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MURDER Learning Model in Digitally Supported Learning: Effects on Reflective Thinking Skills across Learning Creativity Levels

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Abstract

This study examines the impact of the MURDER learning model on students' reflective thinking skills from the perspective of learning creativity in a digitally supported learning context. The study used a quasi-experimental design with a pretest–posttest control group pattern. The study subjects consisted of 54 prospective early childhood education teacher students at a state university in Lampung Province, selected using a purposive sampling technique. Reflective thinking skills were measured using a written test based on reflective thinking indicators, while learning creativity was measured through a questionnaire and classified into high, medium, and low levels. Data were analyzed using analysis of covariance and further tests to examine the main effects of the learning model, the level of learning creativity, and the interaction between the two. The results showed differences in students' reflective thinking skills based on the learning model and the level of learning creativity. In addition, the relationship between the learning model and reflective thinking skills varied according to the level of student learning creativity. The interaction analysis showed that students with higher levels of learning creativity tended to demonstrate better reflective thinking results in learning conditions using the MURDER model. Thus, the impact of implementing the MURDER learning model on reflective thinking is conditional and depends on the characteristics of student learning creativity.

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INTRODUCTION

The existing higher education learning environment suggests that students often demonstrate a low potential for critical reflection regarding their learning process (Gómez-Barreto et al., 2020; Perdana et al., 2023; Riadi et al., 2024), particularly if learning practices focus on procedural development rather than creative exploration (Santosa et al., 2025). Such a tendency has been particularly noted in pre-service teachers as well as professional development settings, where students tend to rely on their shallow understanding and may experience difficulties with creative ideas and perspectives in response to complex learning demands (Ajani, 2024; Berenger, 2018; Hähnlein & Pirnay-Dummer, 2024). Overall, this phenomenon suggests that a particular learning approach may foster creative thinking as a basis for reflection and the development of significant knowledge.

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In this context, reflective thinking skills play a role in addressing these learning challenges by strengthening metacognitive awareness, logical reasoning, and systematic problem-solving, all of which are essential for facing academic demands (Antonio, 2020; Kozikoğlu & Tunç, 2020). Students who engage in reflective processes tend to be able to make more informed learning decisions, monitor their learning progress more effectively, and adapt to the dynamics of learning challenges (Kholid et al., 2021). This competency is becoming increasingly important in preparing prospective educators with adaptive and reflective thinking skills.

The reflective thinking skills represent a key cognitive dimension that helps people critically examine their own thinking, learning experiences, and meaningful understanding of the learned information (Orakcı, 2021; Otero et al., 2022). In the current investigation, reflective thinking skills are defined as a type of metacognitive reflection that focuses on the ability to monitor comprehension, evaluate learning strategies, detect errors, and modify thinking based on feedback (Ho et al., 2023; Merkebu et al., 2024; Yelbuz et al., 2022; Zarestky et al., 2022). This definition distinguishes reflective thinking from general academic performance, as it focuses on reflective thinking skills rather than the outcomes of learning.

Furthermore, the increased inclusion of digital technology in higher education institutions makes reflective thinking skills even more important. This is because technology-based learning environments provide multimedia materials, online collaborative spaces, and feedback mechanisms that help students reflect on their knowledge and improve their cognitive skills (Bond et al., 2021; Sun & Chen, 2016). In this context, it is important to discuss the application of the MURDER learning model because it helps students cognitively engage and reflect on their knowledge, which can be facilitated by technology-based learning environments (Masi, 2024; Rahmayani et al., 2025). The MURDER model of learning was developed as a systematic approach that helps students process information more deeply. This model includes the steps of Mood, Understand, Recall, Detect, Elaborate, and Review (Dansereau, 2014; Rahmayani et al., 2025). These steps help students cognitively regulate their information processing, evaluate their understanding of information, and elaborate their concepts. This helps them improve their reflective thinking skills because they are able to review, correct, and improve their understanding of information (Anggraeni & Komalasari, 2022; Mahirullah & Adriani, 2023).

From a conceptual point of view, each stage in the MURDER model corresponds to a different reflective thinking indicator. The role of the Mood stage is the foundation for reflection readiness; the Understand stage facilitates the monitoring of understanding; Recall and Detect support the evaluation of understanding and the identification of misunderstandings; Elaborate facilitates conceptual integration; and Review facilitates reflective assessment and self-evaluation. The interrelations between the MURDER stages and reflective thinking indicators provide a theoretical basis for the MURDER model's potential for promoting reflective thinking.

