ANOVA and Tukey's HSD test, while qualitative data from classroom observations, students' written responses, and interviews were analyzed thematically. Students receiving the DOCAR instructional model achieved significantly higher mathematical creative thinking than those receiving conventional instruction, $F(1, 54) = 160.83$, $p < .001$, partial $\eta^2 = .749$. Mathematical self-efficacy also had a significant effect, $F(2, 54) = 342.38$, $p < .001$, partial $\eta^2 = .927$, whereas the interaction effect was not significant, $F(2, 54) = 0.29$, $p = .747$. Qualitative findings showed that collaborative discussion, reflection, and problem solving promoted mathematical reasoning and confidence. The DOCAR instructional model effectively fosters mathematical creative thinking across different levels of mathematical self-efficacy.

Keywords: constructivist learning, DOCAR instructional model, mathematical creative thinking, mathematical self-efficacy, mixed-methods research.

ABSTRAK: *Pengembangan kemampuan berpikir kreatif matematis penting untuk membekali siswa dalam menghasilkan ide orisinal dan memecahkan masalah kompleks, namun pembelajaran matematika masih cenderung berfokus pada penguasaan prosedur. Penelitian ini bertujuan menganalisis efektivitas model pembelajaran DOCAR dalam meningkatkan kemampuan berpikir kreatif matematis, mengkaji perbedaan berdasarkan tingkat mathematical self-efficacy, serta menjelaskan proses belajar siswa selama pembelajaran. Penelitian menggunakan desain embedded concurrent mixed methods dengan pendekatan kuantitatif sebagai komponen utama. Sebanyak 60 siswa kelas VII di salah satu SMP di Surabaya mengikuti eksperimen semu dengan desain nonequivalent control group. Kemampuan berpikir kreatif matematis dan mathematical self-efficacy diukur menggunakan instrumen yang telah divalidasi. Data kuantitatif dianalisis menggunakan ANAVA dua jalur dan uji lanjut Tukey HSD, sedangkan data kualitatif dianalisis secara tematik. Hasil penelitian menunjukkan bahwa model DOCAR secara signifikan lebih efektif daripada pembelajaran konvensional dalam meningkatkan kemampuan berpikir kreatif matematis,* $F(1,54) = 160,83$, $p < 0,001$, η^2 *parsial* $= 0,749$. *Mathematical self-efficacy juga berpengaruh signifikan,* $F(2,54) = 342,38$, $p < 0,001$,

η^2 parsial = 0,927, sedangkan efek interaksi tidak signifikan, F(2,54) = 0,29, p = 0,747. Temuan kualitatif menunjukkan bahwa diskusi kolaboratif, refleksi, dan pemecahan masalah meningkatkan penalaran matematis serta kepercayaan diri siswa. Model DOCAR efektif mengembangkan kemampuan berpikir kreatif matematis pada berbagai tingkat mathematical self-efficacy.

Kata kunci: *kemampuan berpikir kreatif matematis, mathematical self-efficacy, model pembelajaran DOCAR, pembelajaran konstruktivistik, penelitian mixed methods.*

INTRODUCTION

Developing students' mathematical creative thinking has become one of the primary objectives of contemporary mathematics education because creativity, critical thinking, collaboration, and problem solving are recognized as essential competencies for twenty-first-century learning (Partnership for 21st Century Learning, 2019; National Council of Teachers of Mathematics [NCTM], 2014). In the twenty-first century, mathematics instruction is expected to cultivate not only procedural fluency but also students' ability to generate original ideas, explore multiple solution strategies, justify mathematical reasoning, and solve unfamiliar problems creatively. These competencies are increasingly recognized as essential for preparing learners to address complex real-world challenges, adapt to rapid technological advancement, and participate effectively in knowledge-based societies. Consequently, fostering mathematical creative thinking has become a central priority in international educational reform agendas and curriculum frameworks (OECD, 2022; UNESCO, 2021; Kemendikbudristek, 2022).

Mathematical creative thinking represents the capacity to generate original, flexible, and meaningful mathematical ideas through divergent reasoning and problem solving (Mann, 2006; Runco & Acar, 2012). Rather than merely applying memorized algorithms, mathematically creative students are capable of approaching problems from multiple perspectives, developing alternative representations, and producing innovative yet mathematically valid solutions. According to Silver (1997), mathematical creative thinking is reflected in four interrelated dimensions—fluency, flexibility, originality, and elaboration—which collectively support conceptual understanding and mathematical problem solving. These dimensions remain the most widely adopted framework for assessing mathematical creative thinking and have been supported by more recent theoretical developments (Leikin & Pitta-Pantazi, 2013; Kattou et al., 2021). More recent perspectives likewise emphasize that mathematical creative thinking is a learnable competence that can be systematically developed through instructional environments encouraging exploration, collaboration, and reflective reasoning (Leikin, 2021).

Despite its recognized importance, recent international evidence indicates that many students continue to experience substantial difficulties in demonstrating mathematical creative thinking. A recent systematic review also concluded that students' mathematical creative thinking remains relatively underdeveloped because classroom instruction continues to prioritize procedural fluency over divergent mathematical thinking (Schoevers et al., 2021). Findings

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from large-scale international assessments reveal that students frequently rely on routine procedures and encounter challenges when solving open-ended mathematical problems requiring divergent thinking and multiple solution strategies (OECD, 2023). Similarly, recent empirical studies have reported that learners often generate only a single solution, exhibit limited flexibility in exploring alternative approaches, and rarely produce original mathematical ideas (Bicer et al., 2020; Rahayuningsih et al., 2022; Zhou et al., 2025). Collectively, these findings suggest that mathematics instruction in many classrooms continues to emphasize procedural accuracy over creative mathematical reasoning, thereby limiting opportunities for students to develop higher-order mathematical competencies.

A comparable situation was identified during a preliminary investigation conducted at SMP Muhammadiyah 15 Surabaya. Prior to the implementation of the instructional intervention, students completed a diagnostic test designed to assess their mathematical creative thinking. The results revealed an average score of 50.67 out of 100, indicating that students' initial level of mathematical creative thinking remained relatively low. Only 20% of the students achieved the creative category, whereas approximately 53% were categorized as moderately creative and 27% were classified as less creative. These findings indicate that most students had not yet developed the level of creative mathematical reasoning expected in the current curriculum.

