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The Effect of CLIS Learning Model on Students Product Creativity in States of Matter Topic

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Abstract. This study evaluates the effectiveness of the Children Learning in Science (CLIS) model in fostering students' creativity in understanding changes in the states of matter. A quantitative approach with a quasi-experimental design was employed. The sample consisted of 54 fourth-grade students selected through cluster random sampling, with 27 students in the experimental group and 27 in the control group. Data were collected using validated written tests, with validity assessed through product-moment correlation and reliability measured using Cronbach's Alpha. Normality, homogeneity, and baseline equivalence tests were conducted to ensure analytical accuracy. Data were analyzed using an independent sample t-test at a 0.05 significance level with SPSS version 23. The results indicate that the CLIS model significantly improves students' creativity ($p = 0.000 < 0.05$; $t = 6.953 >$ t-table = 2.006). The experimental group achieved higher post-test scores than the control group, suggesting that the CLIS model enhances creative thinking, independent problem-solving, and active participation. These findings confirm that the CLIS model is an effective alternative for teaching the science and social studies subject, particularly on changes in the states of matter. Theoretically, this study reinforces constructivist principles by demonstrating the model's role in promoting creativity through active and meaningful learning.

Keywords: CLIS Model; Student Creativity; Matter Changes; Elementary Students; Constructivist Learning.

1. Introduction

The low level of Indonesian students' creativity is reflected in various international surveys. The 2011 TIMSS results showed that Indonesia ranked 40th out of 42 countries with an average score of 406, where more than 95% of students were only able to reach the intermediate level. This finding is consistent with the 2009 PISA results, which placed Indonesia at 57th out of 65 countries with a science score of 383, indicating that the majority of students only mastered material up to level 3, while students in many other countries achieved levels 4, 5, and even 6 (Wulandari et al., 2019). These results reveal that higher-order thinking skills, including creative thinking, remain very low and have not been optimally developed in schools. Kusmiati, (2022) further emphasized that the lack of creativity and learning outcomes is caused by students' reluctance to express new ideas, combined with limited opportunities to express themselves and convey opinions in line with their creative potential. One of the main causes of low creativity is the persistence of teacher-centered learning, which restricts students' opportunities to develop creative thinking (Sulistiawati & Prastowo, 2021). Moreover, limitations in instructional media, strategies, and teaching models hinder students from channeling their ideas, even when they possess strong creative potential (Salma et al., 2024). Therefore, creativity can only flourish when teachers create non-authoritarian learning environments, provide students with the trust to think independently, and support them with adequate motivation and meaningful challenges.

The *Kurikulum Merdeka* (Independent Curriculum), which is now being implemented across various educational levels in Indonesia, offers teachers flexibility in designing instruction that suits students' characteristics. This curriculum emphasizes the importance of developing critical thinking skills, creativity, and problem-solving abilities as key components of 21st-century learning (Xu & Zhou, 2022)). At the elementary level, this approach is realized through the IPAS subject (a combination of Natural and Social Sciences), which aims to integrate scientific aspects with students' real-life experiences.

One key topic in IPAS is the change in the states of matter. However, instructional approaches remain largely theoretical, making learning less engaging and failing to foster students' creativity (Arndt et al., 2025). One such approach is the Children Learning in Science (CLIS) model, which is designed to empower students in exploring their initial ideas. Through this model, students are able to conduct experiments and reconstruct their understanding scientifically through reflection (Wannomai et al., 2024).

Although several studies have examined the effectiveness of the CLIS model, few have specifically evaluated its impact in the context of IPAS (Integrated Science and Social Studies) learning on the topic of changes in the states of matter at the elementary level. Therefore, this study aims to examine the effect of the CLIS model on students' product creativity in this topic area (Amal, M. R., 2022).

1.1. Problem Statement

One of the main problems in current IPAS (Integrated Science and Social Studies) instruction is the low level of student creativity in producing learning products. Many students are only able to imitate or replicate examples given by the teacher, without being able to develop new ideas independently (Arslan et al., 2020). This condition stems from the continued use of conventional teaching models, such as lectures and written assignments, which provide little opportunity for students to explore and experiment actively. As a result, students' potential to think creatively and innovatively in understanding and applying IPAS concepts becomes hindered (Ginanjar et al., 2019). On the topic of changes in the states of matter, the application of CLIS is highly relevant because students can directly observe, document, and analyze these changes through simple experiments (Yang & Quigley, 2020). Students not only understand the concepts theoretically but are also able to express their creative ideas in the form of tangible products such as visual aids, experiment reports, or digital learning media. This aligns with the idea that project- and experiment-based learning can stimulate the development of creativity and critical thinking skills in elementary students (Hmelo et al., 2023). Previous studies have shown that the low level of creativity among elementary school students is partly influenced by teacher-centered instructional practices, which provide limited opportunities for students to explore and create.