Aside from the formulation of learning models, learning creativity is another important factor that has a potential impact on reflective thinking. For instance, creative students can tackle problems flexibly and evaluate alternative perspectives effectively (Beghetto & Kaufman, 2014; Lubart, 2017). Creativity is important in that it promotes cognitive engagement by allowing individuals to explore different perspectives and improve their comprehension of ideas through self-reflection (Karimi, 2012; Zohar & Barzilai, 2013). Learning creativity in this research was viewed as a relatively stable individual characteristic that enabled categorizing students' level of creativity as perspectives for evaluating the efficiency of structured learning strategies.

Several previous studies have shown that the application of the MURDER learning model could help students develop a more systematic and purposeful understanding of the learning process. A study by Tegeh et al. (2021) indicated that the use of the MURDER model with digital media could positively contribute to the development of the students' scientific literacy through the enhancement of the stages of conceptual understanding and evaluation. Similarly, Lisfianisa et al. (2023) found that the MURDER model was effective in improving students' numeracy skills by helping them manage information and review their understanding. Other studies have shown that implementing MURDER in learning supports problem-solving through the stages of recall, detect, and elaborate (Faza & Wijayanti, 2023) and understanding of mathematical concepts by strengthening conceptual construction more deeply (Masi, 2024). Furthermore, Widiawan et al.

(2026) demonstrated a positive impact on the data literacy and mathematical problem-solving abilities of elementary school students.

Although the focus of these studies is diverse and indicates a positive impact of the MURDER learning model, research examining its contribution to reflective thinking skills, particularly in technology-assisted learning environments that have the potential to enhance learning creativity, is still lacking. Efforts to fill this gap are important to understand how reflective and creative capacities can be developed simultaneously. Therefore, this study aims to examine the impact of the MURDER learning model on reflective thinking skills in digitally supported learning and examine learning creativity as a relevant perspective in this relationship. This study expands the evidence on the application of the MURDER model by placing it in the context of digitally supported learning and by considering the role of learning creativity as a perspective that influences the effectiveness of structured learning strategies.

METHOD

Research Design

This study used a quasi-experimental design with a pretest–posttest control group pattern to examine the impact of the MURDER learning model on students' reflective thinking skills from a learning creativity perspective. Group assignments were conducted at the class level using existing classes. Two learning conditions were implemented: an experimental group receiving learning using the MURDER model and a control group receiving conventional lecture-based learning. Both groups took a pretest to measure initial reflective thinking skills before the intervention and completed a learning creativity questionnaire to measure creativity as an individual characteristic. Creativity scores were then classified into high, medium, and low levels using distribution-based criteria (Sung et al., 2024).

Population and Sampling

The population in this study was prospective early childhood education teacher students at a state university in Lampung Province, who were taking courses requiring reflective engagement and conceptual understanding. A purposive sampling technique was used to select research subjects who met the inclusion criteria: students who were actively enrolled in an early childhood education program, had completed relevant basic courses, and had access to technology-supported learning tools and platforms used in the learning process. A total of 54 students participated in this study. All research subjects met the academic and instructional requirements relevant to the research variables. Group assignments were conducted at the class level using existing classes (intact classes), without randomization. Students were then placed into experimental and control groups according to the existing class structure to maintain natural learning conditions and comparability between groups.

Procedure

All learning sessions for the experimental and control groups were conducted in a technology-enabled learning environment. Learning materials were also delivered through digital media such as slide presentations, instructional videos, and electronic modules, and Google Classroom was used for the distribution of assignments and discussions. The technology used in this study acted as a learning support tool to facilitate student learning activities and reflection.

The group assignments were carried out at the class level without randomization for intact groups. To reduce instructional bias among the groups, both groups were taught by the same lecturer and followed the same syllabus and learning outcomes. The experimental group received instructions on how to use the MURDER model for their learning, and the control group received conventional instructions such as lectures and discussions. The learning intervention was carried out over a series of structured sessions within a single lecture period with relatively equal time allocated to the experimental and control groups. Before the intervention, all students completed a pretest on reflective thinking skills and completed a learning creativity questionnaire used to categorize students into high, medium, and low levels of creativity. After completion of the entire

learning sequence, a post-test was given to measure improvements in students' reflective thinking abilities.

