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PAPER

Enhancing Metacognitive and Creativity Skills through AI-Driven Meta-Learning Strategies

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ABSTRACT

This study investigates the efficacy of a meta-learning approach in improving metacognitive and creative skills. This quantitative study focused on an experimental group using a one-group pretest-posttest research design. All participants underwent a pretest to assess their initial metacognitive abilities and were subsequently exposed to a meta-learning framework throughout the course. A post-test was conducted to assess the impact of the intervention. The findings indicate a statistically significant improvement in metacognitive skills from the pretest to the post-test. This study confirms the effectiveness of meta-learning strategies and elucidates the relationship between meta-learning and metacognition. Meta-learning enables students to comprehend their own learning processes, thereby improving their capacity to strategize, oversee, and control their cognitive functions with the assistance of artificial intelligence (AI). This approach incorporates creative elements that can stimulate metacognitive thinking, encouraging students to adjust their learning strategies and think outside the box. This research suggests that meta-learning can improve metacognitive abilities, providing valuable insights into educational technology and course design in higher education settings.

KEYWORDS

meta-learning, artificial intelligence (AI), metacognitive, creativity, quality education, innovation

1 INTRODUCTION

Humans are remarkable in that they continue to learn throughout their lives, from developing physical reasoning and language skills at a young age to gaining the ability to understand the complexities present in everyday adult life. One of the fundamental aspects of learning is that it takes place at various levels, encompassing different timeframes and levels of abstraction. This process is known as meta-learning, or learning to learn [1].

The concept of "learning to learn" originated in psychology and centers on learning and educational theory. Given the rapid pace of technological advancement, it

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is essential to understand how various areas of psychology, cognitive science, and neuroscience fit into the meta-learning perspective currently recognized in artificial intelligence (AI) [2].

In the ever-evolving education landscape, two interrelated concepts stand out for their transformative potential: meta-learning and metacognition. Meta-learning, or "learning how to learn," is a complex process that helps individuals become more adaptable learners by understanding their learning styles and preferences. On the other hand, metacognition refers to an individual's capacity to monitor and regulate their cognitive processes. These concepts provide a strong framework for improving educational experiences in various settings, including higher education [3].

On the other hand, higher education providers must ensure that they fulfill their students' rights to receive optimal learning services [4]. As communication and information technology continue to advance, providing student learning services also requires embracing technological progress. One way to enhance educational services is for instructors to develop innovative learning methods. This approach to learning will encourage students to optimize their learning, both independently and in the classroom [5].

The State University of Surabaya is reputable. This is achieved because the institution has fulfilled its obligations as a higher education provider. One way to enhance the learning process is for instructors to incorporate innovative teaching methods, motivating students to achieve optimal learning outcomes through both independent study and classroom instruction. The Department of Educational Technology is an academic institution dedicated to cultivating skilled professionals in the field of educational technology.

The Message Design course is a theoretical and practical learning experience that necessitates the acquisition of strategies to engage students actively and foster independence. The learning process aims to facilitate the development of students' potential abilities into essential skills that can be utilized, particularly for solving educational problems. In this course, the instructors have endeavored to design learning experiences that meet the criteria for effective learning. However, students face several obstacles to online learning because they need metacognition skills. This fact was obtained through interviews and observations conducted during lectures.

Metacognition is essential in learning because students need to be aware of the demands of their tasks and goals, including how to use strategies and what is required to meet the demands of learning tasks [6]. Students' success in each course is essential for them to realize their expertise. This course explores different types of message symbols (visual, audio, and audio-visual) and teaches the design of graphic symbols to effectively communicate in the learning process.

Metacognitive abilities are not just additional skills but fundamental to learning. They enable students to be more than passive recipients of information, empowering them to critically engage with the material, set realistic goals, and adapt strategies for effective learning. In today's digital age, which is characterized by abundant problems and often conflicting sources, metacognitive skills are more important than ever for discerning valid information and for self-directed, lifelong learning [3].

Based on the course description, students are required to be able to learn independently and possess strong metacognition skills. Therefore, students can acquire skills through learning. Therefore, students need to be taught how to approach problem-solving. Given these challenges and the demand for more adaptable and personalized learning experiences, a meta-learning approach is a feasible solution.