1.2. Related Studies

Research by Kaçar et al. (2021) shows that exploration-based learning plays an important role in increasing students' creativity in science education. Through exploratory approaches, students are encouraged to search, observe, and test various concepts directly, which significantly enhances their ability to generate ideas and create learning products. Furthermore, a study by Picardal & Sanchez (2022) emphasizes the effectiveness of inquiry-based learning models in improving students' creative thinking skills. Inquiry models require students to pose questions, conduct investigations, and independently draw conclusions—directly training their ability to think critically and creatively in solving scientific problems. Meanwhile, a study by Runco & Acar (2012) asserts that the implementation of constructivist models such as Children Learning in Science (CLIS) contributes positively to creativity development. While previous studies have discussed the overall benefits of such models, this study specifically examines the impact of CLIS on the topic of changes in the states of matter at the elementary school level. Therefore, the CLIS model can provide a more targeted focus for applying this model in the context of elementary science education.

1.3. Research Objective

Based on the explanation above, this study aims to provide a clear picture of the effectiveness of the CLIS model in improving students' product creativity in the topic of changes in the states of matter. The findings are expected to serve as a foundation for teachers and curriculum developers to support the development of 21st-century skills (Arslan et al., 2020). The research question of this study is: Does the implementation of the Children Learning in Science (CLIS) model significantly influence students' creativity in learning the topic of changes in the states of matter in IPAS? To address this question, the study is guided by the hypothesis that the CLIS model can positively affect students' creativity by encouraging active engagement, exploration, and hands-on learning. The null hypothesis (H_0) assumes that there is no significant difference in students' creativity before and after the implementation of the CLIS model, while the alternative hypothesis (H_1) suggests that students' creativity will significantly improve as a result of learning through CLIS.

2. Theoretical Framework

2.1. Product Creativity

Creativity in product development reflects the ability of individuals or groups to generate new, valuable ideas that can be effectively implemented in products or services (Alves et al., 2021). This process involves a combination of expertise, creative thinking skills, and intrinsic motivation—all necessary for creating innovative products that are competitive in the market. Stankiewicz et al. (2020) introduce the concept of effectuation, which refers to optimal use of available resources and product development based on evolving market needs. This approach allows producers to create products that are not only innovative but also relevant to consumer demands. Originality is also a key factor in developing innovative products to gain competitive advantage (Nigmatullina & Gerasimenko, 2016). Thus, product creativity is the ability to create and combine new concepts to produce innovative products that are market competitive.

Product creativity places emphasis on the tangible outcomes of the creative process—the product itself. Indicators of product creativity include originality and novelty, transformation or change in form, and feasibility, which includes product quality and appeal. Damli & Ünl Yavas (2016) state that product creativity can be expressed through the creation of new ideas or the renewal of existing ones, sourced from various origins to maintain competitive advantage. Yuningsih et al. (2022) highlight aspects of product creativity in terms of visual accuracy, material presentation, language use, and color selection, emphasizing the importance of timely and valuable innovation. In general, product creativity indicators include: 1) Product originality; 2) Product innovation or transformation; 3) Product feasibility or quality (Puchongprawet & Chantraukrit, 2022).

2.2. Children Learning in Science (CLIS) Learning Model

A model is a simplified representation of real-life events that reflects actual conditions. It is an abstraction designed systematically for use in specific contexts (Olsson et al., 2022). In education, a model refers to an operational design that serves as a guideline for implementing instruction (Valverde-Berrocoso et al., 2020). According to (Pauw et al., 2015), a learning model is a framework used to organize content, structure curriculum, and guide classroom teaching. (Taslim & Susanto, 2021) define a learning model as a guide that teachers can use to manage classroom activities, including planning learning resources, media, instructional aids, and assessment. A learning model typically has six main characteristics: 1) It is grounded in a learning theory; 2) It has specific learning objectives; 3) It directs learning activities; 4) It consists of syntax, social system, reaction principles, and support system; 5) It is supported by internal motivation; 6) It provides a guide for using structured instructional strategies (Briana & Turnip, 2016).

3. Method

3.1. Research Design

This study employed a quasi-experimental design. The quasi-experimental design was selected in this study because it provides a rigorous yet practical approach to evaluate the impact of the CLIS learning model on students' product creativity. In educational contexts, random assignment is often not feasible due to intact classroom settings; therefore, quasi-experimental methods such as the nonequivalent control group design are widely used to assess the effectiveness of instructional models (Nargund-Joshi et al., 2011). This design enables comparison between experimental and control classes without disrupting the natural learning process, while pretests and posttests help control external variables and strengthen causal inferences (Bell, 2009). Moreover, quasi-experimental studies are increasingly employed in science education research to measure higher-order outcomes like creativity, problem-solving, and cognitive flexibility (Aydın Kılıç & Çelik Ercoşkun, 2024).

3.2. Participants

In this study, the population consisted of all fourth-grade students at Ta'mirul Islam Surakarta Elementary School during the 2024/2025 academic year, encompassing four parallel classes with a relatively homogeneous distribution of students in terms of age and prior learning experience. The sample refers to a subset of the population that is studied directly by the researcher. In this study, two fourth-grade classes were selected because the topic of changes in the states of matter appears in the IPAS curriculum for Phase B, which corresponds to Grade IV in Indonesian elementary schools. A cluster random sampling technique was employed since the unit of selection was based on intact class groups rather than individual students (Creswell, 2012). Class IV.3 (n = 27) was assigned as the control group, taught using the Project-Based Learning (PjBL) model, while Class IV.4 (n = 27) was assigned as the experimental group, taught using the Children Learning in Science (CLIS) model. The demographic distribution of participants is summarized in Table 1, which presents the frequency and percentage of students according to group and gender.