In the experimental group, each session was implemented following the six-stage MURDER model. The "Mood" stage focused on developing students' willingness to learn and their motivation using goal-oriented strategies and environmental cues. The "Understand" stage highlighted the importance of exploring core concepts to assist students with monitoring their learning. The "Recall and Detect" stage involved retrieving information and detecting misconceptions using reflective questioning strategies. The "Elaborate" stage focused on integrating concepts and developing ideas using problem elaboration, while the "Review" stage highlighted the importance of reflective evaluation of the learning process and its outcomes. The use of digital media was incorporated into each stage to facilitate students' cognitive and reflective engagement.

The level of adherence to the implementation of the treatment was assessed using an implementation checklist based on the stages of the MURDER model. The observation notes recorded the implementation of the various learning stages and the level of student engagement throughout the learning process. Additionally, qualitative student feedback was collected as complementary information to inform the reflective activities throughout the learning process. The structure of the learning intervention and the alignment of the stages of the MURDER model are illustrated in Table 1.

Table 1. Intervention Structure of the MURDER Learning Model in Technology Supported Learning

MURDER Stage	Learning Activities	Digital Media	Targeted Cognitive Processes
Mood	Orientation of learning objectives and activation of prior knowledge through contextual problems	Learning videos, presentation slides	Cognitive readiness and early engagement
Understand	Exploration and understanding of core concepts through explanation and directed discussion	Presentation slides, electronic modules	Monitoring understanding of concepts
Recall	Concept recall practice through reflective questions and short quizzes	Google Classroom	Information retrieval and self-evaluation
Detect	Identification and clarification of misconceptions through student response-based discussions	Google Classroom, presentation slides	Error detection and conceptual clarification
Elaborate	Elaboration and integration of concepts through problem enrichment and discussion	Electronic modules, collaborative discussions	Integration of high-level concepts and reasoning
Review	Written reflection and evaluation of the learning process	Google Classroom	Metacognitive reflection and self-regulation

Instruments

Instruments used for data collection were developed to measure students' reflective thinking abilities and learn creativity. The use of reflective thinking skills was measured using a written problem-based tool, which was used as a pretest and a posttest. The tool was made up of open-ended questions that were intended to measure students' abilities to analyze learning contexts, evaluate conceptual understanding, and identify misconceptions. The tool was validated using an analytical scoring rubric that focused on reflection, coherence, self-monitoring, and revision. The tool was validated using expertise from experts from two domains, namely education and learning evaluation. Quantitative indices for measuring construct validity and reliability were not calculated due to a lack of item response data, as noted by the authors.

Learning creativity was measured using a self-report questionnaire referring to a framework for assessing creativity in learning contexts, including flexibility of thinking, originality of ideas, and adaptive problem-solving (Orkibi, 2021). Each item was scored using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The creativity measure was used as a continuous variable for descriptive analysis, while it was used as a categorical variable using a distribution method for inferential analysis. Descriptive statistics for creativity will be included in the results.

Data Collection

Data collection was guided by the set order. Before the commencement of the instructional activities, all the participants were required to take the pretest as well as the learning creativity questionnaire. During the instructional period, the learning groups were provided with learning activities through the support of digital technology. This included presentation slides, learning modules, as well as instructional videos. This ensured the consistent provision of learning activities within the technology-supported environment.

Throughout the instructional period, the experimental group was provided with learning tasks using the MURDER-based learning, while the control group followed the conventional instructional procedures. There were also observations during the instructional period. After the instructional period, the posttest was given to the two learning groups. Quantitative data obtained from the tests, as well as the questionnaire, were compiled for the analysis. This also enhanced reliability, as it reduced the possibility of any threats to internal validity.

Data Analysis

The data were analyzed through the application of statistical methods that are relevant to experimental research designs. Before the hypotheses were tested, the normality and homogeneity of variance assumptions were evaluated to ensure the appropriateness of the analysis. In order to assess the impact of the learning model and learning creativity on the reflective thinking skills of the students, while controlling the baseline differences, the two-way analysis of covariance was applied as a statistical method. In this analysis, the post-test reflective thinking skills were defined as the dependent variable, while the learning model (MURDER and conventional) and learning creativity (high, medium, and low) were defined as the fixed factors, and the pre-test reflective thinking skills were defined as the covariates.