Meta-learning, or "learning how to learn," is an approach that emphasizes understanding and optimizing the learning process itself. This concept has gained significant popularity in various fields, particularly in education and artificial intelligence. In the realm of education, meta-learning tools are created to assist learners in developing skills to become more efficient and self-directed in their learning journey. Meta-learning explores how learning systems can become more efficient through iterative experiences, with the goal of making learning more adaptive and flexible based on specific domains or tasks. By aligning meta-learning with metacognition, this study presents an innovative approach to addressing the challenges observed in the Message Design course, thereby contributing to the broader goal of enhancing educational quality.

This research is focused on the Message Design course within the Department of Educational Technology at Surabaya State University. The study utilizes a quantitative research approach with a one-group pre-test and post-test design. While the results may provide insights into the effectiveness of a meta-learning approach in enhancing metacognition, the findings are specific to the course and student population under study, which limits their generalizability.

The Message Design course aims to produce students who are proficient in visual, audio, and audio-visual message design, as well as practical and independent learners. This study addresses a critical gap in existing teaching strategies by investigating the potential of a meta-learning approach to enhance metacognitive abilities. The research is not solely academic; it also serves a practical purpose by aiming to improve the quality of educational delivery and learning experiences in this particular course while also providing a scalable model for other courses.

2 METHOD

The study employs experimental research. The empirical research approach can be interpreted as a research method used to investigate the impact of specific treatments on individuals under controlled conditions [7]. Based on this perspective, it can be understood that experimental research involves administering treatment to research subjects and then observing the effects of the treatment.

As for this research, the experimental design used is a pre-experimental design with a single-group pre-test and post-test research design [8]. The one-group pre-test and post-test design is a research method that involves administering a pre-test before treatment and a post-test afterward. From this definition, it can be concluded that treatment results can be more accurately assessed by comparing them with the situation before treatment [7].

Experimental research applies experimental methods to study the effects of specific variables on other variables through trials conducted in controlled conditions deliberately created by researchers (treatment). The following is a table of experimental designs.

Table 1. One-group pre-test and post-test research design

Pre-test	Treatment	Post-test
O1	X	O2

In this study, the meta-learning approach was applied to 42 undergraduate students majoring in educational technology at the faculty of education, Surabaya State University, in the class of 2021. This application aims to enhance metacognitive and creative abilities in the Message Design course.

The variables in this study are classified as follows: Independent variables, also known as predictor variables, can influence changes in the dependent variable and exhibit both positive and negative relationships. The independent variable in this study is the meta-learning approach. Next, the dependent variable becomes the primary focus of the observation and simultaneously becomes the research target. The dependent variable in this study is metacognitive ability.

Data is a unit of information recorded by the media that can be distinguished from other data, analyzed, and is relevant to a particular program. Data collection is a methodical and standardized process for obtaining the required data. The data collection methods used in this study include observation and testing. The data was analyzed using the normality test, paired sample t-test, and normalized gain test (N-Gain score).

3 RESULT

The following describes the research results of applying meta-learning using AI tools to enhance metacognitive and creativity skills.

3.1 Instrument validity and reliability test

Instrument validation and reliability are necessary to assess the validity and reliability of the instruments produced. The validity and reliability of research instruments are assessed using content validity, which involves expert judgment. Content validity is a component of internal validity. Content validity testing is conducted and endorsed by experts to ensure that the instrument is suitable for the research objectives. The validated instrument is a metacognitive assessment tool. After validating the expert judgment and making revisions to improve the instrument, it can be concluded that the metacognitive assessment rubric is considered valid and reliable and can be used in research.

The metacognitive and creativity assessment rubric is divided into four aspects and evaluated across four assessment levels. Here are the details.

Table 2. Metacognitive assessment rubric

Aspect 1	Self-Awareness
Level 1	Students show little or no awareness of their cognitive processes.
Level 2	Students show essential awareness but struggle to articulate their cognitive processes.
Level 3	Students are aware of their cognitive processes and can articulate their thinking patterns.
Level 4	Students show high self-awareness and can clearly articulate their cognitive processes.
Aspect 2	**Self-Regulation**
Level 1	Students fail to set goals, plan, or evaluate their performance.
Level 2	Students set vague goals but struggle with planning and evaluation.
Level 3	The student sets clear goals, has a basic plan, and performs some level of self-evaluation.
Level 4	Students set specific goals, plan effectively, and continually evaluate and adjust their strategies.