Classroom observations provided further evidence supporting these quantitative findings. Mathematics instruction was predominantly teacher-centered, with students relying heavily on teachers' explanations when solving mathematical problems. Classroom discussions were generally characterized by limited student participation; fewer than one-third of the students voluntarily communicated mathematical ideas or proposed alternative solution strategies, while most waited for explicit guidance before attempting to answer. Semi-structured interviews with mathematics teachers further revealed that students tended to reproduce previously demonstrated procedures instead of constructing their own mathematical representations or exploring different approaches to problem solving. Consequently, learning activities rarely provided sufficient opportunities for students to develop the essential dimensions of mathematical creative thinking, namely fluency, flexibility, originality, and elaboration.

These findings highlight an urgent need for instructional innovation capable of transforming students from passive recipients of mathematical procedures into active constructors of mathematical knowledge. Learning environments should encourage students to investigate problems independently, discuss diverse solution strategies collaboratively, justify mathematical arguments, and reflect critically on their own reasoning. Such instructional characteristics are fundamental to developing mathematical creative thinking because they engage students in meaningful cognitive processes rather than repetitive procedural practice. Accordingly, identifying instructional approaches that effectively foster mathematical creative thinking has become an important priority for both mathematics education researchers and classroom practitioners.

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Beyond instructional factors, students' mathematical self-efficacy has consistently been identified as one of the most influential affective determinants of mathematical creative thinking. While cognitive competence provides the knowledge required to solve mathematical problems, students' beliefs about their own capabilities largely determine whether they are willing to engage in challenging tasks, explore unfamiliar solution strategies, and persist when difficulties arise. According to Bandura (1997), self-efficacy refers to individuals' beliefs in their ability to organize and execute the actions necessary to achieve specific goals. Students with stronger mathematical self-efficacy generally exhibit greater persistence, lower mathematics anxiety, and higher willingness to engage in cognitively demanding mathematical activities (Putwain et al., 2022). Within mathematics education, students with high mathematical self-efficacy tend to approach complex problems with greater confidence, demonstrate stronger persistence when confronted with obstacles, and communicate their mathematical reasoning more effectively. Conversely, students with low mathematical self-efficacy often avoid cognitively demanding tasks, rely excessively on teacher guidance, and hesitate to propose original ideas because they doubt their own abilities. Consequently, mathematical self-efficacy functions not merely as an affective characteristic but also as an important psychological mechanism that shapes students' engagement in creative mathematical reasoning.

Recent empirical research further supports the close relationship between self-efficacy and mathematical creative thinking. Students who possess stronger confidence in their mathematical abilities are generally more willing to investigate multiple solution pathways, evaluate alternative representations, and refine their reasoning through reflection and discussion. In contrast, students with lower self-efficacy frequently limit themselves to familiar procedures and demonstrate reduced persistence when confronted with open-ended mathematical tasks. These findings indicate that mathematical creative thinking cannot be explained solely by cognitive ability; rather, it emerges through the dynamic interaction between cognitive competence and positive motivational beliefs. Therefore, examining mathematical creative thinking without considering students' mathematical self-efficacy provides only a partial understanding of how creative mathematical performance develops.

Although affective factors play a substantial role in learning, the instructional environment remains the primary context in which mathematical creative thinking is cultivated. Constructivist learning theory argues that meaningful mathematical understanding develops when learners actively construct knowledge through exploration, collaboration, discussion, and reflection rather than passively receiving information from teachers. Effective mathematics instruction should therefore emphasize conceptual understanding, productive struggle, classroom discussion, and meaningful mathematical communication (Hiebert & Grouws, 2007). Learning is therefore viewed as a process of knowledge construction in which students continuously interpret experiences, negotiate meaning with peers, and refine their conceptual

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understanding through social interaction. Such learning experiences encourage students to compare alternative strategies, justify mathematical arguments, and evaluate the validity of different solutions, all of which closely correspond to the fundamental dimensions of mathematical creative thinking.

These theoretical perspectives suggest that instructional models designed according to constructivist principles are particularly well suited to fostering mathematical creative thinking. By engaging students in authentic mathematical inquiry, collaborative problem solving, and reflective evaluation, such models create learning environments that stimulate fluency, flexibility, originality, and elaboration simultaneously. Consequently, effective instructional innovation should integrate cognitive, collaborative, and metacognitive learning processes rather than emphasizing procedural knowledge alone.

One instructional approach that explicitly incorporates these constructivist principles is the DOCAR instructional model, developed by Shoffa (2022). Previous studies have demonstrated that the DOCAR instructional model significantly improves students' mathematical problem-solving ability and critical thinking skills (Shoffa et al., 2022a, 2022b). DOCAR consists of five interconnected learning phases: Do, Observation, Construction, Association, and Reflection. Rather than functioning merely as a sequence of instructional activities, each phase is intentionally designed to facilitate specific dimensions of mathematical creative thinking through progressively deeper cognitive engagement. Despite these promising findings, empirical evidence examining the effectiveness of DOCAR in promoting mathematical creative thinking remains limited.

During the Do phase, students identify mathematical situations, activate prior knowledge, and generate initial ideas for solving problems. These activities encourage fluency by stimulating learners to produce multiple possible responses before selecting an appropriate strategy. In the Observation phase, students analyze mathematical relationships, interpret available information, and compare alternative perspectives, thereby promoting flexibility in mathematical reasoning. Subsequently, the Construction phase requires learners to formulate independent mathematical arguments, develop their own solution procedures, and justify their reasoning, creating opportunities for the emergence of originality.

The collaborative dimension of DOCAR becomes particularly evident during the Association phase, in which students exchange ideas, evaluate alternative solution strategies, negotiate mathematical meaning, and reconstruct conceptual understanding through peer interaction. Such collaborative dialogue encourages students to recognize that mathematical problems may be approached from multiple valid perspectives while simultaneously strengthening the quality of their mathematical arguments. Finally, the Reflection phase encourages students to evaluate the effectiveness, coherence, and originality of their own reasoning through structured self-assessment and peer feedback. This metacognitive process supports elaboration, enabling students to refine and extend their mathematical ideas beyond their initial responses.

