

The Creative-Based Learning Integrated with Model-Based Learning for Promoting the Creative Thinking in Science of Grade-7 Students

Warakul Phalaphon¹, Panwilai Dokmai^{2*}

¹Master Science Education Program, Rajabhat Mahasarakham University, Thailand

²Faculty of Education, Rajabhat Mahasarakham University, Thailand

*E-mail: 658210300101@rmu.ac.th

Received: 30 Jan. 2026 Revised: 27 May 2026 Accepted: 27 May 2026

Abstract. The objectives of this research were: 1) To compare the creative thinking of Grade-7 students before and after the Creative-Based Learning integrated with Model-Based Learning on the topic of the basic unit of life. 2) To compare the learning achievement in science of Grade-7 students after the Creative-Based Learning integrated with Model-Based Learning on the topic of the basic unit of life with the 75% criterion. This study employed a quasi-experimental design with the sample of 40 Grade-7 students who were selected through simple random sampling by drawing lots. The research instruments included lesson plans of Creative-Based Learning integrated with Model-Based Learning, a creative thinking assessment form, and a science achievement test. The data analysis statistics were mean, standard deviation, dependent-sample t-test for comparing pre- and post-test creativity scores, and one-sample t-test for comparing science achievement score against the 75% threshold. The findings revealed that: 1) The students' creative thinking after the learning management was significantly higher than before the learning management at the .05 level of significance. 2) The students' learning achievement in science after the learning management was significantly higher than the 75% criterion at the .05 level of significance.

Keywords: Creative Thinking; Model; Creative-Based Learning; Model-Based Learning

INTRODUCTION

The educational policy of the Ministry of Education emphasizes the development of 21st-century skills in students, identifying creativity and innovation as essential skills that must be fostered. Creative thinking plays a crucial role in human development and has led to continuous advancement in science and technology worldwide. It helps students confidently face the modern world by building their capacity to adapt to changes. Promoting creative thinking in students should focus on developing initiative, artistic imagination, aesthetic appreciation, and sense of value with these qualities affect quality of life. Moreover, learners must stay abreast of changes and be capable of creatively utilizing knowledge of daily living, vocations, and technology in their work to compete on both national and international levels. (Ruachaiphanit & Nimitpongsakul, 2019). In the current economic climate, organizations must adapt to survive and keep pace with rapidly changing economic growth. Continuous innovation strategy development is one approach that helps organizations achieve sustainable growth. This depends on the ability of personnel and organizations

to learn concepts, techniques, tools, methods, developments, and various technologies from external sources. Broadening perspectives and exchanging experiences and knowledge from both within and outside the organization to foster creativity and drive innovation. For organizational development to build innovation capacity, the factors that create innovation are personnel, skills, knowledge, and management support to drive organizational growth steadily. Therefore, it is essential for organizations to cultivate personnel understanding, creative thinking and innovation mindset, courage to think creatively, courage to act with reason (Growth Mindset), as well as organizational development for innovation, creating an atmosphere for creative thinking, and providing opportunities for everyone in the organization to think creatively and dare to propose good ideas to develop and extend into innovations or invent new things (Suksawang, 2023). Additionally, the Ministry of Education through the Office of the Basic Education Commission has reviewed the Basic Education Core Curriculum B.E. 2551 (2008), using data from the 12th National Economic and Social Development Plan, the 20-Year National Strategy, and the National Education Plan B.E. 2560-2579 (2017-2036) as frameworks and directions for curriculum development to be more appropriate and clearer. It was deemed necessary to revise the curriculum in Mathematics and Science learning areas, and Geography in the Social Studies, Religion and Culture learning area, which are important for national development and serve as crucial foundations to help humans develop initiative, creative thinking, systematic reasoning, and ability to analyze problems or situations carefully and thoroughly. This includes organizing learning activities that promote students' development of thinking skills including logical thinking, creative thinking, critical thinking, important skills including scientific process skills and 21st-century skills in researching and creating knowledge through inquiry processes, systematic problem-solving, and decision-making using diverse and verifiable evidence (Ministry of Education, 2017).