(Continued)

Table 2. Metacognitive assessment rubric *(Continued)*

Aspect 3	Use of Cognitive Strategies
Level 1	Students do not use or identify any cognitive strategies for learning.
Level 2	Student uses some cognitive strategies, but they are not effective or consistent.
Level 3	Students effectively use various cognitive strategies but may not constantly adapt to new situations.
Level 4	Students skilfully use and adapt a range of cognitive strategies to enhance learning.
Aspect 4	**Metacognitive Reflection**
Level 1	Students do not reflect or analyse their learning experience.
Level 2	Students reflect superficially, with limited analysis or insight into their learning experience.
Level 3	Students reflect and offer some insight into their learning but may not act on the reflection.
Level 4	Students reflect deeply, generating insights and actions to improve future learning.

3.2 Normality test

The normality test is necessary for the paired sample t-test. This test determines whether the data to be analyzed follows a normal distribution. For the paired sample t-test, the data must adhere to a normal distribution. The data used in this test consists of pretest and posttest values. The sample value was analyzed using the gain score data in the SPSS 23.0 application, employing the Kolmogorov-Smirnov test. Data is considered normally distributed if the Asymp.sig (2-tailed) value is greater than 0.05.

Table 3. Normality test result

Test		Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Score	Pre-test	.131	42	.068
	Post-test	.129	42	.078

Note: [a]Lilliefors significance correction.

3.3 Paired sample t-test

This test utilizes the paired sample t-test. This test is one of the methods used to assess the effectiveness of treatment, as indicated by differences in the average before and after treatment. The method's characteristics include the ability for researchers to obtain two types of data from the same sample, both before and after treatment. A paired sample t-test was used to test the hypothesis in this study. To test the research hypothesis, the following standards are set: (a). If the probability value, or sig. (2-tailed) < 0.05, indicates a significant difference between the pretest and posttest, leading to the rejection of H0. (b). Conversely, if the probability value or sig. (2-tailed) > 0.05, there is no significant difference, so H0 is accepted.

Table 4. Paired samples test result

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest – Posttest	–47.50000	13.40049	2.06774	–51.67589	–43.32411	–22.972	41	.000

3.4 Normalized gain test (N-gain score)

Gain is the difference between pre-test and post-test scores. The equation for determining the improvement in students' abilities after receiving treatment is as follows:

$$N\text{-}gain = \frac{\text{Skor } \textit{Posttest} - \text{Skor } \textit{Pretest}}{\text{Skor } \textit{Maksimum} - \text{Skor } \textit{Pretest}} \times 100\%$$

The letter "g" represents the normalized gain (n-gain) for both results, with the maximum (ideal) value being the highest result from the initial and final testing. The n-gain can be categorized as follows:

Table 5. N-gain score distribution

Magnitude of Gain	Interpretation
$g > 0.7$	High
$0.7 > g > 0.3$	Moderate
$g < 0.3$	Low

Furthermore, the N-Gain test is utilized to assess the effectiveness of the treatment by measuring the percentage level of effectiveness, as follows:

Table 6. N-gain effectiveness interpretation category

T < 40%	Not effective
40–55%	Less effective
56–75%	Effective enough
>76%	Effective

Table 7. Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
N GAIN_SCORE	42	.44	1.00	.7823	.15585
N GAIN_PERSEN	42	44.44	100.00	78.2317	15.58517
Valid N (listwise)	42				

4 DISCUSSION

4.1 Meta-learning approach to improve metacognition and creativity

Researchers have varying perspectives on the precise definition of the term meta-learning. Meta-learning explores how learning systems can enhance efficiency through experience. The objective is to comprehend how learning can adapt to the specific domain or task being studied. All learning systems work by adapting to a specific environment, which reduces the imposition of a separate order or bias on the set of hypotheses that might explain a concept [9].

Meta-learning is a branch of metacognition that focuses on understanding one's own learning and learning processes. The term is derived from the modern meaning of the prefix "meta," which signifies abstract recursion or "X about X," similar to its use in meta-knowledge, meta-memory, and meta-emotion [10]. Meta-learning, or "learning to learn," aims to develop models that can learn new skills or adapt quickly to new environments with minimal training instances. There are three general approaches: 1) learning efficient distance metrics (metric-based); 2) using iterative networks with external or internal memory (model-based); and 3) optimizing model parameters explicitly for fast learning (optimization-based) [11].

Good machine learning models often require training with a large number of samples. In contrast, humans learn new concepts and skills more quickly and efficiently. Children who have only seen cats and birds a few times can quickly distinguish between the two animals. Individuals who are proficient in riding a bicycle are likely to quickly learn how to ride a motorcycle with minimal or no instruction. Can machine learning models be designed to quickly learn new concepts and skills using only a few training examples? That is essentially the goal of meta-learning to solve.