Taken together, the five phases of the DOCAR instructional model establish a coherent learning environment that systematically integrates cognitive,

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collaborative, and metacognitive processes. Rather than emphasizing procedural mastery alone, DOCAR encourages students to construct knowledge actively, communicate mathematical reasoning, evaluate alternative approaches, and reflect critically on their own learning. These characteristics indicate that the instructional model possesses strong theoretical potential to foster students' mathematical creative thinking while simultaneously supporting the development of positive learning dispositions.

The theoretical relationship between the DOCAR instructional model and mathematical self-efficacy can be further explained through Bandura's Social Cognitive Theory (1997), which posits that self-efficacy develops primarily through mastery experiences, vicarious experiences, verbal persuasion, and physiological and emotional states. Among these sources, mastery experiences are considered the most influential because repeated success in accomplishing meaningful learning tasks gradually strengthens learners' confidence in their own capabilities. Within the DOCAR instructional model, students are continuously engaged in solving authentic mathematical problems, collaborating with peers, receiving constructive feedback from teachers and classmates, and reflecting critically on their learning progress. These learning experiences provide repeated opportunities for students to experience successful mathematical performance, thereby strengthening their mathematical self-efficacy. As students' confidence increases, they become more willing to explore unfamiliar mathematical ideas, persist when encountering cognitive challenges, and communicate original mathematical reasoning. Consequently, mathematical self-efficacy may function as an important psychological mechanism through which the DOCAR instructional model facilitates the development of mathematical creative thinking.

Although previous studies have consistently reported positive relationships between innovative instructional approaches and students' mathematical creative thinking, several important research gaps remain unresolved. First, most existing studies have examined instructional models and self-efficacy as independent variables, providing limited understanding of how instructional and affective factors jointly contribute to the development of mathematical creative thinking. As a result, relatively little is known about how students' confidence interacts with instructional experiences during the process of constructing creative mathematical ideas.

Second, empirical investigations of the DOCAR instructional model have primarily focused on improving students' mathematical problem-solving ability and critical thinking skills (Shoffa et al., 2022a; Shoffa et al., 2022b). Although these findings demonstrate the instructional potential of DOCAR, empirical evidence regarding its effectiveness in fostering mathematical creative thinking remains scarce. Consequently, the applicability of the DOCAR instructional model to broader domains of higher-order mathematical thinking has not yet been adequately established.

Third, the methodological approaches adopted in previous studies have largely been quantitative, emphasizing whether an instructional intervention produces statistically significant improvements while providing limited

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explanation of the learning processes underlying those outcomes. Although quantitative findings are valuable for determining instructional effectiveness, they offer relatively little insight into how students with different levels of mathematical self-efficacy develop creative mathematical thinking throughout the learning process. Understanding these developmental processes requires the integration of quantitative evidence with qualitative data capable of capturing students' reasoning, classroom interactions, and reflective experiences during instruction.

Finally, previous studies have rarely integrated constructivist learning theory and Social Cognitive Theory within a single analytical framework. Constructivist perspectives explain how students construct mathematical knowledge through exploration, collaboration, and reflection, whereas Social Cognitive Theory explains how learners' beliefs influence motivation, persistence, and engagement in challenging learning situations. Examining these complementary theoretical perspectives simultaneously provides a more comprehensive explanation of how instructional innovation and affective characteristics interact to support the development of mathematical creative thinking.

To address these theoretical, methodological, and empirical gaps, the present study employed an embedded concurrent mixed-methods design, in which quantitative and qualitative data were collected simultaneously but served complementary purposes. The quantitative component examined the effectiveness of the DOCAR instructional model and investigated differences in students' mathematical creative thinking across levels of mathematical self-efficacy. Simultaneously, qualitative evidence obtained through classroom observations, semi-structured interviews, and students' written responses was used to explain the cognitive, collaborative, and reflective processes through which students developed mathematical creative thinking during the implementation of the instructional model. The integration of these complementary forms of evidence provides a richer understanding of instructional effectiveness than either quantitative or qualitative approaches alone.

Accordingly, this study offers several important contributions to contemporary mathematics education research. Unlike previous studies that focused primarily on instructional effectiveness, the present study integrates quantitative and qualitative evidence to explain the learning processes underlying mathematical creative thinking. Methodologically, it extends previous investigations by integrating quasi-experimental analysis with qualitative inquiry within an embedded concurrent mixed-methods design, thereby enabling statistical findings to be interpreted through evidence derived from authentic classroom learning processes. Theoretically, the study contributes by integrating constructivist learning theory and Social Cognitive Theory to explain how instructional experiences and mathematical self-efficacy collectively support the development of mathematical creative thinking. Empirically, the study provides one of the earliest comprehensive examinations of the effectiveness of the DOCAR

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instructional model in fostering mathematical creative thinking while simultaneously considering differences in students' mathematical self-efficacy.

Based on these considerations, this study was conducted to achieve three objectives: (1) to examine whether the DOCAR instructional model significantly improves students' mathematical creative thinking compared with conventional instruction; (2) to investigate differences in mathematical creative thinking among students with high, moderate, and low levels of mathematical self-efficacy; and (3) to explain how students with different levels of mathematical self-efficacy develop mathematical creative thinking throughout the implementation of the DOCAR instructional model. It is expected that the findings will contribute to the growing body of mathematics education research while providing practical guidance for teachers in designing instructional environments that effectively foster students' mathematical creative thinking.

METHOD

Research Design

This study employed an embedded concurrent mixed-methods design (Creswell & Plano Clark, 2018), in which quantitative data served as the primary source of evidence, while qualitative data were collected concurrently to explain and enrich the quantitative findings. This design was selected because it enables statistical evaluation of instructional effectiveness while simultaneously providing in-depth explanations of the learning processes underlying students' mathematical creative thinking.

The quantitative component adopted a non-equivalent control group quasi-experimental design, which is widely used in educational research where random assignment of participants is not feasible. This design is widely recommended when random assignment is impractical in authentic educational settings (Creswell & Creswell, 2018). Two intact classes received different instructional interventions while completing identical pretest and posttest assessments. The experimental group was taught using the DOCAR instructional model, whereas the control group received conventional teacher-centered instruction. The research design is presented in Table 1.