According to the Global Creative Thinking Index (GCI) reported by the Martin Prosperity Institute, data collected in 2015 showed that Thailand's creative capacity ranked 81st out of 139 countries. The Creative Productivity Index (CPI) report by The Economist Intelligence Unit (EIU) for the Asian Development Bank (ADB), with data collected in 2014, showed Thailand's creative capacity ranked 15th out of 24 countries, including 22 Asian countries plus the United States and Finland (Creative Economy Agency, 2020). This demonstrates Thailand's low creative capacity, consistent with the National Reform Plan B.E. 2565 (2022) report stating that educational assessment results, both nationally and internationally, remain concerning and require urgent development. Regarding teaching and learning processes, most still emphasize content and memorization rather than developing skills and competencies, resulting in students lacking analytical thinking processes, creative thinking, and effective problem-solving skills. Thai education still prioritizes academic content over skills and focuses on test scores for ranking purposes. Moreover, society has instilled fear of mistakes in students. When students enter schools with various regulations and predetermined learning curricula not arising from students', communities', and society's needs, these factors gradually diminish students' creative thinking skills and may eventually disappear due to absence of sustained development and promotion of these skills (Phumikonsarn, 2022). This is consistent with Sirinthorn School's Self-Assessment Report in the 2022 academic year, which was informed by suggestions to organize teacher learning emphasizing thinking processes, practical implementation, student participation, learning organization that can stimulate students' learning habits and mutual learning exchange, creating opportunities for students to seek knowledge independently. Regarding student quality, areas needing development include finding approaches or processes to develop students with academic achievement below good level, requiring planning to solve problems/develop this student group based on learning assessment results for students being promoted to study in the 2023 academic year, specifically Grade 7-9 students, emphasizing knowledge and process skills according to the indicators of curriculum to help the students achieve higher learning development (Sirindhorn School, 2022). The school's educational system, which emphasizes academics, memorization, and competitive examinations, may limit opportunities to develop students' various process skills. Additionally, overcrowded classrooms create an atmosphere not conducive to

expressing opinions, potentially obstructing students' Creative Thinking, resulting in students with achievement below good level.

Research studies related to promoting students' creative thinking have found teaching models that promote creative thinking, including Creative-Based Learning and Model-Based Learning. Creative-Based Learning is a teaching model developed from Problem-Based Learning and parallel thinking approaches to creative thinking development. It applies creative thinking theory to create a new learning model called Creative-Based Learning, consisting of 5 learning management steps: 1) Stimulating interest, 2) Posing problems and grouping by interest, 3) Researching and thinking, 4) Presenting, and 5) Evaluating. Studies found that Creative Thinking -Based Learning results in student creative thinking and affects development of other skills such as teamwork skills, presentation skills, and research skills, which are 21st-century skills (Ruachaiphanit & Nimitpongsakul, 2019). This leads to higher student academic achievement, work skills, and positive attitudes toward learning. It also enhances teaching effectiveness, creates motivation for student interest, making them want to learn and participate in activities, resulting in students having better knowledge, skills, attitudes, and necessary future skills (Singsamran, 2022). Model-Based Learning is learning organization that allows students to use knowledge from study and previous experience integrated with imagination in identifying and explaining data, abstract concepts, and principles through mental models via two-dimensional drawings, and using three-dimensional models to help explain data, concepts, and principles clearly and completely through concrete, tangible models, resulting in creative thinking in learning (Lamboon, Prasert, and Latwong, 2020). This aligns with according to Torrance; creative thinking is a person's ability to think creatively or produce novel things that no one has done before. These things may arise from gathering various knowledge from experience and connecting it with new situations, appearing as artistic products, literature, science, or simply as processes (Torrance, 1962). It also emphasizes students learning content from creating, using, modifying, and elaborating models to use models as mental representatives in explaining phenomena, with 4 activity steps: 1) Generation-allowing students to create as many mental models as possible, with teachers stimulating and arousing student interest through questions, media, or activities for students to observe and create mental models from prior knowledge to explain or predict various phenomena; 2) Evaluation-teachers stimulate students to connect relationships between variables and evaluate consistency of created models with empirical evidence using exploration and fact-finding processes to compare data discovered during learning with models created in the generation step; 3) Modification-students modify and correct models seen as unable to serve as mental representatives until creating complete models that can correctly explain data and serve as representatives in explaining or predicting phenomena; and 4) Elaboration-students use modified models to explain and predict natural phenomena or other similar situations (Kanthawang, 2023). The studies revealed the Model-Based Learning helps promote student development of understanding scientific concepts (Suya, 2021) and promotes scientific process skills, with created models able to be modified until achieving complete models ready for application in other daily life situations (Suatsuang & Kitkoekun, 2021).

The researcher recognizes the importance of promoting creative thinking and academic achievement in students and is therefore interested in promoting student creative thinking through organizing learning using Creative-Based Learning integrated with Model-Based Learning in teaching "Basic Units of Living Things" in Grade-7 Science, to promote their creative thinking and science achievement.