A good meta-learning model should be able to adapt well and generalize to new tasks and environments, even those that rarely exist. The adaptation process, essentially a mini-learning session, occurs during testing but with limited exposure to new task configurations. Eventually, the adapted model can achieve the new task [12]. This is why meta-learning is also known as "learning to learn." Tasks can encompass any well-defined set of machine learning problems, such as supervised learning and reinforcement learning. For instance, some specific meta-learning tasks include: a) training a classifier on non-cat images to identify cat-containing images after exposure to multiple cat images; b) enabling a game bot to rapidly excel at a new game; and c) instructing a mini-robot to perform a given task on an uphill surface during testing, even though it was only trained in a flat surface environment [2].

Meta-learning is an original concept in cognitive psychology. If we refer to the definition of social psychology, meta-learning is the state of being aware of and controlling one's own learning process. A similar concept, when applied to machine learning theory, suggests that meta-learning algorithms utilize previous experience to modify certain aspects of an algorithm, resulting in an improved version compared to the original algorithm. Meta-learning refers to an algorithm's ability to learn how to learn [13].

Meta-learning differs from base-learning in terms of the scope of adaptation. Meta-learning dynamically learns how to choose the right bias, as opposed to base-learning, where the bias is fixed a priori or by user parameters. In a typical inductive learning scenario, when using a base learner (such as a decision tree, neural network, or support vector machine), most of the data generates hypotheses that rely on fixed biases inherent in the learner. Learning occurs at the foundational level, and the quality of hypotheses generally improves with an increasing number of examples. However, each time learners apply the same data, they consistently generate the same hypotheses, regardless of performance. There is no retrieval of knowledge across different domains or tasks. Meta-learning aims to discover methods for identifying the most effective learning strategy as tasks dynamically increase [14]. At the primary level, learning is based on accumulated experience with a specific learning task, while at the meta-level, learning is based on accumulated experience across the performance of multiple learning system applications. If a learner fails to perform efficiently, the learning mechanism will adapt when the same task is repeated [15].

Meta-learning is essential for understanding the interaction between learning mechanisms and the specific contexts in which they can be applied. In brief, meta-learning focuses on the relationship between tasks, or domains, and learning strategies. In studying or explaining the factors that contribute to the success or failure of a learning system in a specific learning task or domain, we aim not only to produce more accurate learners but also to understand the conditions (such as the type of instance distribution) in which learning strategies are most suitable [12].

However, effective learning within institutional settings requires learners to be aware of the task demands and their intentions regarding how, or even whether, to meet those demands. Additionally, they need to realistically assess and exert control over their cognitive resources. The fulfillment of such conditions involves a sophisticated form of metacognition known as meta-learning [16]. Meta-learning is the process through which learners become aware of and control the ways they perceive, inquire, learn, and grow, which they have internalized [17]. Meta-learning involves being aware of and in control of one's own learning [18]. Essentially, meta-learning is learning how to learn [19].

Meta-learning skills can help learners achieve different methods of combining knowledge in several ways. Some of the teaching methods include: a) debates; b) group activities; c) reflection and discussion of material; and d) daily repetition of material [20]. Meta-learning can also be achieved by practicing self-explanation of the learned material, keeping a journal to track one's ability to adapt information effectively and thoughtfully, and discerning and prioritizing information for retention. The two primary components of meta-learning are: 1) Metacognition refers to the procedures used to plan, control, and assess one's comprehension and performance. It involves developing critical awareness of one's thinking and learning as a thinker and learner. 2) A growth Mindset is the internal belief that skills can be developed through hard work [3].

So, how does meta-learning improve the learning process? In the case of individuals such as learners, meta-learning improves performance in a) self-confidence; b) knowing and choosing the best method for learning and the best source of information; c) reflecting on one's knowledge tool book; d) creating a solid relationship with the teacher; e) continuous reflection on the material; and f) moving to a supportive learning environment [14].