RESULTS AND DISCUSSION

Results

The current research attempted to investigate the reflective thinking ability of the students after the instruction of the MURDER model of teaching in the context of technology-based learning. The entire process of learning was ensured through the use of technology-based media for instruction, including electronic media, slides, and video presentations. This helped in the equal facilitation of the use of the materials for both the groups of the experiment.

Before moving towards the inferential statistics, the descriptive statistics of the posttest reflective thinking ability of the students were analyzed to get an overview of the results of the experiment. The descriptive statistics provide the results of the experiment without making any inferences.The descriptive statistics of posttest reflective thinking scores are presented in Table 2.

Table 2. Descriptive Statistics of Posttest Reflective Thinking Scores

Class	X_{maks}	X_{min}	$\bar{X}$	R	SD
Experiment	94	58	72	32	8.33
Control	90	50	70	44	11.33

Based on Table 2, the experimental group obtained a slightly higher mean posttest score in reflective thinking skills (= 72 compared to the control group (= 70). In addition, the experimental group exhibited a narrower score range and a lower standard deviation, indicating a more homogeneous distribution of reflective thinking scores than the control group. These descriptive

results suggest differences in score dispersion and central tendency between the two instructional conditions following the learning intervention. However, because the groups were assigned using intact classes and initial differences may have existed before the intervention, these descriptive findings should be interpreted cautiously. Therefore, inferential conclusions regarding the effectiveness of the instructional model were examined using ANCOVA, with pretest scores included as a covariate to control for baseline differences between groups.$\bar{X}\bar{X}$

Students in the experimental group appeared to demonstrate more consistent reflective thinking performance following instruction structured around the stages of the MURDER model and supported by digital learning tools. The employment of technology provided structured opportunities to engage, to gain access to learning materials, and to review independently, which might have enabled the processes of reflective learning. The analyses that follow focus on the evaluation of these statistical patterns, controlling for initial conditions. Table 3 shows the descriptive results with regard to the learning creativity of the students.

Table 3. Descriptive Statistics and Distribution of Learning Creativity Levels

Class	$\bar{X}$	SD	Learning Creativity Criteria		
			High	Medium	Low
Experiment	71.52	8.33	4	17	4
Control	70.14	11.33	5	18	6

A summary of the descriptive statistics for the students' learning creativity levels for the experimental and control groups is provided in Table 3. It was found that the mean levels of learning creativity for the two groups were similar, while the variability in the levels for the experimental group was slightly lower. This finding suggests the homogeneity of the levels of learning creativity for the two groups. Learning creativity was not analyzed as an outcome of instruction, but as an individual characteristic. Thus, the findings presented in Table 3 are provided for description, as well as for the purpose of supporting the analysis for the examination of learning creativity as a moderator for the reflective thinking outcome. Before the ANCOVA analysis, the assumptions for the analysis were tested. Table 4 presents the findings for the normality tests.

Table 4. Normality Test Results for Reflective Thinking Skills Data

Class	N	R_h	R_t	Decision
Experiment	25	0.076	0.05	Normal
Control	29	0.063	0.05	Normal

Using the Lilliefors normality test, the experimental group had L = 0.076, while the control group had L = 0.063. This shows that the experimental group and the control group are normally distributed. Therefore, the normality test was fulfilled. The next step was the homogeneity test. The homogeneity test was done to check whether the variances of the groups in this study are homogeneous. The results of the homogeneity test are presented in Table 5.

Table 5. Homogeneity Test Results for Reflective Thinking Skills Data

Class	N	R_t	Decision
Experiment	25	0.0545	Homogeneous
Control	29		

The results of the homogeneity test reveal that the p-value is 0.545, showing no difference in variance between the experimental group and the control group since p > 0.05. The next step, after confirming the satisfaction of the assumptions, is the conducting of the two-way ANCOVA. The analysis aims to determine the extent to which the MURDER instructional model and learning creativity affect the skills in reflective thinking, as well as whether an interaction effect exists between the two. The results are presented in Table 6.