Table 1. Characteristics of Participants

Group	Gender	Frequency	Percentage (%)	Age Range	Educational Background
Control (IV.3)	Male	14	25.9	9–10	Elementary (Grade IV, Fase B)
	Female	13	24.1	9–10	Elementary (Grade IV, Fase B)
Experimental (IV.4)	Male	15	27.8	9–10	Elementary (Grade IV, Fase B)
	Female	12	22.2	9–10	Elementary (Grade IV, Fase B)
Total		54	100	9–10	Elementary (Grade IV, Fase B)

3.3. Data Collection

The purpose of data collection is to generate reliable information about the variables being studied in a research project (Nurhayati & Handayani, 2020). This study used non-test methods to collect data, specifically through the use of performance evaluation sheets or performance assessment rubrics. Students' creativity was assessed through practical tasks evaluated using these performance sheets. The experimental group received instruction using the CLIS model, while the control group was taught using the PjBL model. To control for the effects of the intervention variable, the performance evaluation sheets in the experimental class were used to assess the impact of the learning model applied (Aparicio-Gómez et al., 2024). In this study, product creativity was assessed using a performance assessment worksheet based on a rubric. The following is an explanation of the instruments used in the research.

3.3.1. Performance Assessment Sheet

This study employed a non-test method for data collection, specifically using a performance assessment sheet to evaluate students' creativity. Students' creativity was assessed through practical tasks aligned with the evaluation sheet as an assessment tool. In the experimental class, the Children Learning in Science (CLIS) model was applied, while in the control class, the Project-Based Learning (PjBL) model was implemented. The use of performance assessment sheets aimed to measure the impact of the instructional models on students' creativity. The criteria for evaluating creativity are presented in the following Table 2.

Table 2. Performance Assessment Criteria for Students' Product Creativity

Variable	Indicator	Descriptor	Item No.	Total Items
Creativity of Product	Originality of product	Creating a candle sculpture independently based on own idea without imitating others; Product has never been sold at school's "Market Day"	1, 2	2
	Innovation or transformation of product	Able to add decoration to the product; Able to innovate product form; Able to modify product without losing originality; Able to add functional value	3, 4, 5, 6	4
	Feasibility or quality of product	Able to follow production steps in correct order; Able to provide packaging; Product contains aesthetics; Able to sell the product	7, 8, 9, 10	4
		Total Items		10

3.3.2. Rubric

A rubric was used as a scoring guideline to evaluate students' creativity in product creation. The rubric outlined specific criteria and indicators, including originality, innovation, and feasibility of the product. This rubric served as a structured guide for assessing students' creative achievements in tasks related to the topic of changes in states of matter. The rubric was tested for validity and reliability to ensure its appropriateness in measuring product creativity. The rubric criteria are shown in the following Table 3.

Table 3. Rubric for Assessing Students' Product Creativity

Variable	Indicator	Descriptor	Item No.	Total Items
Creativity of Product	Originality of product	Creating a candle sculpture independently based on own idea without imitating others; Product has never been sold at school's "Market Day"	1, 2	2
	Innovation or transformation of product	Able to add decoration to the product; Able to innovate product form; Able to modify product without losing originality; Able to add functional value	3, 4, 5, 6	4
	Feasibility or quality of product	Able to follow production steps in correct order; Able to provide packaging; Product contains aesthetics; Able to sell the product	7, 8, 9, 10	4
		Total Items		10

3.4. Data Analysis

The data analysis in this study consisted of prerequisite tests and hypothesis testing. The prerequisite tests included normality, homogeneity, and equivalence tests. The normality test was performed using the Kolmogorov Smirnov test in SPSS version 23 to determine whether the data followed a normal distribution, with a significance level of 0 (Doğru et al., 2024). The homogeneity test was conducted using Levene's test in SPSS 23 at a significance level of 0.05

to assess variance similarity between groups; the data were considered homogeneous if $p > 0.05$ (Lestari et al., 2024). The equivalence test (balance test) was carried out using the t-test for equal variances (Pooled Variance method) to verify that the experimental and control groups had comparable initial abilities, also at a 0.05 significance level (DEMİR, 2022 ;Lie et al., 2024). For hypothesis testing, if the data met the assumptions of normality and homogeneity, an independent samples t-test was applied to compare mean scores between groups, with significance set at $p < 0.05$. Conversely, if the assumptions were not met, the non-parametric Mann–Whitney test was used to assess group differences.

3.5. Validity and Reliability

The instruments used in this study were validated by experts in their respective fields. The feasibility test was conducted by two university lecturers who specialize in science education. The content validity of the performance assessment sheet and the scoring rubric was calculated using Gregory's Content Validity formula. Based on the validation results from the two experts, the rubric achieved a validity score of 0.75, which falls under the "High" category, indicating that the instrument was suitable for use in the study (see Table 4).