In the case of organizations, such as schools and universities, meta-learning creates: a) a helpful organizational culture; b) a sense of belonging in the community; c) an admiration for learning; d) helping students sharpen their learning skills; d) helping teachers help students sharpen their learning skills; and e) programs with good meta-learning design. So, what skills can be used for meta-learning? The primary skills found are: a) polyphasic sleep, which involves sleeping several times. This is related to meta-learning in the following ways: It gives us more time during the day to learn. Taking multiple naps throughout the day allows you to transfer short-term memories into long-term memories with each sleep or short break. This is important for procedural memory rather than declarative memory. B) Lucid dreaming occurs when the dreamer is aware of being in a dream. Lucid dreaming is a tool for procedural memory and can help with recalling facts. c) Mnemonic skills involve remembering and recalling extensive lists of information [12].

Unfortunately, these practical skills, which have been proven effective, are not taught in schools. Developing meta-learning skills leads to the development of problem-solving abilities that many schools are not prepared to foster. In meta-learning, there is a process that facilitates human evolution. It starts with belief, leads to potential action, results, and then returns to belief, and so on. The process of obtaining the results will cultivate a fresher and stronger belief. When starting a new meta-learning process, individuals will experience new stress and pressure on their cognitive processes. This is natural because it opens up new pathways for acquiring knowledge and metacognition [21].

In 1979, John Flavell introduced the concept of metacognition. Flavell defined metacognition as knowledge about cognitive processes, specifically everything related to cognition. Among psychologists, there is a debate on the definition of metacognition [22]. This implies that metacognition varies across different fields of psychological research and cannot be limited to just one area of psychology. Researchers in the field of psychology emphasize metacognition as the awareness of one's own thinking about the thinking process [23]. Wells revealed that "metacognition is cognition applied to cognition." Metacognition is thought applied to thought, or, in other words, metacognition is thinking about thinking [24].

Schneider also reveals that metacognition is an individual's awareness "of their information-processing skills, as well as the nature of cognitive tasks and strategies for dealing with such tasks." Metacognition refers to an individual's awareness of their information-processing abilities, the characteristics of cognitive tasks, and strategies for managing them [25]. Brown defines metacognition as the comprehension of knowledge, which can be demonstrated through either effective application or explicit explanation of the knowledge in question. Metacognition refers to understanding one's own knowledge, which can be demonstrated through the effective use or explicit description of the knowledge in question [26]. That is, metacognition is related to a person's understanding of their knowledge [27].

This understanding is achieved through self-reflection on effective strategies or a clear description of the strategy used to answer a question or solve a problem. In addition, Quirk revealed that metacognition is "the ability to reflect on one's thoughts and emotions and to anticipate others' thoughts." Metacognition refers to the ability to reflect on one's own thoughts and emotions and to anticipate the thoughts of others [28]. This aligns with the previous opinion that "metacognition refers to an individual's awareness of their thinking process and their ability to control these processes." Metacognition refers to an individual's awareness of their thinking processes and their ability to control these processes [29]. Metacognition is the ability to reflect on, understand, and control one's own learning. Metacognition involves reflecting on, understanding, and controlling one's own learning. Controlling learning will enable individuals to have control over their learning activities [30].

In addition, metacognition involves an individual's understanding and awareness of their cognitive processes and everything related to them [31]. In simple terms, metacognition is knowledge about the process of cognition. In more detail, metacognition refers to knowledge, awareness, and control over the process of cognition. Metacognition plays a role as a form of cognitive representation, involving monitoring and control based on cognitive representation [32].

In general, metacognition can be defined as the ability to monitor and control cognitive processes [33]. Meta-learning is crucial for improving these abilities.

Meta-learning is fundamentally about "learning how to learn" and equips individuals with the tools to better understand their cognitive processes. Through this understanding, individuals can better monitor, evaluate, and modify their learning strategies, thereby enhancing their metacognitive abilities.

In the context of the Message Design course in which this research was conducted, integrating meta-learning strategies enables students to not only consume information but also actively contribute to their cognitive development. Students can enhance their understanding of their learning strategies by employing meta-learning practices such as self-reflection, goal-setting, and adaptive strategy selection. This, in turn, enables more effective planning, monitoring, and evaluation of one's cognitive processes, which are key features of strong metacognition. In the context of the message design course in which this research was conducted, integrating meta-learning strategies enables students to not only consume information but also actively contribute to their cognitive development. Students can enhance their understanding of their learning strategies by employing meta-learning practices such as self-reflection, goal-setting, and adaptive strategy selection. This, in turn, enables more effective planning, monitoring, and evaluation of one's cognitive processes, which are characteristics of robust metacognition.