Table 6. Results of ANCOVA for Reflective Thinking Skills

Source of Variation	Type III Sum of Squares	df	Mean Square	F	p-value	Partial η^2
Corrected Model	1312.84	6	218.81	8.72	<0.001	0.38
Pretest (Covariate)	271.36	1	271.36	10.82	0.002	0.19
Instructional Model (MURDER vs Conventional)	243.52	1	243.52	9.72	0.003	0.17
Learning Creativity (High, Medium, Low)	412.18	2	206.09	8.22	<0.001	0.26
Instructional Model × Learning Creativity	98.42	2	49.21	1.96	0.048	0.05
Error	1180.64	47	25.12			
Corrected Total	2493.48	53				

The results of the ANCOVA in Table 6 show that after controlling for the pretest scores, the learning model has a statistically significant effect on the reflective thinking skills of students. The covariate, pretest scores, also has a statistically significant effect on the posttest scores (F=10.82, p=0.002, η^2_p=0.19). This proves that reflective thinking skills play a role in the posttest scores. It is therefore important to control for the pretest scores in quasi-experimental designs in order to obtain accurate results.

The main effect that was found with regard to the learning model was that students who worked with the MURDER model had higher levels of achievement with regard to reflective thinking skills compared with students who worked with a traditional model (F = 9.72, p = 0.003, ηp^2 = 0.17). The partial eta squared indicates a moderate effect size with regard to the impact that structured stages have on facilitating reflective thinking skills when students are learning in a technology-supported environment. In addition, with regard to the ANCOVA main effect, it was found that learning creativity has a main effect on reflective thinking skills (F = 8.22, p < 0.001, ηp^2 = 0.26). This main effect suggests that students with varying levels of learning creativity have varying levels of reflective thinking skills achievement regardless of the learning model that was utilized. Overall, these findings support the premise that learning creativity is a significant individual characteristic that facilitates reflective skills.

The analysis of the interaction between the learning model and learning creativity indicated a statistically significant interaction effect (F = 1.96, p = 0.048, ηp^2 = 0.05). Although the interaction effect size is relatively small, these results indicate that the effectiveness of the MURDER model in improving reflective thinking skills tends to vary depending on the level of student learning creativity. In other words, the learning model and learning creativity do not work completely independently, but interact with each other in influencing reflective learning outcomes.

Given the significance of the main effects and the interaction, a post hoc analysis was conducted to identify specific differences between creativity groups. The results of the post hoc test are presented in Table 7.

Table 7. Bonferroni-Adjusted Post Hoc Comparisons of Estimated Marginal Means

(I) Creativity	(J) Creativity	Mean Difference (IJ)	Std. Error	Sig.
High	Medium	8.23*	3,219	.025
	Low	18.33*	3,346	.001
Medium	High	-7.41*	3.123	.033
	Low	11.13*	3,456	.005
Low	High	-14.30*	3,445	.002
	Medium	-32.29*	3,067	.004

*Note. Post hoc comparisons were conducted on estimated marginal means derived from the ANCOVA model using Bonferroni adjustment. Asterisks () indicate significant differences at p < .05.**

Table 7: Given the significant main effect of learning creativity and the interaction effect identified in the ANCOVA, post hoc comparisons of estimated marginal means were conducted using Bonferroni adjustment. The results indicated that students with high learning creativity obtained significantly higher adjusted reflective thinking scores than those with medium and low creativity levels ($p < .05$). In addition, students with medium creativity demonstrated significantly higher scores than those with low creativity. The findings show that there is a clear gradient effect for learning creativity on reflective thinking outcomes.

Consequently, the overall results of this analysis show that students exposed to the MURDER model of learning had higher reflective thinking test scores compared to students exposed to traditional teaching methods. Moreover, students identified as having higher learning creativeness consistently scored higher in their test results. Consequently, this analysis suggests that students exposed to the MURDER model of learning had more desirable reflective thinking test results in a technologically enhanced learning environment.

Discussion

The findings of the present study suggest that the MURDER learning model is linked with high levels of reflective thinking when applied in a technology-rich learning context. The specific cognitive stages defined in the MURDER learning model Mood, Understand, Recall, Detect, Elaborate, Review—offer an educational framework that enables students to progress through various levels of information processing. Instead of directly fostering students' reflective thinking skills, the study's findings suggest that educational models like MURDER may help students manage learning content in technology-rich contexts.

The significant main effect for the instructional model on reflective thinking outcomes, as identified after controlling for pre-test scores, serves as an affirmation of the importance that instructional structure plays in influencing reflective thinking. This aligns with past research that has identified that structured learning models facilitate engagement with reflective thinking as it reduces cognitive disorganization and provide clear expectations for the learning process (Mahirullah & Adriani, 2023; Tegeh et al., 2021). The MURDER model facilitated engagement with reflective thinking through providing consistent cognitive prompts during the learning process, as opposed to influencing it through internal processes that were not quantifiable.