Table 1. Nonequivalent Control Group Design

Group	Pretest	Instructional Intervention	Posttest
Experimental	O_1	DOCAR instructional model	O_2
Control	O_1	Conventional instruction	O_2

Pretest scores were used to establish the initial equivalence of the two groups, whereas posttest scores were analyzed to determine the effectiveness of the instructional intervention.

Participants

The study was conducted at SMP Muhammadiyah 15 Surabaya, Indonesia, during the second semester of the 2022/2023 academic year. The study

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population consisted of all Grade VII students distributed across six classes (VII-A to VII-F).

Two intact classes were selected through purposive sampling based on comparable mathematics achievement, similar academic characteristics, and recommendations from mathematics teachers. Class VII-B (n = 30) was assigned as the experimental group, whereas Class VII-A (n = 30) served as the control group, resulting in a total sample of 60 students.

For the qualitative component, six participants were selected using maximum variation purposive sampling according to their mathematical self-efficacy levels. Two students represented each category (high, moderate, and low self-efficacy). This sampling strategy enabled the researchers to capture diverse perspectives regarding students' mathematical creative thinking throughout the implementation of the DOCAR instructional model.

Research Instruments

Mathematical Creative Thinking Test

Students' mathematical creative thinking was assessed using two open-ended mathematical problems developed according to Silver's (1997) framework of mathematical creative thinking. The assessment measured four dimensions of mathematical creative thinking: fluency, flexibility, originality, and elaboration. Each dimension was evaluated using an analytic scoring rubric to ensure consistent and objective assessment.

Mathematical Self-Efficacy Questionnaire

Students' mathematical self-efficacy was measured using a four-point Likert-scale questionnaire ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). The questionnaire was developed based on Bandura's (1997) three dimensions of self-efficacy: magnitude, strength, and generality.

Higher scores indicated stronger mathematical self-efficacy

Classroom Observation Protocol

Classroom observations were conducted throughout the instructional intervention using a structured observation protocol designed to document students' participation, collaborative interactions, mathematical communication, and engagement during each phase of the DOCAR instructional model.

Semi-Structured Interview Protocol

Semi-structured interviews were conducted with six selected students after completion of the instructional intervention. The interviews explored students' problem-solving experiences, confidence in mathematical reasoning, perceptions of the learning process, and development of mathematical creative thinking. Interview data served primarily to explain and triangulate the quantitative findings.

Instrument Validity and Reliability

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Prior to data collection, all research instruments underwent expert validation involving three specialists in mathematics education to establish content validity. Feedback provided by the validators was incorporated into the revised instruments before pilot testing.

The empirical validity of the mathematical creative thinking test was examined using the Pearson product–moment correlation coefficient, whereas the validity of the mathematical self-efficacy questionnaire was assessed using corrected item–total correlation analysis. Instrument reliability was evaluated using Cronbach's alpha (Cronbach, 1951), with coefficients greater than .70 considered acceptable for educational research.

The pilot study demonstrated that both the mathematical creative thinking test and the mathematical self-efficacy questionnaire possessed satisfactory validity and internal consistency reliability. All validity coefficients met the established acceptance criteria, and all reliability coefficients (Cronbach's α) exceeded the recommended threshold of .70, indicating that both instruments were appropriate for use in the main study.

Ethical Considerations

Prior to data collection, permission to conduct the study was obtained from the principal of SMP Muhammadiyah 15 Surabaya and the mathematics teachers responsible for the participating classes. Students and their parents/guardians were informed about the purpose of the study, and participation was entirely voluntary. All participants were assured that their responses would be kept confidential, used solely for research purposes, and reported anonymously to protect their identities. Throughout the study, the researchers ensured that the instructional intervention posed no physical or psychological risk to the participants and that all research procedures complied with the ethical principles for educational research.

Data Collection Procedures

Data collection was conducted concurrently in accordance with the embedded concurrent mixed-methods design. The quantitative data consisted of: pretest scores, posttest scores, and mathematical self-efficacy questionnaire scores.

The qualitative data consisted of classroom observation records, semi-structured interview transcripts, and students' written responses to mathematical tasks. Although both forms of data were collected simultaneously, quantitative analysis constituted the primary component of the study, whereas qualitative evidence was used to explain the statistical findings and strengthen methodological triangulation.

Data Analysis

Quantitative data were analyzed using IBM SPSS Statistics. Statistical analyses followed the recommendations proposed by Field (2018) and Pallant (2020). Descriptive statistics, including means, standard deviations, minimum

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scores, and maximum scores, were first calculated to summarize students' mathematical creative thinking.

Before hypothesis testing, the assumptions underlying parametric analysis were evaluated. Normality was examined using the Shapiro-Wilk test, while homogeneity of variance was assessed using Levene's test. Independence of observations was ensured through the use of separate intact classes and independent student responses. The assumptions of multivariate analysis followed Hair et al. (2019).

After all assumptions were satisfied ($p > .05$), a two-way analysis of variance (Two-Way ANOVA) was performed to examine: 1) the main effect of the instructional model; 2) the main effect of mathematical self-efficacy; 3) the interaction effect between the instructional model and mathematical self-efficacy on students' mathematical creative thinking. Because a significant main effect of self-efficacy was identified, Tukey's Honestly Significant Difference (HSD) test was subsequently conducted to determine pairwise differences among the three self-efficacy categories. Pairwise comparisons were performed using Tukey's HSD procedure (Tukey, 1949).

To strengthen the interpretation of statistical significance, partial eta squared (η^2) was calculated as a measure of effect size and interpreted according to Cohen's (1988) guidelines.

Finally, qualitative data obtained from classroom observations, interviews, and students' written responses were analyzed using thematic analysis. The qualitative findings were integrated with the quantitative results during the interpretation stage to explain how the DOCAR instructional model facilitated the development of students' mathematical creative thinking across different levels of mathematical self-efficacy.

RESULT AND DISCUSSION

Descriptive Statistics of Mathematical Creative Thinking

Descriptive statistics were calculated to examine students' mathematical creative thinking before and after the instructional intervention. As presented in Table 2, both groups demonstrated identical pretest mean scores (M = 50.67), indicating comparable initial levels of mathematical creative thinking prior to the intervention.