RESEARCH OBJECTIVES

1. To compare creative thinking of Grade-7 students before and after the Creative-Based Learning integrated with Model-Based Learning on the topic "Basic Units of Living Things"
2. To compare the post-learning achievement in science with the 75 percent criterion of Grade-7 students in Creative-Based Learning integrated with Model-Based Learning on the topic "Basic Units of Living Things"

METHODOLOGY

The study on Creative-Based Learning integrated with Model-Based Learning to promote creative thinking and learning in science of Grade-7 students employs quasi-experimental research. The researcher conducted the following steps: and

Participants

The population consisted of Grade-7 students enrolled in the regular program at Sirindhorn School, under the Secondary Educational Service Area Office Surin, during the first semester of the 2023 academic year. This population comprised 240 students across 6 classrooms (Classrooms 7/7 to 7/12).

The sample consisted of 40 Grade-7 students from a single classroom (Grade-7/9) at Sirindhorn School during the first semester of the 2023 academic year through Cluster Sampling, based on the following procedures and rationales:

1. Sampling Method: The researcher employed a Cluster Sampling technique by randomly selecting one classroom from the 6 available regular classrooms via drawing lots.

2. Selection Criteria: Given that students across all 6 regular program classrooms share similar academic backgrounds and proficiency levels based on the school's homogeneously organized placement criteria, utilizing the classroom as the Sampling Unit was considered appropriate. This ensures the study reflects an authentic classroom setting without disrupting the instructional organization of other subject areas.

3. Variable Control: As the researcher served as the instructor for all classrooms in science subject, pedagogical consistency and teacher-related variables were strictly controlled and standardized throughout the experimental period.

Research Tools

This research employed three types of instruments: lesson plans, a creative thinking assessment form, and a science achievement test. The details are as follows:

1. The lesson plans integrate Creativity-Based Learning (CBL) with Model-Based Learning (MBL) focusing on the topic of "Basic Units of Living Things". A total of 4 lesson plans were developed, covering 12 hours. The learning activities consist of 7 stages synthesized from the following frameworks:

- 1.1 Creativity-Based Learning (CBL): Synthesized from three sources, comprising 5 stages: 1) Stimulating Interest, 2) Problem Setting and Grouping, 3) Research and think, 4) Presentation, and 5) Evaluation.

- 1.2 Model-Based Learning (MBL): Synthesized from three sources, comprising 4 stages: 1) Generation Phase / Response to Task, 2) Evaluation, 3) Revision and Revision, and 4) Elaboration.

The researcher integrated these frameworks into a synthesized instructional model to promote creativity, consisting of the following 7 stages:

1. Stimulating Interest: The teacher uses positive reinforcement to pique students' curiosity and eagerness to find answers. This involves using problems, current events, media, video clips, or games to stimulate self-directed learning.

2. Problem Setting and Grouping: Students identify problems and form groups based on their interests. Unlike traditional methods, the teacher does not predefine the questions; students explore and select problems within the lesson themselves.

3. Research and think: Students collaborate to investigate their chosen problems. The teacher provides guidance to ensure groups explore diverse topics, expanding the overall knowledge base of the class.

4. Formation Initial Model: Groups design their models by sketching them in activity sheets, specifying details and materials. Students then construct physical models based on their ideas,

while the teacher uses stimulating questions to encourage the fullest expression of their mental models.

5. Implementation and Evaluation: Students test their models. Peer groups review and verify the accuracy of the models. The teacher introduces scientific models (3D models, computer animations, or other media) for students to compare and validate their work.

6. Revision and Revision: Groups use feedback from peer evaluations to discuss and refine their models. The teacher provides additional knowledge on specific points to ensure completeness.

7. Elaboration: Students apply their revised models to explain other similar situations or data. The teacher highlights the scope and limitations of the models.

The lesson plans were evaluated from five experts using a 5-point Likert scale. The mean scores were interpreted based on the criteria by Best (1981 cited in Srisa-ard, 2010) as follows:

Mean Score	Interpretation
4.51 – 5.00	Highest level of appropriateness
3.51 – 4.50	High level of appropriateness
2.51 – 3.50	Moderate level of appropriateness
1.51 – 2.50	Low level of appropriateness
1.00 – 1.50	Lowest level of appropriateness

The results indicated that three lesson plans were at the highest level of appropriateness, while one plan was at a high level (Overall $\bar{X}$ = 4.51, S.D. = 0.12), as shown in Table 1.

Table 1: Shows that the evaluation results for all four lesson plans indicated.

Lesson Plans	1	2	3	4
$\bar{X}$	4.56	4.54	4.42	4.53
S.D.	0.17	0.20	0.13	0.22
Interpretation	Highest	Highest	High	Highest

2. The creative thinking assessment form applied Guilford's (1967) concept, covering 4 dimensions: fluency, flexibility, elaboration, and originality. The 4-point scoring rubric was utilized for the creative thinking assessment form, with scores ranging from 1 to 4, totaling 3 items, worth 16 points. Item 1 measured fluency and flexibility, Item 2 measured elaboration, and Item 3 measured originality, as shown in Table 2.