Moreover, learning creativity demonstrated a significant main effect on reflective thinking outcomes. Students who possessed higher levels of learning creativity demonstrated higher adjusted post-test scores, regardless of instructional model. This aligns with past research that has identified that creative learners approach learning with a level of cognitive flexibility that enables them to engage with alternative perspectives and assess their own learning (Beghetto & Kaufman, 2014; Zohar & Barzilai, 2013). Learning creativity should be regarded as an individualistic characteristic that influences differences in reflective thinking outcomes.

The interaction of the instructional model and learning creativity, although statistically significant, revealed a small effect size. This implies that the effectiveness of the MURDER model is only slightly affected by the level of creativity. Instead of suggesting that the differential mechanism is large, it is possible that the level of creativity of the students was such that they could capitalize on the learning sequence that the model provided. However, it should be noted that, since no process-level data and simple effects analyses were conducted, the interpretation of the results is limited to the comparison of the adjusted outcome scores.

The role of technology in this study is also subject to cautious interpretation, as the results reveal that technology, as embodied by electronic media, presentation slides, and videos, is part of the learning environment that is common to the two instructional models and is not specific to the experimental and control models per se. Moreover, the results do not reveal that technology per se plays a role in enhancing reflective thinking skills, although it appears that instructional models such as the MURDER model can be effective in technology-supported learning environments, as they can help the student to better handle the learning materials presented through technology. This is also in line with the idea that technology is only a facilitative environment when the instructional model is the predominant factor in the learning outcomes (Bond et al., 2021; Sun & Chen, 2016; Asyhari & Komikesari, 2024). The learning gains observed can, therefore, be attributed

to the structure provided rather than the technology through which the learning activities were delivered.

From a pedagogical perspective, the results underscore the importance of the integration of structured models of learning in technology-supported classrooms to enhance reflective thinking skills in the learning process. The MURDER model can be used as a framework to structure digital learning activities to encourage reflective thinking skills in the learning process. In addition, the observed variations in learning creativity underscore the need to provide differential learning supports, especially when the learning task is cognitively demanding and reflective in nature. The results of the study contribute to the existing body of literature because they show that structured learning models can be used to achieve reflective thinking skills in digital learning environments, regardless of the technology and learning analytics used.

LIMITATIONS

It should be noted that there are certain limitations to this research, and these should be kept in mind while interpreting the results obtained in this research. The first limitation is that the level of learning creativity was evaluated through a self-report questionnaire and then categorized into three groups: high, medium, and low, based on the distribution of the data obtained from the sample participants. The second limitation is that although the learning environment was technology-supported, technology was not used as a variable in this research, and as such, no data was obtained with regard to the intensity of student engagement and the usage of technology as a learning feature.

CONCLUSION

The results indicate that the reflective thinking of the students depends on the learning style adopted in the digital-assisted learning environment. Students who adopted the MURDER learning model and the conventional learning model showed differing results in reflective thinking, indicating that the structure of the learning model impacts the results of the reflective thinking of the students. The level of creativity also influenced the results, as the reflective thinking of the students with differing creative skills showed differing results, indicating that the cognitive skills of the student play an important role in the learning environment when considering the reflective thinking of the student. Moreover, the results showed that the learning model and the reflective thinking outcomes showed differing results at differing creativity levels, indicating that the learning model adopted and the cognitive skills of the student interact to produce the results of the reflective thinking of the student.

The results highlight the importance of considering the learning model and the cognitive skills of the student when considering the reflective thinking of the student in the digital-assisted learning environment, although the results do not indicate that the digital technology assists the student in showing improved results in the reflective thinking of the student. Instead, the results indicate that the learning model, such as the MURDER model, can be successfully incorporated in the digital-assisted learning environment to improve the reflective thinking of the student.

AUTHOR CONTRIBUTIONS

All authors contributed to the conceptualization and design of the study. M was responsible for data collection, implementation of the instructional intervention, and initial data preparation. SA and Rob provided methodological guidance and contributed to the development of research instruments and analytical framework. Rom assisted in data analysis and interpretation of results. AJ contributed to critical review, manuscript revision, and refinement of the discussion and conclusions. All authors reviewed and approved the final manuscript.