Table 2. Descriptive Statistics of Mathematical Creative Thinking

Group	*n*	Pretest Mean	Posttest Mean	Mean Gain
Experimental (DOCAR)	30	50.67	76.60	25.93
Control (Conventional)	30	50.67	65.97	15.30

Following the instructional intervention, both groups demonstrated improved posttest performance. However, students in the experimental group achieved a higher posttest mean (M = 76.60) than those in the control group (M = 65.97). Likewise, the experimental group exhibited a larger mean gain (25.93) than

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the control group (15.30), indicating greater improvement in mathematical creative thinking following instruction using the DOCAR instructional model.

To provide further insight, descriptive statistics were also analyzed according to students' mathematical self-efficacy levels.

Mathematical Creative Thinking Across Self-Efficacy Levels

Table 3. Descriptive Statistics by Mathematical Self-Efficacy

Self-Efficacy	Experimental Pretest	Experimental Posttest	Gain	Control Pretest	Control Posttest	Gain
High	59.50	88.50	29.00	59.50	77.50	18.00
Moderate	49.50	76.20	26.70	49.50	66.10	16.60
Low	39.50	62.00	22.50	39.50	52.50	13.00

Across all mathematical self-efficacy categories, students who learned through the DOCAR instructional model demonstrated higher gain scores than those who received conventional instruction. Students with high mathematical self-efficacy achieved the largest improvement (29.00), followed by students with moderate (26.70) and low (22.50) self-efficacy. A similar pattern was observed in the control group, although the magnitude of improvement was consistently smaller.

These descriptive findings suggest that both the instructional model and mathematical self-efficacy were associated with differences in students' mathematical creative thinking. Inferential analyses were subsequently conducted to determine whether these differences were statistically significant.

Assumption Testing

Normality Test

Prior to hypothesis testing, the normality assumption was examined using the Shapiro-Wilk test. Normality testing employed the Shapiro–Wilk procedure (Shapiro & Wilk, 1965).

Table 4. Shapiro-Wilk Test of Normality

Group	W	*p*
Experimental	0.940	.092
Control	0.939	.088

The Shapiro-Wilk test indicated that posttest scores in both groups were normally distributed ($p > .05$).

Homogeneity of Variance

Homogeneity of variance was evaluated using Levene's test.

Table 5. Levene's Test of Homogeneity of Variance

Levene Statistic	*p*
0.404	.844

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Because the significance value exceeded .05, the assumption of homogeneity of variance was satisfied. Accordingly, the dataset met the assumptions required for parametric analysis using a two-way analysis of variance.

Two-Way ANOVA

A two-way analysis of variance (ANOVA) was conducted to examine the effects of the instructional model, mathematical self-efficacy, and their interaction on students' mathematical creative thinking.

Table 6. Two-Way ANOVA Results

Source	SS	df	*F*	*p*	Partial η²
Instructional Model	1560.600	1	160.825	< .001	.749
Mathematical Self-Efficacy	6644.633	2	342.376	< .001	.927
Model × Self-Efficacy	5.700	2	0.294	.747	.011
Error	524.000	54	-	-	-

The analysis revealed a statistically significant main effect of the instructional model, $F(1, 54) = 160.83$, $p < .001$, partial $\eta^2 = .749$. A significant main effect of mathematical self-efficacy was also observed, $F(2, 54) = 342.38$, $p < .001$, partial $\eta^2 = .927$.

In contrast, the interaction between the instructional model and mathematical self-efficacy was not statistically significant, $F(2, 54) = 0.29$, $p = .747$, partial $\eta^2 = .011$.

Post Hoc Comparisons

Because the main effect of mathematical self-efficacy was statistically significant, Tukey's Honestly Significant Difference (HSD) test was performed to identify pairwise differences among self-efficacy categories.

Table 7. Tukey's HSD Multiple Comparisons of Mathematical Creative Thinking

Comparison (I–J)	Mean Difference (I–J)	Std. Error	*p* -Value	95% CI Lower	95% CI Upper	Interpretation
Experimental-High vs Experimental-Moderate	12.30	1.82	< .001	7.82	16.78	Significant
Experimental-High vs Experimental-Low	26.50	1.82	< .001	22.02	30.98	Significant
Experimental-Moderate vs Experimental-Low	14.20	1.82	< .001	9.72	18.68	Significant
Control-High vs Control-Moderate	11.40	1.82	< .001	6.92	15.88	Significant
Control-High vs Control-Low	25.00	1.82	< .001	20.52	29.48	Significant
Control-Moderate vs Control-Low	13.60	1.82	< .001	9.12	18.08	Significant
Experimental-High vs Control-High	11.00	1.82	< .001	6.52	15.48	Significant

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Comparison (I–J)	Mean Difference (I–J)	Std. Error	*p* -Value	95% CI Lower	95% CI Upper	Interpretation
Experimental-Moderate vs Control-Moderate	10.10	1.82	< .001	5.62	14.58	Significant
Experimental-Low vs Control-Low	9.50	1.82	< .001	5.02	13.98	Significant
Experimental-High vs Control-Moderate	22.40	1.82	< .001	17.92	26.88	Significant
Experimental-High vs Control-Low	36.00	1.82	< .001	31.52	40.48	Significant

Because the main effect of mathematical self-efficacy was statistically significant, Tukey's Honestly Significant Difference (HSD) test was conducted to determine pairwise differences among the six treatment groups. As shown in Table 7, Most pairwise comparisons were statistically significant, although two comparisons were not statistically significant ($p < .001$), indicating clear differences in mathematical creative thinking across instructional models and self-efficacy levels.

However, two comparisons did not reach statistical significance. The difference between students with moderate self-efficacy in the experimental group and students with high self-efficacy in the control group was not significant ($p = .936$), suggesting that the DOCAR instructional model enabled students with moderate self-efficacy to attain a level of mathematical creative thinking comparable to that of highly self-efficacious students receiving conventional instruction. Likewise, the comparison between students with low self-efficacy in the experimental group and those with moderate self-efficacy in the control group approached but did not reach statistical significance ($p = .051$). These findings indicate that the DOCAR instructional model substantially reduced performance gaps associated with students' mathematical self-efficacy.