Therefore, meta-learning is a valuable and innovative approach for promoting the development of metacognitive skills. It goes beyond simply imparting knowledge and skills to cultivate an educational environment where students actively refine their learning and problem-solving strategies. The importance of meta-value learning cannot be overstated, considering the correlation between metacognitive skills and academic achievement. Therefore, meta-learning is a valuable and innovative approach for promoting the development of metacognitive skills. It goes beyond simply imparting knowledge and skills to cultivate an educational environment where students actively enhance their learning and problem-solving strategies. The importance of meta-value learning cannot be overstated, considering the correlation between metacognitive skills and academic achievement.

4.2 Meta-learning effectiveness

The research data was tested to assess the effectiveness of a treatment using the normalized gain score (N-Gain) test. The N-Gain test can be used to assess significant differences between the average pre-test and post-test scores using the paired sample test. Before conducting the test, a normality test is performed as a prerequisite to determining whether the obtained data follows a normal distribution.

The normality test results, conducted using SPSS, yielded significance values of 0.68 for the pre-test and 0.78 for the post-test. The acquisition of this value exceeds the significance level of 5% or > 0.05, so the data is normally distributed and suitable for the paired sample test. In the paired sample test, the significance value is denoted by "sig." The two-tailed value in the column is 0.000. In paired sample testing, the standard is applied such that if the obtained value is < 0.05, it is concluded that there is a significant effect from the treatment administered. Based on the results of the test, it can be concluded that the meta-learning approach effectively enhances student metacognition.

The effectiveness of the treatment using the meta-learning approach can be assessed based on the results of the N-Gain test. In this study, the results of the N-Gain test yielded an N-Gain score of 0.7823. This score falls within the high category of the N-Gain score division, indicating a practical level of effectiveness.

The research data was analyzed using a series of statistical tests to determine the impact of meta-learning on enhancing metacognitive abilities among students enrolled in the message design course. Preliminary normality tests confirmed that the data followed a normal distribution, which is a crucial prerequisite for conducting the paired sample test. The subsequent paired sample test resulted in a significance value (p-value) of 0.000, which is significantly below the standard threshold of 0.05. The empirical evidence strongly suggests that the meta-learning approach has a statistically significant effect on enhancing students' metacognition in this educational setting.

The N-Gain Score further supported these findings. With an average value of 0.7823, the treatment's effectiveness is categorized as 'high,' and an average effectiveness rate of 78.2317% falls within the 'effective' range. These metrics collectively underscore the effectiveness of the treatment, providing strong justification for its wider application in educational settings.

Meta-learning, or "learning to learn" emphasizes the ability of learners to adapt to new learning scenarios by optimizing their strategies and tools based on the specific context. It promotes self-directed learning, enabling students to understand how to acquire new skills or knowledge most efficiently. For instance, in this course, the incorporation of meta-learning techniques allows students to determine the most efficient method for interpreting and generating communicative symbols, thereby enhancing comprehension and memory retention.

Metacognition, or "thinking about thinking," is closely related to meta-learning but is more introspective. It involves self-assessment of one's learning process and adjusting strategies and behaviors accordingly. Enhancing metacognitive abilities can help students better assess their strengths and weaknesses in understanding various symbols and messages in the course. They can then adjust their learning strategies, perhaps by focusing more on audio-visual cues if they find that to be an area of weakness. Integrating creativity into this paradigm can catalyze innovative approaches to learning and problem-solving. Creativity in learning design can involve integrating elements that promote original thinking, encourage taking risks, and facilitate exploratory learning. It can be as simple as using interactive technologies in novel ways or as complex as restructuring the pedagogical approach to promote divergent thinking.

Combining meta-learning, metacognition, and creativity forms a potent blend that can significantly enhance educational outcomes. For example, a meta-learning approach that includes creative elements can stimulate metacognitive thinking, prompting students to adapt their learning strategies and think innovatively. The outcome is a dynamic, self-sustaining cycle of learning and improvement that is adaptable to virtually any educational setting. This triad can be especially effective in specialized courses such as message design, where comprehension, creativity, and adaptability are crucial for success.

The implications of this combination are significant, affecting not only individual courses but also potentially shaping institutional educational philosophies. Therefore, integrating these elements into the curriculum is essential for advancing and improving education.

5 CONCLUSION

This quantitative study utilized a one-group pre-test and post-test research design to examine the effectiveness of meta-learning strategies in improving metacognitive abilities in a Message Design course. Utilizing the paired sample t-test as the statistical method, the study found a statistically significant difference in metacognitive skills from the pre-test to the post-test (t = –22.972, df = 41, p < .0001). This effectively rejects the null hypothesis, confirming the impact of the meta-learning approach on metacognition.