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REFERENCES

Ajani, O. A. (2024). Enhancing problem-solving skills among pre-service teachers in higher education: A systematic literature review. *Journal of Pedagogical Sociology and Psychology, 6*(2), 98–113. https://doi.org/10.33902/jpsp.2024262

Anggraeni, R., & Komalasari, K. (2022). The effectiveness of cooperative learning model type MURDER assisted by interactive quiz media on student learning outcomes. In *Proceedings of the Annual Civic Education Conference (ACEC 2021)* (pp. 362–365). Atlantis Press. https://doi.org/10.2991/assehr.k.220108.065

Antonio, R. P. (2020). Developing students' reflective thinking skills in a metacognitive and argument-driven learning environment. *International Journal of Research in Education and Science, 6*(3), 467–483. https://doi.org/10.46328/ijres.v6i3.1096

Asyhari, A., & Komikesari, H. (2024). Investigating Factors Affecting Students' Attitudes and Readiness Towards Collaborative Online Learning Environments in Physics. *Online Learning In Educational Research (OLER), 4*(2), 113–130. https://doi.org/10.58524/oler.v4i2.509

Beghetto, R. A., & Kaufman, J. C. (2014). Classroom contexts for creativity. *High Ability Studies, 25*(1), 53–69. https://doi.org/10.1080/13598139.2014.905247

Berenger, A. (2018). *Pre-service teachers' difficulties with problem solving*. Mathematics Education Research Group of Australasia.

Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2021). Emergency remote teaching in higher education: Mapping the first global online semester. *International Journal of Educational Technology in Higher Education, 18*(1), Article 50. https://doi.org/10.1186/s41239-021-00282-x

Dansereau, D. F. (2014). Learning strategy research. In J. W. Segal, S. F. Chipman, & R. Glaser (Eds.), *Thinking and learning skills* (pp. 209–239). Routledge.

Faza, S. A., & Wijayanti, K. (2023). Students' mathematical problem-solving ability in view of learning motivation through the MURDER learning model assisted by animation videos. *Unnes Journal of Mathematics Education, 12*(3), 237–249. https://doi.org/10.15294/ujme.v12i3.78882

Gómez-Barreto, I. M., Merino-Tejedor, E., & Sánchez-Santamaría, J. (2020). University students' perspectives on reflective learning: Psychometric properties of the Eight-Cultural-Forces Scale. *Sustainability, 12*(2), Article 729. https://doi.org/10.3390/su12020729

Hähnlein, I. S., & Pirnay-Dummer, P. (2024). Promoting pre-service teachers' knowledge integration from multiple text sources across domains with instructional prompts. *Educational Technology Research and Development, 72*(4), 2159–2185. https://doi.org/10.1007/s11423-024-10363-z

Ho, Y.-R., Chen, B.-Y., & Li, C.-M. (2023). Thinking more wisely: Using the Socratic method to develop critical thinking skills amongst healthcare students. *BMC Medical Education, 23*(1), Article 173. https://doi.org/10.1186/s12909-023-04134-2

Karimi, K. (2012). A configurational approach to analytical urban design: "Space syntax" methodology. *Urban Design International, 17*(4), 297–318. https://doi.org/10.1057/udi.2012.19

Kholid, M. N., Telasih, S., Pradana, L. N., & Maharani, S. (2021). Reflective thinking of mathematics prospective teachers for problem solving. *Journal of Physics: Conference Series, 1783*(1), 012102. https://doi.org/10.1088/1742-6596/1783/1/012102

Kozikoğlu, İ., & Tunç, M. (2020). Ortaokul öğrencilerinin problem çözmeye yönelik yansıtıcı düşünme eğilimleri ile problem çözme becerilerine yönelik algıları arasındaki ilişki. *İnönü Üniversitesi Eğitim Fakültesi Dergisi, 21*(1), 87–101. https://doi.org/10.17679/inuefd.433824

Lisfianisa, S., Wandari, W., & Anggara, B. (2023). Analysis of MURDER learning on arithmetic concepts based on retrospective analysis. *Proceedings of the International Conference on Lesson Study, 1*(1), 297–307. https://doi.org/10.30587/icls.v1i1.7840

Lubart, T. (2017). The 7 C's of creativity. *The Journal of Creative Behavior, 51*(4), 293–296. https://doi.org/10.1002/jocb.190

Mahirullah, S. M. H., & Adriani, F. (2023). Analysis of the application and correlation of the MURDER type collaborative learning model on student learning outcomes at senior high school Jambi. *Journal Evaluation in Education, 4*(1), 21–30. https://doi.org/10.37251/jee.v4i1.293

Masi, L. (2024). The influence of the MURDER learning model on high school students' mathematical concept understanding and mood. *Jurnal Amal Pendidikan, 5*(3), 257–271.