Overall, students with higher mathematical self-efficacy consistently achieved higher mathematical creative thinking scores than those with lower self-efficacy, regardless of the instructional model. Nevertheless, the DOCAR instructional model enabled students with moderate and low self-efficacy to perform at levels comparable to students with higher self-efficacy under conventional instruction.

Integration of Quantitative and Qualitative Findings

To complement the quantitative findings, qualitative data obtained from classroom observations, students' written responses, and semi-structured interviews were analyzed.

Classroom observations indicated that students in the experimental group became progressively more active during mathematical discussions throughout the implementation of the DOCAR instructional model. During the early instructional sessions, students tended to depend on teacher guidance when solving mathematical problems. As the intervention progressed, however, they

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increasingly proposed alternative solution strategies, justified their mathematical reasoning, and evaluated peers' ideas during collaborative discussions.

Interview findings further supported these observations. Students with high mathematical self-efficacy reported greater confidence in exploring multiple solution strategies and communicating their mathematical reasoning. Students with moderate self-efficacy described collaborative discussions as an important factor that broadened their understanding of alternative mathematical approaches. Meanwhile, students with low self-efficacy acknowledged that peer interaction and teacher feedback gradually increased their confidence in expressing mathematical ideas despite their initial hesitation.

Students' written responses also demonstrated qualitative differences across self-efficacy levels. Learners with higher mathematical self-efficacy generally produced more flexible, original, and well-elaborated mathematical solutions, whereas those with lower self-efficacy tended to rely on familiar solution procedures. Nevertheless, improvements in mathematical creative thinking were observed across all self-efficacy categories following implementation of the DOCAR instructional model.

Discussion

The Effect of the DOCAR Instructional Model on Mathematical Creative Thinking

The present study demonstrates that students who learned through the DOCAR instructional model achieved significantly higher mathematical creative thinking scores than those who received conventional teacher-centered instruction. The Two-Way ANOVA revealed a statistically significant main effect of the instructional model, accompanied by a large practical effect (partial $\eta^2 = .749$), indicating that the observed improvement was not only statistically significant but also educationally meaningful. These findings suggest that the DOCAR instructional model provides an instructional environment that effectively promotes the development of students' mathematical creative thinking.

The superiority of the DOCAR instructional model can be explained from the perspective of constructivist learning theory, which argues that meaningful mathematical knowledge is actively constructed through exploration, collaboration, and reflection rather than passively transmitted by teachers. These findings are also consistent with previous studies indicating that creativity-oriented learning environments encourage students to construct original mathematical ideas through active participation and collaborative inquiry (Beghetto, 2021; Sternberg, 2021). Throughout the five instructional phases of DOCAR (Do, Observation, Construction, Association, and Reflection) students were consistently encouraged to investigate mathematical problems independently, discuss alternative solution strategies, justify their reasoning, and evaluate the validity of their own ideas. Such learning experiences engage students in higher-order cognitive processes that directly correspond to the dimensions of mathematical creative thinking, namely fluency, flexibility, originality, and elaboration.

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Classroom observations provided additional evidence supporting these quantitative findings. Students initially relied heavily on teacher guidance when solving mathematical problems. However, as the instructional intervention progressed, they became increasingly confident in proposing multiple solution strategies, questioning peers' reasoning, and refining their own mathematical arguments through collaborative discussion. These qualitative findings indicate that mathematical creative thinking developed gradually through repeated opportunities to engage in authentic mathematical inquiry rather than through procedural practice alone.

These findings are consistent with recent international studies reporting that inquiry-oriented and collaborative instructional approaches create more favorable conditions for developing mathematical creative thinking than traditional teacher-centered instruction. For example, Leikin (2021) emphasized that mathematical creative thinking develops when students are encouraged to generate multiple mathematical representations and explore diverse problem-solving strategies. Similar conclusions were reported by Schoevers et al. (2021), who argued that sustained mathematical creative thinking requires instructional environments that support divergent mathematical thinking. Likewise, Bicer et al. (2020) found that learning environments promoting open-ended investigation significantly enhanced students' mathematical creative thinking. More recently, Zhou et al. (2025) reported that collaborative mathematical problem-solving strengthened students' originality and flexibility by encouraging learners to evaluate alternative mathematical ideas collectively.

Although the present findings support those reported by these previous studies, particularly Leikin (2021), the current study extends existing evidence by demonstrating that mathematical creative thinking can also be enhanced through a structured instructional sequence that systematically integrates cognitive, collaborative, and metacognitive learning processes within the DOCAR instructional model. Unlike earlier studies, which primarily examined the effectiveness of inquiry-based or collaborative learning approaches, the present study explains how the sequential phases of DOCAR facilitate students' development of fluency, flexibility, originality, and elaboration while simultaneously providing qualitative evidence of the learning processes underlying these improvements. This integrated perspective offers a more comprehensive explanation of how instructional design can foster mathematical creative thinking in authentic classroom settings.

Nevertheless, the present findings extend previous research in several important ways. Whereas earlier studies generally examined inquiry-based learning or problem-based learning, the present study specifically demonstrates the effectiveness of the DOCAR instructional model, whose structured sequence integrates cognitive, collaborative, and metacognitive learning processes within a single instructional framework. This integrated learning sequence may explain the substantial effect size observed in the present study, suggesting that mathematical creative thinking develops most effectively when students

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repeatedly construct, communicate, and critically evaluate mathematical knowledge throughout the learning process.

The Role of Mathematical Self-Efficacy

These findings are also consistent with Putwain et al. (2022), who reported that students with stronger self-efficacy demonstrate greater persistence and cognitive engagement during mathematical learning. Students with high mathematical self-efficacy consistently outperformed those with moderate and low self-efficacy, regardless of the instructional model implemented. Moreover, the effect size associated with mathematical self-efficacy (partial $\eta^2 = .927$) indicates that students' confidence in their mathematical abilities constitutes one of the strongest predictors of mathematical creative thinking in the present study.

These findings are consistent with Bandura's Social Cognitive Theory, which proposes that individuals' beliefs about their capabilities substantially influence cognitive engagement, persistence, and learning performance. Students with stronger mathematical self-efficacy demonstrated greater willingness to attempt unfamiliar mathematical problems, explore multiple solution pathways, and persist despite cognitive difficulties. Conversely, students with lower self-efficacy tended to rely on familiar procedures and exhibited greater hesitation when communicating mathematical ideas.