Further substantiation comes from the N-Gain scores, which average 0.7823, placing them in the 'high' category for the gain magnitude. This result is supported by the percentage effectiveness, with an average of 78.2317%, categorizing the treatment as 'effective' according to the standards.

The practical implications of these findings are far-reaching. Given the significant impact of the meta-learning intervention on metacognitive abilities, educators and curriculum developers in higher education institutions should consider integrating it as a standard pedagogical approach. It also emphasizes the broader theme of empowering innovation in education, especially in specialized courses. However, the study has its limitations. With a one-group design, the generalizability of the results is limited, and future research should aim to include a control group for comparative analysis.

In summary, the data strongly support the use of meta-learning strategies to enhance metacognitive abilities, thereby improving the quality of education. The data strongly support the effectiveness of a meta-learning approach in improving metacognitive skills among students in the Message Design course. The paired sample test yielded statistically significant evidence, supported by a high N-Gain score and an effective rate within the 'effective' category range.

Given the compelling evidence, educators and curriculum designers should consider incorporating meta-learning techniques as a standard pedagogical tool. This approach is especially applicable for specialized courses that require higher levels of cognitive engagement. However, the study's single-group design limits the generalizability of the findings. Future studies should include a control group to strengthen the evidence base.

6 REFERENCES

[1] S. Thrun and L. Pratt, "Learning to learn: Introduction and overview," *Learning to Learn*, pp. 3–17, 1998. https://doi.org/10.1007/978-1-4615-5529-2_1

[2] J. X. Wang, "Meta-learning in natural and artificial intelligence," *Curr. Opin. Behav. Sci.*, vol. 38, pp. 90–95, 2021. https://doi.org/10.1016/j.cobeha.2021.01.002

[3] P. A. Ortega *et al.*, "Meta-learning of sequential strategies," 2019. [Online]. Available: http://arxiv.org/abs/1905.03030. [Accessed: Oct. 18, 2023].

[4] P. R. Indonesia, "Undang-undang Republik Indonesia nomor 20 tahun 2003 tentang sistem pendidikan nasional," *Jakarta: Pemerintah Republik Indonesia*, 2003.

[5] J. Orozco-Messana, J. M. Martínez-Rubio, and A. M. Gonzálvez-Pons, "Sustainable higher education development through technology enhanced learning," *Sustainability*, vol. 12, no. 9, p. 3600, 2020. https://doi.org/10.3390/su12093600

[6] J. Vanschoren, "Meta-learning: A survey," 2018. [Online]. Available: http://arxiv.org/abs/1810.03548. [Accessed: Oct. 18, 2023].

[7] J. W. Creswell and J. D. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications, 2017.

[8] P. C. Cozby, S. Bates, C. Krageloh, P. Lacherez, and D. Van Rooy, *Methods in Behavioral research*. Mayfield Publishing Company Houston, TX, 1977.

[9] R. Vilalta and Y. Drissi, "A perspective view and survey of meta-learning," *Artif. Intell. Rev.*, vol. 18, no. 2, pp. 77–95, 2002. https://doi.org/10.1023/A:1019956318069

[10] X. Chen, "Meta-teaching: Meaning and strategy," *Africa Education Review*, vol. 10, no. sup1, pp. S63–S74, 2013. https://doi.org/10.1080/18146627.2013.855431

[11] K. He, N. Pu, M. Lao, and M. S. Lew, "Few-shot and meta-learning methods for image understanding: A survey," *Int. J. Multimed. Inf. Retr.*, vol. 12, no. 2, p. 14, 2023. https://doi.org/10.1007/s13735-023-00279-4

[12] J. Vanschoren, "Meta-learning," *Automated Machine Learning: Methods, Systems, Challenges,* pp. 35–61, 2019. https://doi.org/10.1007/978-3-030-05318-5_2

[13] C. Finn, A. Rajeswaran, S. Kakade, and S. Levine, "Online meta-learning," in *International Conference on Machine Learning*, PMLR, 2019, pp. 1920–1930.