Table 2: Creative thinking assessment Analysis Table.

Item No.	Creative Thinking Dimensions	Creative Thinking Score
1	Fluency	4
	Flexibility	4
2	Elaboration	4
3	Originality	4
Total		16

The details of the Creative thinking assessment in each item are the following;

1. A light microscope is a tool for microscopic objects study. Which living cells (both plant and animal) do you think could be studied under a microscope? Try to provide as many possible answers as you can within 5 minutes. (Fluency and Flexibility)

2. If your school is a single cell, and locations within the school are compared to internal cell structures (organelles), which structures do you think your school has and why? Provide examples of school locations, their corresponding cell structures, a descriptive drawing with labels, and supporting reasons. (Time: 10 minutes) (Elaboration)

3. Stem Cells are progenitor cells capable of unlimited division and can differentiate into various cell types, such as skin, blood, connective tissue, bone, and fat cells, depending on their origin. They also function to generate new cells to replace aged or damaged ones through a developmental mechanism that restores bodily functions efficiently. Based on this information, if you were a scientist, which part of the body would you collect stem cells to repair, and why? You may provide more than one answer. (Time: 5 minutes) (Originality)

The creative thinking rubric scoring is shown as table 3.

Table 3: Creative Thinking Rubric.

Assessment Criteria	4 score (Excellent)	3 score (Good)	2 score (Fair)	1 score (Needs Improvement)
Fluency (Item 1)	Able to provide >10 correct responses within time.	Able to provide 7–9 correct responses within time.	Able to provide 3–6 correct responses within time.	Able to provide 0–2 correct responses within time.
Flexibility (Item 1)	Able to provide >6 different categories/examples of cells.	Able to provide 4–5 different categories/examples of cells.	Able to provide 2–3 different categories/examples of cells.	Able to provide 0–1 different categories/examples of cells.
Elaboration (Item 2)	Illustrates and describes >6 locations with labels, comparisons, and reasons.	Illustrates and describes 4–5 locations with labels, comparisons, and reasons.	Illustrates and describes 2–3 locations with labels, comparisons, and reasons.	Illustrates and describes 0–1 locations with labels, comparisons, and reasons.
Originality (Item 3)	Response given by only 1–5% of the total students.	Response given by 6–10% of the total students.	Response given by 11–20% of the total students.	Response given by >21% of the total students.

The creativity assessment form was submitted to three experts to evaluate its content validity. The evaluation focused on whether the item clearly measures the intended objective. The experts' ratings then were used to calculate the Item-Objective Congruence (IOC) Index. The validation of the creative thinking assessment form, IOC ranged from 0.67-1.00. The refined creativity assessment tool was pilot-tested with 40 seventh-grade students (Class 7/9) in a regular program classroom at Sirindhorn School during the first semester of the 2022 academic year and explored reliability coefficient of 0.73, indicating that the instrument is reliable for research purposes.

3. A science achievement test on the unit "Basic Units of Living Things" was a multiple-choice test with 4 options, consisting of 20 items worth 20 points, was developed in accordance with Bloom's Revised Taxonomy. The initial test consisted of 34 items, from which 20 items were selected to evaluate specific content areas and behavioral objectives. The scoring system was defined as 1 point for each correct answer and 0 points for incorrect answers, unanswered items, or items with more than one selected option. The distribution of the test items presented in Table 4.

A Science Achievement Test on the unit "Basic Units of Living Things" was submitted to the three experts. The experts assessed the content validity of the instrument using the Index of Item-Objective Congruence (IOC). The analysis revealed the IOC values ranged from 0.67 to 1.00. The test then piloted to determine the item difficulty (p) and the discrimination (r). A total of 20 items were selected for data collection based on the standard criteria: a difficulty between 0.20 and 0.80 and a discrimination between 0.20 and 0.80. The selected items demonstrated a difficulty ranging

from 0.43 to 0.73, discrimination ranging from 0.23 to 0.84, and reliability coefficient of 0.96, indicating that the instrument is reliable for research purposes.

Table 4: Content Analysis of the Science Achievement Test.