Interview findings further supported this interpretation. Students with high mathematical self-efficacy described themselves as confident in experimenting with alternative mathematical approaches even when they were uncertain of the final answer. In contrast, students with lower self-efficacy frequently reported concerns about making mistakes and therefore preferred reproducing previously demonstrated procedures. Nevertheless, students in the experimental group indicated that collaborative discussions and constructive teacher feedback gradually strengthened their confidence throughout the instructional intervention, illustrating how instructional experiences may reinforce positive efficacy beliefs.

These findings corroborate previous international studies indicating that self-efficacy is positively associated with mathematical creative thinking because confident learners are more likely to engage in exploratory reasoning and sustained cognitive effort. However, the present study contributes additional evidence by demonstrating that mathematical self-efficacy influences creative mathematical performance even within an innovative instructional environment, highlighting the importance of integrating cognitive and affective perspectives in mathematics education research.

Why Was No Interaction Effect Observed?

Contrary to the initial expectation, the interaction between the instructional model and mathematical self-efficacy was not statistically significant. This finding indicates that the effectiveness of the DOCAR instructional model remained relatively consistent across students with high, moderate, and low levels of mathematical self-efficacy. In other words, although students with higher

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mathematical self-efficacy consistently achieved better overall performance, the instructional benefits of DOCAR were experienced by learners across all self-efficacy categories.

Several explanations may account for the absence of a significant interaction effect. First, the instructional characteristics of the DOCAR model appear to provide learning opportunities that benefit students regardless of their initial confidence levels. Collaborative discussion, peer feedback, and structured reflection may reduce barriers typically experienced by students with lower mathematical self-efficacy while simultaneously providing sufficient cognitive challenge for students with higher self-efficacy.

Second, the relatively balanced improvement observed across all self-efficacy categories suggests that the instructional model functioned as an equalizing learning environment. Rather than amplifying differences between students, DOCAR encouraged all learners to participate actively in mathematical exploration and collaborative reasoning. Such findings reinforce the view that well-designed constructivist instruction can support diverse learners by providing multiple opportunities to engage in meaningful mathematical activity.

The absence of an interaction effect should therefore not be interpreted as evidence of limited instructional effectiveness. Instead, it suggests that the DOCAR instructional model possesses broad applicability across heterogeneous classrooms characterized by varying levels of mathematical self-efficacy. This finding has important practical implications because mathematics classrooms typically consist of students with diverse motivational characteristics and learning needs.

Integration of Quantitative and Qualitative Findings

The integration of quantitative and qualitative findings provides a more comprehensive explanation of how the DOCAR instructional model facilitated students' mathematical creative thinking. Quantitative analyses demonstrated significant improvements in mathematical creative thinking, whereas qualitative evidence clarified the learning processes responsible for these improvements.

Classroom observations revealed progressively richer mathematical discussions as students advanced through the instructional intervention. Interview findings demonstrated increased confidence, greater willingness to communicate mathematical ideas, and more frequent exploration of alternative solution strategies. Students' written responses likewise illustrated gradual improvements in fluency, flexibility, originality, and elaboration across successive learning activities.

From a mixed-methods perspective, these complementary findings strengthen the credibility of the overall conclusions because statistical improvements were consistently supported by observable changes in students' learning behaviors. Rather than merely demonstrating that the DOCAR instructional model was effective, the integration of quantitative and qualitative evidence explains why the instructional model promoted mathematical creative thinking. This explanatory integration represents an important methodological

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contribution of the present study and illustrates the value of employing an embedded concurrent mixed-methods design in mathematics education research.

CONCLUSION

The findings of this study directly address the research objectives. The first objective was to examine the effect of the DOCAR instructional model on students' mathematical creative thinking. The results demonstrate that students who participated in DOCAR-based instruction achieved significantly higher levels of mathematical creative thinking than those who received conventional teacher-centered instruction. The structured learning experiences embedded within the DOCAR instructional model provided meaningful opportunities for students to generate multiple solution strategies, construct mathematical arguments, communicate their reasoning, and refine their ideas through collaborative reflection. These learning processes collectively supported the development of the four dimensions of mathematical creative thinking: fluency, flexibility, originality, and elaboration.

The second objective was to investigate the role of mathematical self-efficacy in students' mathematical creative thinking. The findings confirm that students with higher levels of mathematical self-efficacy consistently demonstrated superior mathematical creative thinking compared with those possessing moderate or low self-efficacy. This result reinforces the proposition that mathematical creative thinking is influenced not only by cognitive competence but also by students' confidence in their ability to engage successfully with challenging mathematical tasks.

The third objective was to examine the interaction between the DOCAR instructional model and mathematical self-efficacy. The findings indicate that no statistically significant interaction effect was observed. Nevertheless, the instructional benefits of the DOCAR model were experienced consistently across all levels of mathematical self-efficacy, suggesting that the model provides an inclusive learning environment capable of supporting students with diverse motivational characteristics.

The integration of quantitative and qualitative findings further strengthens these conclusions. While the quantitative analyses demonstrated significant improvements in students' mathematical creative thinking, classroom observations, students' written responses, and semi-structured interviews clarified the instructional processes underlying these improvements. Students became progressively more confident in proposing alternative mathematical strategies, communicating mathematical ideas, and evaluating their peers' reasoning throughout the instructional intervention. This convergence of quantitative and qualitative evidence highlights the value of employing an embedded concurrent mixed-methods design to obtain a more comprehensive understanding of instructional effectiveness than could be achieved through a single methodological approach.

From a theoretical perspective, this study contributes to mathematics education research by integrating Constructivist Learning Theory and Social

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Cognitive Theory within a unified explanatory framework. The findings suggest that mathematical creative thinking develops through the interaction between meaningful instructional experiences and positive efficacy beliefs. While constructivist learning environments provide opportunities for students to actively construct mathematical knowledge, mathematical self-efficacy influences learners' willingness to engage in exploration, persist when encountering challenges, and communicate original mathematical ideas. Consequently, this study extends previous research by demonstrating how instructional and affective factors jointly contribute to the development of mathematical creative thinking.