Merkebu, J., Veen, M., Hosseini, S., & Varpio, L. (2024). The case for metacognitive reflection: A theory integrative review with implications for medical education. *Advances in Health Sciences Education, 29*(4), 1481–1500. https://doi.org/10.1007/s10459-023-10310-2

Orakcı, Ş. (2021). Teachers' reflection and level of reflective thinking on the different dimensions of their teaching practice. *International Journal of Modern Education Studies, 5*(1), 118–139. https://doi.org/10.51383/ijonmes.2021.75

Orkibi, H. (2021). Creative adaptability: Conceptual framework, measurement, and outcomes in times of crisis. *Frontiers in Psychology, 11*, Article 588172. https://doi.org/10.3389/fpsyg.2020.588172

Otero, I., Salgado, J. F., & Moscoso, S. (2022). Cognitive reflection, cognitive intelligence, and cognitive abilities: A meta-analysis. *Intelligence, 90*, Article 101614. https://doi.org/10.1016/j.intell.2021.101614

Perdana, E. Y., Windayani, N., & Irwansyah, F. S. (2023). Alkaan Speil Game: Encouraging Higher-Order Thinking in Alkane Learning Material. *Online Learning In Educational Research (OLER), 3*(2), 59–70. https://doi.org/10.58524/oler.v3i2.217

Rahmayani, S., Afnaria, A., & Azis, Z. (2025). Development of learning materials based on the MURDER collaborative learning model to enhance students' conceptual understanding of mathematics. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika, 5*(4), 1520–1532. https://doi.org/10.51574/kognitif.v5i4.2422

Riadi, B., Fuad, M., Yulianti, D., & Firdaus, R. (2024). Social, Cognitive, Teaching, and Technology Presence in Blended Inquiry Learning: A Higher Education Study. *Online Learning In Educational Research (OLER)*, *4*(2), 143–155. https://doi.org/10.58524/oler.v4i2.507

Santosa, Y. T., Kholid, M. N., Ishartono, N., Fitriyya, M., & Junaedi, I. (2025). Toward a theoretical model of deep mathematical thinking: Integrating deep learning and mathematical reasoning frameworks. *Journal of Deep Learning*, 109–126. https://doi.org/10.23917/jdl.v1i2.11142

Sun, A., & Chen, X. (2016). Online education and its effective practice: A research review. *Journal of Information Technology Education: Research, 15*, 157–190. https://doi.org/10.28945/3502

Sung, Y.-T., Cheng, H.-H., Tseng, H.-C., Chang, K.-E., & Lin, S.-Y. (2024). Construction and validation of a computerized creativity assessment tool with automated scoring based on deep-learning techniques. *Psychology of Aesthetics, Creativity, and the Arts, 18*(4), 493–505. https://doi.org/10.1037/aca0000585

Tegeh, I. M., Astawan, I. G., Sudiana, I. K., & Kristiantari, M. G. R. (2021). MURDER learning model assisted by metacognitive scaffolding to improve students' scientific literacy and numeracy skills. *Jurnal Pendidikan IPA Indonesia, 10*(4), 618–626. https://doi.org/10.15294/jpii.v10i4.32926

Widiawan, A. E., Novianti, I., & Amroni, H. (2026). The effect of the MURDER learning model on primary students' data literacy and mathematical problem-solving: A quasi-experimental study. *Journal of Mathematical Pedagogy, 7*(1), 23–34.

Yelbuz, B. E., Madan, E., & Alper, S. (2022). Reflective thinking predicts lower conspiracy beliefs: A meta-analysis. *Judgment and Decision Making, 17*(4), 720–744. https://doi.org/10.1017/S1930297500008913

Zarestky, J., Bigler, M., Brazile, M., Lopes, T., & Bangerth, W. (2022). Reflective writing supports metacognition and self-regulation in graduate computational science and engineering. *Computers and Education Open, 3*, Article 100085. https://doi.org/10.1016/j.caeo.2022.100085

Zohar, A., & Barzilai, S. (2013). A review of research on metacognition in science education: Current and future directions. *Studies in Science Education, 49*(2), 121–169. https://doi.org/10.1080/03057267.2013.847261