Science Standard Indicators	Rem.		Und.		App.		Anal.		Eva.		Cre.		Total	
	Gen	Use	Gen	Use	Gen	Use	Gen	Use	Gen	Use	Gen	Use	Gen	Use
SC 1.2 M.1/1 Observe and compare the forms and structures of plant and animal cells, and explain the specific functions of the following essential components: cell wall, cell membrane, cytoplasm, nucleus, vacuole, mitochondria, and chloroplast.	2	1	2	1	2	1	3	2	3	2	3	2	15	10
SC 1.2 M.1/2 Effectively use a light microscope to observe and study cells and various internal cell structures.	2	1	2	1			2	1					6	3
SC 1.2 M.1/3 Explain the relationship between the forms of cells and their specialized functions within an organism.							2	1					2	1
SC 1.2 M.1/4 Explain the biological organization of living things, beginning from the cell, to tissues, organs, organ systems, and ultimately the complete organism.			2	1					2	1			4	2
SC 1.2 M.1/5 Experiment and explain the processes of diffusion and osmosis based on empirical evidence, and provide examples of these processes occurring in daily life.			2	1	2	1					3	2	7	4
Total	4	2	8	4	4	2	7	5	5	3	6	4	34	20

Data Collection

This research conducted data collection from a single experimental group using a One Group Pre-test-Post-test Design in the first semester of the 2023 academic year. The research procedure began with pre-testing using the creative thinking assessment form. Then, the researcher organized learning using Creative-Based Learning integrated with Model-Based Learning lesson plans, consisting of 4 plans totaling 12 hours. Upon completion of the learning, post-testing was conducted using the creative thinking assessment form and science achievement test to compare the results with pre-learning scores and the 75 percent criterion. Subsequently, scoring was performed and the data were analyzed statistically.

Data Analysis

Data analysis involved comparing the mean scores of creative thinking and science achievement test. Creative thinking was assessed from pre- and post- tests of 3 items. Item 1 measured fluency and flexibility, Item 2 measured elaboration, and Item 3 measured originality. Each dimension is scored out of 4 points, resulting in a total possible score of 16 points. The scores were then used to calculate means and standard deviations of pre- and post- tests score, and compared using dependent-sample t-test statistics.

Additionally, the post-learning mean scores of science achievement test were compared with 75 percent criterion. The 75 percent criterion was established based on the standardized academic performance benchmarks set by the Ministry of Education (2017). The science achievement score was calculated to find out mean, standard deviation, and analyzing with one-sample t-test.

RESULTS AND DISCUSSION

The study on creative-based learning integrated with model-based learning to promote creative thinking of Grade-7 students, the research results can be summarized as follows:

The comparison of pre- and post-tests of creative thinking on basic units of living things

The dependent-sample t-test analysis compared pre- and post-test mean scores of the creative thinking of Grade-7 students after the Creative-Based Learning integrated with Model-Based Learning on the topic "Basic Units of Living Things" is shown in Table 5.

Table 5: Comparison of pre- and post-test scores of creative thinking on basic units of living things.

Creative Thinking Dimension	Pre-test		Post-test		T	Df	Sig
	$\bar{X}$	S.D.	$\bar{X}$	S.D.			
Fluency	2.08	0.76	3.15	0.70	25.49	39	.000*
Flexibility	2.38	0.87	3.35	0.77	17.27	39	.000*
Originality	1.93	0.47	2.98	0.53	21.00	39	.000*
Elaboration	1.43	0.59	2.45	0.60	41.00	39	.000*
Mean	1.96	0.67	2.98	0.65	26.19	39	.000*

*Statistically significant at the .05 level

From Table 5, the comparison of creative thinking on the topic "Basic Units of Living Things" of 40 Grade-7 students in Creative-Based Learning integrated with Model-Based Learning instruction, with a full score of 4 points for each dimension, found pre-test creative thinking scores for fluency had a mean score of 2.08 (S.D.=0.76); flexibility had a mean score of 2.38 (S.D.=0.87); originality had a mean score of 1.93 (S.D.=0.47); and elaboration had a mean score of 1.43 (S.D.=0.59). The overall mean score for all 4 dimensions was 1.96 (S.D.=0.67). The post-test results from the creative thinking assessment showed that fluency had a mean score of 3.15 (S.D.=0.70); flexibility had a mean score of 3.35 (S.D.=0.77); originality had a mean score of 2.98 (S.D.=0.53); and elaboration had a mean score of 2.45 (S.D.=0.60). The overall mean score for all 4 dimensions was 2.98 (S.D.=0.65). The comparison of students' post-test creative thinking revealed significantly higher than pre-test creative thinking at the .05 statistical significance level.

The comparison of post-test of science achievement score on basic units of living things

The one sample t-test analysis compared post-test mean score of science achievement after the Creative-Based Learning integrated with Model-Based Learning instruction on the topic "Basic Units of Living Things" and 75 percent criterion is shown in Table 6.

Table 6: The comparison of post-test score of science achievement on basic units of living things.

N	Criterion Score	$\bar{X}$	S.D.	t	df	Sig
40	15.00	16.00	1.28	4.94	39	0.00*

* Statistically significant at the .05 level

From Table 6, the science achievement on the topic "Basic Units of Living Things" of 40 Grade-7 students in Creative-Based Learning integrated with Model-Based Learning instruction, with a full score of 20 points, showed that the science achievement scores were significantly higher than the 75 percent criterion at the .05 statistical significance level.