From a methodological perspective, this study demonstrates the value of combining quasi-experimental analysis with qualitative inquiry through an embedded concurrent mixed-methods design. The integration of statistical evidence with classroom observations, interviews, and students' written work enabled not only the evaluation of instructional effectiveness but also the explanation of the learning processes underlying the quantitative outcomes. This methodological approach provides a richer and more nuanced understanding of mathematics learning and offers a useful framework for future studies investigating higher-order thinking skills.

From a practical perspective, the findings suggest that mathematics teachers should design learning environments that extend beyond procedural instruction by encouraging students to explore multiple solution strategies, justify mathematical reasoning, collaborate with peers, and engage in structured reflection. The DOCAR instructional model offers a practical framework for achieving these goals because it systematically integrates cognitive, collaborative, and metacognitive learning activities. In addition, teachers should pay close attention to students' mathematical self-efficacy by providing constructive feedback, meaningful learning experiences, and supportive classroom interactions that strengthen students' confidence in their mathematical abilities.

Several limitations should be acknowledged. The study was conducted in a single junior secondary school with a relatively limited sample size, which may restrict the generalizability of the findings to broader educational contexts. Furthermore, the instructional intervention focused specifically on mathematical creative thinking and mathematical self-efficacy within a single instructional model. Future research should therefore examine the effectiveness of the DOCAR instructional model across different educational levels, mathematical topics, and cultural contexts while incorporating additional cognitive and affective variables, such as mathematical resilience, metacognitive awareness, self-regulated learning, and problem-solving ability. Longitudinal studies are also recommended to investigate the sustainability of improvements in mathematical creative thinking over extended periods of instruction.

In conclusion, the findings indicate that the DOCAR instructional model represents a promising instructional innovation for promoting mathematical creative thinking in secondary mathematics education. By integrating meaningful mathematical inquiry, collaborative learning, reflective practice, and positive motivational support, the model provides a comprehensive learning environment

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that enables students to develop the knowledge, confidence, and creative reasoning required to address increasingly complex mathematical challenges in the twenty-first century.

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Author's Contribution

Shoffan Shoffa designed the research concept, supervised the research process, conducted statistical analysis, interpreted the findings, and prepared the manuscript. Febriana Kristanti contributed to data collection, classroom observations, instrument validation, and data organization. Alfina Damayanti assisted with field implementation, designed the research methodology, data collection, qualitative data analysis, literature review, and manuscript editing. All authors reviewed, revised, and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

REFERENCES

Aljughaiman, A. M., & Mowrer-Reynolds, E. (2005). *Teachers' conceptions of creativity and creative students*. *Journal of Creative Behavior, 39*(1), 17–34.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman.

Beghetto, R. A. (2021). *Uncertainty x design: Educating for complex futures*. Routledge.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage.

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). Sage.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297–334.

Field, A. (2018). *Discovering statistics using IBM SPSS Statistics* (5th ed.). Sage.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Hiebert, J., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students' learning. In F. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 371–404). Information Age Publishing.

Corresponding author: Shoffan Shoffa (shoffanshoffa@um-surabaya.ac.id)

Kattou, M., Kontoyianni, K., Pitta-Pantazi, D., & Christou, C. (2021). Connecting mathematical creative thinking to mathematical ability. *ZDM–Mathematics Education, 53*(1), 125–138.

Kemendikbudristek. (2022). *Capaian pembelajaran mata pelajaran matematika pada Kurikulum Merdeka*.

Kemendikbudristek. (2024). *Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia Nomor 12 Tahun 2024 tentang kurikulum pada pendidikan anak usia dini, jenjang pendidikan dasar, dan jenjang pendidikan menengah*.

Leikin, R. (2021). *Creativity in mathematics education: Theoretical perspectives and empirical findings*. Springer.

Leikin, R., & Pitta-Pantazi, D. (2013). Creativity and mathematics education. *ZDM–Mathematics Education, 45*(2), 159–166.

Levene, H. (1960). Robust tests for equality of variances. In I. Olkin (Ed.), *Contributions to probability and statistics* (pp. 278–292). Stanford University Press.

Mann, E. L. (2006). Creativity: The essence of mathematics. *Journal for the Education of the Gifted, 30*(2), 236–260.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. NCTM.

OECD. (2022). *PISA 2022 assessment and analytical framework*. OECD Publishing.

Pallant, J. (2020). *SPSS survival manual* (7th ed.). McGraw-Hill Education.

Partnership for 21st Century Learning. (2019). *Framework for 21st century learning*. P21.

Putwain, D. W., Wood, P., & Pekrun, R. (2022). Achievement emotions and self-efficacy in mathematics learning. *Learning and Individual Differences, 94*, 102122.

Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creativity Research Journal, 24*(1), 66–75.

Schoevers, E. M., Kroesbergen, E. H., & Kattou, M. (2021). Mathematical creative thinking: A systematic literature review. *Educational Research Review, 33*, 100385.

Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality. *Biometrika, 52*(3–4), 591–611.

Shoffa, S. (2022). *Model pembelajaran DOCAR*. Satria Indra Prasta Publishing.

Shoffa, S., Mustaji, & Arianto, F. (2022). The effect of the DOCAR learning model on students' mathematical problem-solving ability. *International Journal of Progressive Sciences and Technologies, 33*(1), 125–130.

Shoffa, S., Mustaji, & Arianto, F. (2022). The influence of the DOCAR learning model on students' critical thinking skills. *International Journal of Social Science and Human Research, 5*(6), 2465–2474.

Silver, E. A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *ZDM–Mathematics Education, 29*(3), 75–80.

Corresponding author: Shoffan Shoffa (shoffanshoffa@um-surabaya.ac.id)

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Sternberg, R. J. (2021). Creativity: A habit of mind. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (2nd ed.). Cambridge University Press.

Sugiyono. (2023). *Metode penelitian kuantitatif, kualitatif, dan R&D* (3rd ed.). Alfabeta.

Torrance, E. P. (1974). *Torrance tests of creative thinking*. Scholastic Testing Service.

Tukey, J. W. (1949). Comparing individual means in the analysis of variance. *Biometrics, 5*(2), 99–114.

UNESCO. (2021). *Reimagining our futures together: A new social contract for education*.

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