Table 4. Summary of Empirical Validity Test Results

No.	r	$r_{table}5\%(29)$	Sig	Criteria
1	0.441	0.367	0.017	Valid
2	0.950	0.367	0.023	Valid
3	0.718	0.367	0.000	Valid
4	0.493	0.367	0.007	Valid
5	0.493	0.367	0.007	Valid
6	0.455	0.367	0.013	Valid
7	0.763	0.367	0.000	Valid
8	0.447	0.367	0.015	Valid
9	0.629	0.367	0.000	Valid
10	0.225	0.367	0.240	Invalid

Based on the empirical validity test conducted by two expert lecturers, 9 out of the 10 items in the performance sheet were found to be valid ($r > r_{table}$). Only item 10 was declared not valid, as its score (0.225) was below the minimum threshold (0.367). Therefore, the performance sheet was considered fit for use in the study with the exclusion of the invalid item. The reliability test was conducted to assess the consistency of the instrument. The reliability of the data depends on how consistently the instrument produces similar measurements under repeated conditions. This study used Cronbach's Alpha formula with SPSS version 23 to assess the internal consistency of the performance assessment instrument.

4. Findings

This study employed a quantitative research design with one independent variable—the Children Learning in Science (CLIS) learning model—and one dependent variable—students' product creativity. The study involved an experimental class and a control class, each implemented in different classrooms. The CLIS model was applied in Class IV.4 at SD Ta'mirul Islam as the experimental group, which consisted of 27 students. The control class, also with 27 students, was taught using the Project-Based Learning (PjBL) model. Before the main study, the performance assessment instrument was piloted at SD Al-Jabar Gondang with 29 students to ensure that it was valid and reliable. The results showed that the calculated r values were greater than the table values $r > 0{,}367$, so the instrument was deemed suitable for use.

4.1. Description of Product Creativity Data in the Experimental Class (CLIS Model)

The students' initial abilities in the experimental class were measured using the product creativity performance sheet, with pretest scores ranging from 17 to 28. The pretest results are as follows in Table 5.

Table 5. Pretest Results – Experimental Class

No.	Interval	Frequency	Percentage
1	17.00-18.67	3	11.11%
2	18.67-20.33	10	37.04%
3	20.33-22.00	2	7.41%
4	22.00-23.67	8	29.63%
5	23.67-25.33	2	7.41%
6	25.33-27.00	2	7.41%
	Total	27	100%

The Table 5 above shows that the highest frequency was in the 18.67–20.33 interval, with 10 students (37.04%). The lowest frequencies were in the 20.33–22.00, 23.67–25.33, and 25.33–27.00 intervals, each with 2 students (7.41%). The CLIS model was implemented in Class IV.4 over three sessions, focusing on the topic of changes in the states of matter. Each session was taught by the class teacher, while the researcher acted as an observer to monitor the implementation of the CLIS learning syntax.

Table 6. Description of Teaching Activities – Experimental Class

Activity			Meeting		
			1	2	3
Introduction			75%	80%	82.5%
CLIS Main Steps		Orientation	100%	100%	100%
		Elicitation of Ideas	75%	75%	75%
		Restructuring of Ideas	75%	75%	75%
		Application of Ideas	100%	100%	75%
		Review of Change in Ideas	95.8%	95.8%	87.5%
	Use of Learning Resources		80%	80%	77.5%
	Student Engagement		79.1%	87.5%	87.5%
	Correct and Appropriate Language		77.5%	80%	80%

From Table 6, the implementation of teaching activities in the experimental class across three meetings was generally in the good to very good category. The introductory activities showed a gradual increase from the first to the third meeting. In the main CLIS stages, the orientation phase was implemented fully (100%) in all meetings, while the elicitation and restructuring of ideas were carried out consistently. The application of ideas and the review of conceptual change reached high percentages, although a slight decrease was observed in the third meeting. In addition, student engagement and the use of learning resources tended to improve over the meetings, indicating that the CLIS-based learning was implemented consistently and effectively.

The CLIS-based instruction used exploration, experimentation, and reflection over the three sessions. In the first session, students expressed their initial understanding through discussion and simple observation (e.g., melting ice) (Amal, M. R., 2022). They formed hypotheses and questions related to various state changes, such as melting, freezing, evaporation, and condensation. In the second session, students conducted group experiments—observing melted ice, water freezing in a freezer, water evaporation, and condensation on a glass. They recorded observations and compared them with their hypotheses. The teacher facilitated understanding through reflective questioning (Legvart et al., 2021). In the third session, students presented their experimental findings and discussed conclusions with the class. The teacher reinforced key concepts and related the findings to scientific theory. The session concluded with student reflection on how changes in states of matter relate to daily life. The CLIS model enabled students not only to grasp theoretical concepts but also to engage meaningfully in the scientific process through hands-on experience (Gajić et al., 2021).

The posttest results of the experimental class (IV.4), which used the Children Learning in Science (CLIS) learning model, were measured using a product creativity performance assessment sheet. The data obtained are as follows in Table 7.