CONCLUSION AND IMPLICATIONS

The research results on Creative-Based Learning integrated with Model-Based Learning to promote creative thinking of Grade-7 students can be discussed as follows:

The comparison of pre- and post-tests of creative thinking on basic units of living things.

The findings showed that students' post-test creative thinking revealed significantly higher than the pre-test at the .05 statistical significance level. The result was a consequence of the implemented instructional approach to foster students' creativity by Creative-Based Learning integrated with Model-Based Learning integrated approach. The Creative-Based Learning integrated with Model-Based Learning instruction consists of seven stages: 1) Stimulating interest, 2) Problem

Setting and Grouping, 3) Research and think, 4) Formation Initial Model, 5) Implementation and Evaluation, 6) Revision and Revision, and 7) Elaboration. Among these, five stages specifically promote student creativity, namely Stage 1, Stage 2, Stage 4, Stage 6, and Stage 7. Based on the aforementioned framework, the results indicated that the integration of CBL and MBL enhanced students' creativity across all four dimensions, with post-test scores significantly higher than pre-test scores. These dimensions include 1) Fluency, 2) Flexibility, 3) Originality, and 4) Elaboration. Upon detailed analysis of each dimension, Flexibility achieved the highest mean score ($\bar{x}=3.35$, S.D.=0.77). This success can be attributed to the fact that most students were able to independently formulate inquiries based on their interests during Stage 2 (Problem Setting and Grouping). In this stage, the teacher allowed students to pose problems related to the topics introduced in Stage 1, such as "Light Microscopy." Students formulated various questions, such as: 1) What are the characteristics of images formed by a light microscope? 2) What are the components of a light microscope? and 3) How is a light microscope operated? Subsequently, students formed groups based on these shared interests. The resulting groups varied in size, allowing students to conduct research tailored to their specific interests, which directly contributed to their cognitive flexibility. Conversely, Elaboration received the lowest mean score ($\bar{x}=2.45$, S.D.=0.53). This is because elaboration requires detailed, step-by-step thinking, and students were not yet fully capable of providing vivid explanations or developing complete, systematic plans. During Stage 6 (Revision and Revision), the teacher had students re-evaluate their initial models to develop a Consensus Model. This stage involved exchanging ideas and receiving teacher guidance to refine the models to better explain phenomena. To address this, teachers should adjust activities to encourage students to add more detail or expand their models for greater completeness. For instance, students could present their revised models to the class, allowing peers to provide feedback or suggest additional details to refine the final output. The findings of this research are consistent with many research studies found that students in CBL exhibited significantly higher scientific creativity than those in conventional classrooms, achieved an average creativity score higher than the 70% criterion (Chaikanya & Sanphandorn, 2018), or even reached the "good" level of creativity (Potikamon et al., 2018). As well as, in an international context, the results correspond with the finding that CBL combined with project-based learning significantly boosted creative problem-solving skills, particularly in flexibility and originality (Wu, 2019), noting that the CBL process in science education fosters "Divergent Thinking," enabling students to generate more innovative hypotheses (Ozkan & Topsakal, 2020), which is originality. The findings indicate that the integration of Creative-Based Learning integrated with Model-Based Learning significantly enhanced students' creative thinking skills, demonstrating the effectiveness of this instructional approach in fostering student creativity.

The comparison of post-test of science achievement score on basic units of living things.

The findings showed that the science achievement scores were significantly higher than the 75 percent criterion at the .05 statistical significance level. The Creative-Based Learning integrated with Model-Based Learning provides a systematic instructional sequence and hands-on activities that empower students to independently investigate their inquiries. By utilizing researched data to construct models that explain specific phenomena or situations, students develop a deeper understanding, leading to the self-construction of knowledge. Five key stages were identified as significant contributors to the enhancement of academic achievement, as detailed below:

Stage 2: Problem Setting and Grouping. In this stage, the teacher encourages students to formulate inquiries based on the topics that stimulated their interest in Stage 1. For instance, regarding "Light Microscopy," students posed questions such as: 1) What are the characteristics of images formed by a light microscope? 2) What are the components of a light microscope? and 3) How is a light microscope operated? Students then formed groups based on these shared interests, resulting in varying group sizes. This autonomy in selecting research topics fostered higher engagement and long-term retention, ultimately leading to academic achievement that exceeded the established criteria. This aligns with Ruachaiphanit & Chandee (2015), who stated that the CBL process is most effective when driven by students' voluntary interest and cooperation. This process

demonstrates that students are not forced to learn but rather develop a self-derived "desire to know," which creates an optimal opportunity for them to fully embrace and internalize the knowledge.