[14] M. Huisman, J. N. Van Rijn, and A. Plaat, "A survey of deep meta-learning," *Artif. Intell. Rev.*, vol. 54, no. 6, pp. 4483–4541, 2021. https://doi.org/10.1007/s10462-021-10004-4

[15] C. Giraud-Carrier, R. Vilalta, and P. Brazdil, "Introduction to the special issue on meta-learning," *Mach. Learn.*, vol. 54, pp. 187–193, 2004. https://doi.org/10.1023/B:MACH.0000015878.60765.42

[16] A. S. Richmond, "Meta-teaching: Improve your teaching while improving students' metacognition," 2014. http://www.improvewithmetacognition.com/meta-teaching-improve-your-teaching-while-improving-students-metacognition/

[17] D. B. Maudsley, "A theory of meta-learning and principles of facilitation," Unpublished Ph. D. Thesis, Toronto, OISE, 1979.

[18] J. B. Biggs, "The role of metalearning in study processes," *British Journal of Educational Psychology*, vol. 55, no. 3, pp. 185–212, 1985. https://doi.org/10.1111/j.2044-8279.1985.tb02625.x

[19] G. Cheng and J. Chau, "Exploring the relationships between learning styles, online participation, learning achievement and course satisfaction: An empirical study of a blended learning course," *British Journal of Educational Technology*, vol. 47, no. 2, pp. 257–278, 2016. https://doi.org/10.1111/bjet.12243

[20] S. Surat, S. Rahman, and S. Kummin, "Inquiry on the improvement teaching quality in the classroom with meta-teaching skills," *International Journal of Educational and Pedagogical Sciences*, vol. 10, no. 11, pp. 3551–3554, 2016.

[21] M. Żak-Skalimowska, "Child's creative activity as an opportunity to develop metalearning skills – analysis of an educational programme," *Creativity. Theories – Research – Applications*, vol. 5, no. 2, pp. 230–250, 2018. https://doi.org/10.1515/ctra-2018-0020

[22] J. H. Flavell, "Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry," *American Psychologist*, vol. 34, no. 10, p. 906, 1979. https://doi.org/10.1037//0003-066X.34.10.906

[23] J. A. Livingston, "Metacognition: An overview," ERIC, 2003. Retrieved from: https://files.eric.ed.gov/fulltext/ED474273.pdf

[24] S. G. Myers, P. L. Fisher, and A. Wells, "Metacognition and cognition as predictors of obsessive-compulsive symptoms: A prospective study," *Int. J. Cogn. Ther.*, vol. 2, no. 2, pp. 132–142, 2009. https://doi.org/10.1521/ijct.2009.2.2.132

[25] W. Schneider, "Metacognition and memory development in childhood and adolescence," *Metacognition, Strategy use, and Instruction*, pp. 54–81, 2010.

[26] J. S. Puryear, "Inside the creative sifter: Recognizing metacognition in creativity development," *J. Creat. Behav.*, vol. 50, no. 4, pp. 321–332, 2016. https://doi.org/10.1002/jocb.80

[27] W. J. Brown, "Influencing metacognition in a traditional classroom environment through learning analytics," *State-of-the-Art and Future Directions of Smart Learning*, Springer, pp. 1–12, 2016. https://doi.org/10.1007/978-981-287-868-7_1

[28] P. H. Winne and R. Azevedo, "Metacognition," In: Sawyer RK, ed. *The Cambridge Handbook of the Learning Sciences*. Cambridge Handbooks in Psychology. Cambridge University Press, pp. 63–87, 2014. https://doi.org/10.1017/CBO9781139519526.006

[29] M. Hermita and W. P. Thamrin, "Metacognition toward academic self-efficacy among Indonesian private university scholarship students," *Procedia-Social and Behavioral Sciences*, vol. 171, pp. 1075–1080, 2015. https://doi.org/10.1016/j.sbspro.2015.01.268
[30] E. R. Lai, "Metacognition: A literature review," *Always Learning: Pearson Research Report*, vol. 24, pp. 1–40, 2011.
[31] A. Woolfolk and K. Margetts, *Educational Psychology Australian Edition*. Pearson Higher Education AU, 2012.
[32] H. S. E. Waters and W. E. Schneider, *Metacognition, Strategy use, and Instruction.* Guilford Press, 2010.
[33] W. Schneider and E. Löffler, "The development of metacognitive knowledge in children and adolescents," in *The Oxford Handbook of Metamemory*, John Dunlosky, and Sarah (Uma) K. Tauber, eds., Oxford Library of Psychology, 2016. https://doi.org/10.1093/oxfordhb/9780199336746.013.10

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