Table 7. Posttest Results – Experimental Class

No.	Interval	Frequency	Percentage
1	20.00-21.00	2	7.41%
2	22.00-24.00	5	18.52%
3	25.00-27.00	2	7.41%
4	28.00-29.00	10	37.04%
5	30.00-32.00	7	25.93%
6	33.00-35.00	1	3.70%
	Total	27	100%

(Source: Processed Primary Data, 2024)

The most frequent posttest score was in the 28.00–29.00 range (37.04%), while the least frequent was 33.00–35.00 (3.70%).

4.2. Description of the Teaching and Learning Process in the Control Class

The implementation of learning using the Project-Based Learning (PjBL) model on the topic of changes in the states of matter for fourth-grade students was carried out over three sessions, with an emphasis on exploration, collaboration, and project-based problem solving. In the first session, the teacher began by providing a stimulus in the form of guiding questions and presenting real-life phenomena related to changes in the states of matter, such as melting ice, evaporating water, or condensation forming on a glass surface. Students were then divided into groups to formulate problems, determine the type of project to be created, and develop a work plan. In the second session, each group began working on their planned project, such as creating interactive posters, simple models made from materials that undergo phase changes, or experimental videos. During this process, students conducted observations, experiments, and documentation to collect data supporting their projects, with the teacher acting as a facilitator. In the third session, each group presented the results of their projects in front of the class, sharing their findings and the experiences gained during the project development process. The teacher provided feedback and linked the projects to the scientific concepts behind changes in the states of matter. The lesson concluded with student reflections on how their projects helped them understand the concept of phase changes and its applications in everyday life. Through the PjBL model, students not only gained a deeper conceptual understanding but also developed critical thinking, creativity, and teamwork skills.

Table 8. Description of the Teaching and Learning Process in the Control Class

Activity				Meeting 1	Meeting 2	Meeting 3
Introduction				75%	80%	82.5%
Main Activities	a)	Mastery of learning material		100%	100%	100%
	b)	Implementation of the Project-Based Learning model	Formulating essential questions	75%	75%	75%
			Product planning	75%	75%	75%
			Scheduling	100%	100%	75%
			Project implementation	95.8%	95.8%	87.5%
			Completion	80%	80%	77.5%
			Presentation	79.1%	87.5%	87.5%
			Evaluation and assessment	77.5%	80%	80%
	c)	Use of learning resources		91.6%	95.8%	91.6%
	d)	Student engagement		72.5%	75%	70%
	e)	Use of proper and correct language in learning		79.1%	79.1%	75%
Closing				77.5%	75%	75%
Mean				79%	80.7%	75.9%

Based on the data in Table 8, each learning session showed different levels of alignment between the learning activities and the PjBL syntax. The highest alignment occurred in Session 2, with a percentage of 80.7%, while the lowest alignment was found in Session 3, at 75.9%. The posttest results for the control class were obtained as follows in Table 9.

Table 9. Posttest Results – Control Class

No.	Interval	Frequency	Percentage
1	20-21	1	3.70%
2	22-23	4	14.81%
3	24-26	3	11.11%
4	27-28	5	18.52%
5	29-30	7	25.93%
6	31-33	7	25.93%
Total		27	100%

(Source: Processed Primary Data, 2024)

Based on the Table 9 above, the posttest results of students in the control class show that the highest frequencies were in the score intervals 29–30 and 31–33, each with 7 students (25.93%).

The lowest frequency was in the 20–21 interval, with only 1 student (3.70%).

5. Discussion

This research is a quantitative study involving one independent variable—the Children Learning in Science (CLIS) learning model—and one dependent variable—product creativity. The experimental class used the CLIS model, while the control class used the Project-Based Learning (PjBL) approach. Both groups measured the level of product creativity in fourth-grade students at SD Ta'mirul Islam. Data analysis results showed that the implementation of the CLIS model had a significant effect on improving students' product creativity, especially in learning about changes in the states of matter. This was confirmed through hypothesis testing using the independent sample t-test, which yielded a significance value (Sig. 2-tailed) of 0.000 ($p < 0.05$), indicating a statistically significant difference between the experimental and control groups.

Based on observations of the learning implementation, the fourth-grade teacher applied the stages of the CLIS model with an average alignment percentage of 83.5% in the first session, 85.1% in the second session, and 81.8% in the third session. The slight decrease in the third session was due to difficulties in understanding the concepts of sublimation and crystallization, which involved heating scented wax. As a result, students only observed a demonstration by the teacher. This limited students' active participation, which is supposed to be one of the central focuses of the CLIS model (Martella & Schneider, 2024). Active participation is a key aspect of CLIS implementation because the model encourages students to develop ideas and life-relevant skills. Teachers are also required to create a learning environment that is responsive to the individual characteristics of learners (Hartikainen et al., 2024).

The CLIS model consists of five main syntax stages: 1) Orientation – capturing students' attention through relevant contextual phenomena; 2) Elicitation of Ideas – exploring students' prior knowledge through discussion or guiding questions; 3) Restructuring of Ideas – reorganizing understanding based on experimental and observational results; 4) Application of Ideas – applying new ideas in other contexts; 5) Review of Change in Ideas – reflecting on the conceptual changes that have occurred (Nittayathammakul et al., 2023).