Stage 3: Research and think. In this stage, students conducted research using textbooks and online resources under the teacher's supervision and guidance. This stage trained students to think critically, search for information, and make informed decisions regarding the data needed to address their inquiries. Self-directed discovery enhanced knowledge retention and post-test achievement. As noted by Ruachaiphani & Chandee (2015), the primary outcome of this process is not merely the correct answer, but the development of thinking and research skills cultivated during the time instructors allow students to fully engage with their topics of interest. CBL serves as a practice for critical thinking and navigating the vast information available through modern digital tools.

Stage 5: Implementation and Evaluation. In this stage, students tested their constructed models to verify their accuracy. The teacher facilitated peer evaluations, comparing student models against established scientific models. This process allowed peers to gain new insights beyond their own initial inquiries. Consequently, academic achievement improved. This is consistent with Gobert and Buckley (2000), who suggested that during application and evaluation, students may find their models rejected if they fail to adequately explain the phenomena. This necessitates revision to improve the model's explanatory power. Furthermore, Delos Reyes & Inocian (2020) found that designing and refining models in Earth Science helped correct misconceptions, thereby increasing academic achievement.

Stage 6: Revision and Revision. The teacher prompted students to re-evaluate their models to develop a Consensus Model. This stage involved the exchange of ideas and supplementary teacher feedback to refine the models for greater clarity and completeness. This resulted in achievement scores higher than the set criteria, aligning with Kuathane, Pongsophon, and Chantraukrit (2014), who noted that model revision allows for collaborative idea exchange. It also supports the research of Suphaphon, Anantasawat, and Fakcharoenphol (2019), which demonstrated that Grade 8 students taught via MBL regarding body systems achieved significantly higher post-test scores than pre-test scores.

Stage 7: Elaboration. The teacher introduced new scenarios, challenging students to design models that explain related phenomena. This encouraged the extension of creative thinking and the application of knowledge to solve problems in different contexts, particularly enhancing the "application" aspect of academic achievement. This aligns with Kuathan, Pongsophon, and Chantraukrit (2014), who defined model extension as the stage where students apply refined models to predict new data or situations. Additionally, Kuatthai (2020) found that MBL in Grade 10 Biology led to a continuous increase in students' modeling capabilities across all learning cycles, proving its applicability in instructional settings.

Based on the aforementioned framework, the integration of CBL and MBL promoted academic achievement exceeding the 75 percent criterion. The findings of this research are consistent with many research studies on CBL and MBL found that students had science achievement passed the criterion of 70 percent (Riangnarong & Silanoi, 2015; Chaikanya & Sanphandorn, 2018), students achieved higher post-test scores or significantly improved achievement (Potikamon et al., 2018; Maikham, Klangraphan, and Phalachit, 2022; Yan, 2020; Wisesa & Naruponjirakul, 2021), exhibited significantly higher scientific achievement than those in conventional classrooms (Kaeodok & Sawangboon, 2019). The implementation of Creative-Based Learning integrated with Model-Based Learning effectively enhanced students' science achievement. The statistical analysis demonstrated the students' post-test scores significantly exceeded the predetermined criteria, confirming the efficacy of this integrated instructional approach.

USE OF ARTIFICIAL INTELLIGENCE TOOLS

During the preparation of this manuscript, the author(s) used ChatGPT, Gemini & Claude for technical support, specifically for spelling and grammar checking, as well as language refinement to improve readability. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the final context and accuracy of the publication.