5.1. Orientation

The orientation stage in science learning plays a crucial role in fostering students' interest in learning (Öncü & Bichelmeyer, 2021). Presenting phenomena that are closely related to everyday life has been shown to help students understand the scientific concepts being taught. Showcasing engaging, real-world phenomena is also effective in directing students' focus and attention toward the learning material (Hartikainen et al., 2024). At this stage, teachers can begin by introducing familiar examples of changes in the states of matter that students commonly encounter in daily life.

One effective approach to building students' curiosity is to apply question-driven learning—a model that starts from exploratory, phenomenon-based questions (Gracyalny & Hurtienne, 2023). This strategy has proven effective in enhancing students' participation and conceptual understanding of science material (Rose, 2025). Additionally, the use of digital technology—such as interactive videos that showcase real-life phenomena—can enrich the learning experience and stimulate students' curiosity in grasping scientific concepts (Sadewo et al., 2025).

In the context of learning about changes in the states of matter, integrating digital simulations such as PhET simulations allows students to virtually observe scientific processes, especially those that are difficult to demonstrate in the classroom, such as sublimation or condensation (Laurence, 2022). This phenomenon-based approach can also be enhanced through collaborative learning strategies, such as small group discussions. These discussions give students the opportunity to critically explore their ideas and deepen their understanding of scientific concepts (Perez et al., 2025).

Exploratory learning can also be extended beyond the classroom through independent observation tasks—for example, observing scientific events at home such as melting ice, steam forming during cooking, or condensation appearing on a glass surface. These activities not only train students' observational and critical thinking skills but also enrich their learning experience in a contextual and meaningful way (Demircioglu et al., 2023).

During the learning process, the teacher provides stimuli in the form of guiding questions related to the phenomena being observed. In the first session, for instance, students were encouraged to think critically through questions like "What happens when a candle is heated?" In the second session, the question might relate to the evaporation of water in a covered pot. In the third session, the teacher initiated discussion with a question about the formation of frost in the freezer. These questions are intended to stimulate curiosity and encourage students to explore scientific concepts based on their prior knowledge and personal experience. Students were then encouraged to develop ideas for the product they could create as an outcome of their exploration of the topic of changes in the states of matter.

5.2. Elicitation of Ideas

The elicitation of ideas stage in the CLIS model can be strengthened through approaches that encourage students to ask critical questions and develop understanding based on direct observation (Kazempour & Amirshokoohi, 2020). This strategy plays an important role in expanding students' conceptual understanding and fostering their engagement in deeper scientific exploration (Johnson et al., 2024). In today's digital era, the use of virtual laboratories is an effective alternative to support learning. These platforms allow students to conduct interactive scientific explorations, either independently or in groups, thereby enhancing their comprehension of phase change concepts (Verdian et al., 2021). In this process, the teacher acts as a facilitator, guiding students to connect their observations with broader scientific theories or concepts to strengthen understanding and its real-world application (Alves et al., 2021).

At this stage, students are invited to express their initial ideas about changes in the states of matter. Group discussions and open-ended questions are used by the teacher to stimulate students' thinking and uncover their pre-existing knowledge (Chapman et al., 2016)). Students then begin developing their initial ideas and outlining their project plans. These ideas form the foundation for creating original products and serve as the starting point for innovation and further refinement. The CLIS model specifically supports the development of students' initial ideas by presenting authentic contexts or real-world scenarios, which encourage them to formulate creative solutions and relate scientific theory to everyday events (Hmelo-Silver et al., 2023). When students are directly engaged in experiments involving physical changes of matter, their critical and reflective thinking abilities improve (ORHAN, 2022). They also learn to organize their thoughts systematically while developing their ability to evaluate scientific ideas critically.

5.3. Restructuring of Ideas Stage

The restructuring of ideas stage in the Children Learning in Science (CLIS) model plays a vital role in reinforcing students' scientific understanding (Chen et al., 2018). In this stage, students are encouraged to evaluate and reconstruct their initial understanding through group discussion and social interaction within a collaborative learning process. This activity prompts students to compare their personal perceptions with those of their peers, allowing for conceptual correction toward a more accurate and scientific understanding (Ünsal & Kasap, 2023).

Students conduct experiments or observations to confirm or revise their initial ideas (Theasy et al., 2021). They analyze data and compare experimental results with their prior knowledge. This stage strengthens the innovation and transformation of ideas, which are essential components of product creativity. Students improve their product designs based on observations and scientific discussion. In addition, the integration of digital learning media, such as PhET interactive simulations, has proven effective in supporting the concept restructuring process (Liswar et al., 2023). The visualizations of abstract concepts presented through these media help students connect scientific theories to concrete phenomena in everyday life (Aparicio-Gómez et al., 2024). The CLIS model, in a consistent and systematic manner, not only enhances conceptual understanding but also sharpens students' critical and analytical thinking. This demonstrates that the restructuring of ideas is an essential component in creating a deep and meaningful science learning experience (Amal, M. R., 2022).

5.4. Application of Ideas

The application of ideas stage in the Children Learning in Science (CLIS) model plays a strategic role in integrating theory with real-world practice. As explained by Ahmed et al. (2024), project-based approaches provide students with opportunities to develop higher-order thinking skills (HOTS) by applying scientific concepts in experiments relevant to everyday life. According to La et al. (2024), the implementation of project-based learning fosters student creativity, as they are actively involved in the design and production of scientific works. This aligns with the findings of (Kongkhen & Chatwattana (2023), which show that this strategy not only enhances students' conceptual understanding but also cultivates independence in completing learning tasks responsibly. The concepts students have acquired and revised are then applied in new contexts. At this stage, students begin to materialize their ideas into concrete products that reflect their understanding of the changes in the states of matter (Kelly et al., 2023). This phase is the direct implementation of creative thinking in tangible form. Indicators of feasibility or product quality are reflected in how well the product's design, function, and usefulness align with the intended learning outcomes.

For example, experimental activities such as creating sculptures from wax provide students with hands-on experiences that reinforce their understanding of phase change concepts, while simultaneously stimulating critical thinking and analytical skills (Ahmed et al., 2024). Similarly, Kongkhen & Chatwattana (2023) state that scientific experiments in educational settings are effective for fostering creativity, as students are challenged to solve problems and apply their knowledge in meaningful, real-life activities. Therefore, the application of ideas stage in the CLIS model plays a critical role in strengthening students' cognitive, affective, and psychomotor skills, while bridging conceptual learning with authentic, applicable experiences.

5.5. Review of Change in Ideas

The review of change in ideas stage in the Children Learning in Science (CLIS) model serves as a strategic moment for deepening students' scientific understanding. At this stage, the teacher plays an active role by providing specific, relevant, and constructive feedback to help students reflect on and integrate the concepts they have learned into a more coherent knowledge structure (Dyment & Downing, 2018). According to Beltran (2021), effective feedback contributes to students' reflection on their understanding and enables them to relate the learning material to new contexts in a more meaningful way. Students' engagement in active discussion during the feedback process is crucial for reinforcing the connection between prior knowledge and newly acquired ideas (Brooks et al., 2019).

In this final phase, students reflect on the changes in their ideas and understanding that occurred throughout the learning process. The teacher provides feedback on both the students' products and their conceptual thinking. This reflection strengthens the evaluative aspect and allows for product improvement. With input from both the teacher and peers, students learn to assess the quality of their work and identify potential improvements for better outcomes. According to Farhady & Selcuk (2022), reflection that is embedded in the learning process not only supports cognitive understanding but also helps students apply concepts in more complex, real-world situations. This aligns with the view of Kastberg et al. (2016), who emphasize that reflection, when paired with constructive feedback, accelerates the internalization of scientific concepts.

Recent research by Pranata (2024) shows that integrating interactive media such as PhET Simulations within the CLIS model significantly enhances students' critical thinking abilities, especially when accompanied by structured feedback. Similarly, Saudelli et al. (2021) found that active discussions during the idea consolidation stage positively influence group collaboration and learning outcomes. Student engagement in reflective and in-depth discussions is a key factor in enhancing content retention and improving analytical thinking skills (Durkaya, 2022).

5.6. Matrix of the Relationship Between CLIS Syntax and Product Creativity Indicators

The originality aspect plays a crucial role across all five stages of the Children Learning in Science (CLIS) model, as this model encourages students to think creatively and solve problems independently through constructive thinking (Bedizel & Azizoglu, 2023). According to He et al. (2022), originality is essential in the implementation of CLIS because it promotes critical, flexible, and imaginative thinking in science learning. Each stage of the CLIS model requires creative thinking to build deep conceptual understanding. Thus, this approach aligns with the core goal of CLIS: to help students comprehend scientific concepts thoroughly and creatively.

The Children Learning in Science (CLIS) model is grounded in constructivist learning principles (Shahat et al., 2022). This is in line with Piaget's theory, which posits that cognitive development occurs through students' active experiences in constructing meaning. Learning is not merely a transfer of knowledge from teacher to student, but rather a process of interpreting personal experiences (Tajolosa et al., 2022). A study by Anggoro et al. (2019) supports this finding, showing that the application of CLIS effectively enhances creativity in learning. Similarly, research by Chen et al., (2019) revealed that this model improves creativity through observation and experimentation, which spark the creation and refinement of scientific ideas. CLIS enables students to connect theory with practical applications in real life.

In the orientation stage, the students began identifying the product they wanted to create based on their own ideas. In the elicitation of ideas stage, they started thinking of ways to modify the product, such as adding decorative elements or creating new designs to make it more visually appealing. During the restructuring of ideas stage, these ideas were organized logically and written down to facilitate implementation. Then, in the application stage, students created a sculpture based on their designs, paying attention to originality and product quality. Finally, in the review of change in ideas stage, students could refine their products, such as by adding new decorations or fixing cracks to ensure the final result meets expectations.

Analysis of the pretest and posttest results in the control class shows that originality was the most dominant indicator, as demonstrated by students' ability to create sculptures independently. However, product quality was the lowest indicator, as most students did not include packaging for their products. Meanwhile, in the experimental class that used the CLIS model, the highest indicators were also originality and innovation, where students successfully created their own products and applied modifications such as added ornaments. Similar to the control class, product quality remained a challenge, as not all students were able to produce well-packaged final products.