REFERENCES

- Chaikanya, S., & Sanphandorn, S. (2018). Development of creative thinking skills in science on interaction in the solar system for Grade 9 students using a creativity-based learning model. *Roi Et Rajabhat University Journal*, 12(1), 157–164.
- Creative Economy Agency. (2020). *CEA outlook: Creative thinking index*. Sanniti Company.
- Dagnew, A., & Endris, A. (2020). Model-based instruction to improve students' concepts of human anatomy in primary school, Ethiopia. *International Journal of Learning and Teaching*, 12(2), 72–85.
- Delos Reyes, R. D., & Inocian, R. B. (2020). Model-based learning approach: Effects on students' academic performance and attitudes in Earth science. *International Journal of Scientific and Technological Research*, 9(6), 112–120.
- Gobert, J. D., & Buckley, B. C. (2000). Introduction to model-based teaching and learning in science education. *International Journal of Science Education*, 22(9), 891–894. <https://doi.org/10.1080/095006900416839>
- Guilford, J. P. (1967). *The nature of human intelligence*. McGraw-Hill.
- Kanthawang, J. (2023). *Model-based learning management in biology to develop academic achievement and scientific reasoning of Mathayom 4 students* [Master's thesis, Burapha University]. BUU Repository. <http://ir.buu.ac.th/dspace/handle/1513/168>
- Kaeodok, P., & Sawangboon, T. (2019). A study of learning achievement and scientific creativity of Grade 10 students using creativity-based learning: Mixed methods research. *Journal of Educational Measurement, Mahasarakham University*, 25(1), 206–224.
- Kuathane, N., Pongsophon, P., & Chantraukrit, P. (2014). Development of mental models on pure substances of Grade 7 students through model-based learning. *Journal of Science, Technology, and Environment for Learning*, 5(2), 126–137.
- Kuatthai, N. (2020). The development of modeling ability of Grade 10 students in biology through model-based learning management. *Sisaket Rajabhat University Journal*, 14(2), 63–71.
- Lamboon, S., Prasert, P., & Latwong, T. (2020). A study of creative thinking and scientific modeling ability of Grade 12 students through model-based learning management. *Journal of Education Sciences, Mae Fah Luang University*, 8(1), 159–172.
- Maikham, M., Klangraphan, M., & Palachit, S. (2022). The development of science learning activity packages using the 7E learning cycle integrated with mind mapping and creativity-based learning affecting analytical thinking, creative thinking, and learning achievement of Grade 9 students. *Journal of Graduate School, Sakon Nakhon Rajabhat University*, 19(85), 69–84.
- Ministry of Education. (2017). *Learning standards and indicators for mathematics, science, and geography (Revised edition 2017) according to the Basic Education Core Curriculum B.E. 2008*. Agricultural Co-operative Federation of Thailand.
- Ozkan, G., & Topsakal, U. (2020). Exploring the effectiveness of project-based learning on students' scientific creativity. *Journal of Biological Education*, 55(3), 293–309.
- Phumikonsarn, N. (2022). Missing creative skills of students and education in the 21st century. *Education Journal*, 5(1), 1–9.
- Pothikamon, N., Sanphandorn, S., Pocharoen, W., & Mongkolsin, B. (2018). Development of creative thinking and scientific attitudes on the unit of life using creativity-based learning for Grade 7 students. *Roi Et Rajabhat University Journal*, 12(1), 59–64.
- Riangnarong, M., & Silanoi, L. (2015). The development of 21st century learning skills and academic achievement using inquiry-based learning (5Es) of Grade 10 students in social studies courses. *Journal of Education Graduate Studies Research, Khon Kaen University*, 9(1), 147–155.
- Ruachaiphanit, W., & Chandee, K. (2015). CBL: Learning by creative effort. *Journal of Learning Innovation*, 1(2), 1–15.

- Ruachaiphanit, W., & Nimitpongsakul, W. (2019). *Teaching and learning with fun in the 4.0 era*. SeaVed Education.
- Singsamran, P. (2022). Development of a community-based creative learning model (CBL Plus) to enhance creative and innovative thinking skills for Mathayom 5 students. *Journal of Professional Teacher Learning Community*, 2(2), 265–280.
- Sirindhorn School. (2022). *Self-assessment report of the educational institution (SAR) for the 2022 academic year*. Surin Secondary Educational Service Area Office.
- Srisa-ard, B. (2010). *Introduction to research* (8th ed.). Suwiriyan.
- Suatsuang, K., & Kitkoekun, S. (2021). Learning management using simulation-based learning integrated with virtual reality technology to promote modeling skills and concepts about solutions of Mathayom 4 students. *Naresuan University Journal of Education*, 23(4), 55–67.
- Suksawang, S. (2023). *Creative to innovation for innovation organization*. HCD Innovation. <https://doi.sasimasuk.com/>
- Suphaphon, R., Anantasawat, S., & Fakcharoenphol, W. (2019). Comparison of learning achievement on human body systems of Grade 8 students taught by model-based learning. *Journal of Education and Human Development*, 3(2), 62–71.
- Suya, S. (2021). The influence of model-based learning management on concepts of eclipses among lower secondary school students. *Journal of Interdisciplinary Studies for Development, Uttaradit Rajabhat University*, 11(1), 73–85.
- Torrance, E. P. (1962). *Guiding creative talent*. Prentice Hall.
- Wisesa, P., & Naruponjirakul, S. (2021). Development of the ability to construct scientific concepts and academic achievement using inquiry-based learning integrated with model-based learning among Mathayom 1 students. *Journal of Academic and Social Sciences*, 16(3), 145–158.
- Wu, H. (2019). Development of a creative project-based learning model to enhance students' creative thinking and problem-solving skills. *International Journal of Instruction*, 12(4), 1–16. <https://doi.org/10.29333/iji.2019.1241a>
- Yan, X. (2020). The effect of model-based learning on the academic success and conceptual understanding of middle-school students. *Journal of Education in Science, Environment and Health*, 6(1), 45–58.