Table 10. Matrix of the Relationship Between CLIS Syntax and Product Creativity Indicators

No.	CLIS Syntax	Learning Activities	Product Creativity Indicators
1.	Orientation	Observing phase change phenomena	Originality of ideas
2.	Elicitation of Ideas	Discussions and guiding questions	New ideas and initiative in product development
3.	Restructuring of Ideas Stage	Experiments, observations, discussion of results	Product transformation or innovation
4.	Application of Ideas	Designing and creating products	Product feasibility or quality

5.	Review of Change in Ideas	Reflection, presentation, and feedback	Product evaluation and refinement

Analysis using the independent sample t-test shows a significant difference in product creativity between the experimental and control classes. Over three meetings, the control class implemented the Project-Based Learning (PjBL) approach, which consisted of stages including planning, implementation, and evaluation of a candle sculpture project. Although this method succeeded in generating interest in learning, student engagement during the final presentation was relatively low. In contrast, students in the experimental class were more actively engaged, as learning was conducted using the CLIS model (Comez, 2025). This model emphasizes observation and exploration of the surrounding environment, making it more suitable for encouraging active and meaningful learning through direct experience (Kalin, 2022).

The t-test results indicated that the experimental class experienced a significant improvement in product innovation, particularly on the topic of changes in the states of matter. Teachers who used the CLIS model were able to promote active student participation in creating candle sculptures while also facilitating their understanding of scientific concepts through the creation of tangible products (Yaşar et al., 2024). This activity also strengthened conceptual understanding, as students were able to articulate acquired knowledge into the form of artifacts. This reflects the core principle of constructivist theory, which asserts that effective learning involves active construction of knowledge from real experiences (Alahmari et al., 2023).

Based on both theoretical review and research findings, it can be concluded that the Children Learning in Science (CLIS) model has a positive and tangible impact on improving students' creativity in producing scientific work, particularly wax-based sculptures (Lam & Siew, 2025). Students in the experimental class demonstrated greater ability in producing products compared to those in the control class, who were taught using a different instructional approach. This difference in instructional method is the main factor influencing the final outcomes, with CLIS proven to be more effective in stimulating students' creative thinking and idea generation through exploratory, experience-based learning (Arik Güngör et al., 2022).

The findings of this study demonstrate that the Children Learning in Science (CLIS) model significantly enhances students' product creativity in the topic of changes in the states of matter compared to the Project-Based Learning (PjBL) approach. The structured phases of CLIS namely orientation, elicitation of ideas, restructuring, application, and review provide a systematic framework that encourages students to express, challenge, and refine their ideas (Sugandi et al., 2021). This process allows learners to not only improve conceptual understanding but also generate creative products, as they are guided to integrate prior knowledge with new scientific concepts. These results align with previous studies highlighting the role of constructivist approaches in promoting creativity and problem-solving (Sari et al., 2020).

6. Conclusion

This study concludes that the Children Learning in Science (CLIS) model significantly enhances students' product creativity in the topic of changes in the states of matter among fourth-grade elementary school students. Through its structured phases orientation, elicitation, restructuring, application, and review CLIS actively engages learners in observation, experimentation, discussion, and reflection, which directly contribute to the development of originality, transformation, and feasibility in creative products. Results of the independent sample t-test confirm that the experimental group taught with CLIS achieved higher creativity levels than the control group, as demonstrated in students' ability to design and modify wax sculptures based on their own ideas. These findings highlight that CLIS not only strengthens conceptual understanding but also fosters meaningful and creative scientific products. The implications of this study are twofold. Theoretically, it enriches the literature on constructivist learning by showing that CLIS promotes not only conceptual mastery but also product creativity in science education. Practically, the findings suggest that teachers can adopt CLIS as an effective alternative to conventional methods, particularly in teaching Natural and Social Sciences (IPAS). By implementing CLIS, teachers may reduce student boredom, enhance engagement, and encourage active participation and creativity in the classroom.

Limitation

This study was conducted in only one elementary school with a limited number of participants; therefore, the generalizability of the findings is confined to similar contexts. Moreover, CLIS-based learning requires more intensive time and preparation, including the teacher's mastery of the syntax and the management of relevant media and experiments.

Recommendation

Wider training programs are needed for educators to implement the CLIS learning model effectively across various elementary school levels. Future researchers are encouraged to examine the effectiveness of this model in different subjects and grade levels, as well as to conduct more in-depth analyses of the factors influencing students' creativity in the context of science learning.

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Conflict of Interest

The author declares that there is no conflict of interest in the preparation and publication of this article.

Declaration of Generative AI Use

This manuscript was prepared with the assistance of Generative AI ChatGPT. AI was used to support drafting, language refinement, and content organization. All intellectual contributions, critical analysis, and final revisions were carried out by the author. The author bears full responsibility for the accuracy, originality, and integrity of the content presented in this work. This manuscript was prepared without the assistance of Generative AI ChatGPT. All intellectual contributions, critical analysis, and final revisions were carried out by the author. The author bears full responsibility for the accuracy, originality, and integrity of the content presented in this work.

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