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Learning Using the CREATE Model on the Topic of Growing Media from Organic Waste to Enhance Students' Scientific Creativity

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Abstract: This study aims to determine the feasibility of the designed learning CREATE model and the improvement of students' scientific creativity (SC) after its implementation. The research employs a Design and Development Research (DDR) approach, categorized as Product and Tool Research. This type of DDR focuses on the development and evaluation of practical products and tools that are directly implemented as solutions to practical problems. The instrument used to assess the feasibility of the CREATE learning model design is the Teaching of Creativity Observation Form (TCOF). Meanwhile, students' scientific creativity improvement was measured using pretests and posttests. The designed learning model achieved a high-level rating in the R-E-A-T steps across all TCOF categories, with scores of 2.53, 2.52, 2.47, and 2.42, respectively. In contrast, the Connecting and Evaluating steps attained a moderate level in all TCOF categories, with scores of 2.35 and 2.30, respectively. These findings indicate that the designed learning model is feasible for implementation based on TCOF evaluation. The most significant improvement in SC indicators was observed in the fluency × thinking × scientific phenomena domain, with N-gain score of 0.74.

Keywords: CREATE Model, Creativity, Organic Waste.

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A. INTRODUCTION

In the era of Industry 4.0, education must be adapted to the characteristics and skills required to meet 21st-century competencies (Yusuf & Asrifan, 2020). One approach to addressing this challenge is by incorporating personalized learning to foster creativity and innovation in education (Engreini et al., 2022). Creativity is a fundamental skill that should be nurtured and developed in students as part of modern learning processes. One of the essential domains of creativity is scientific creativity, which is regarded as a primary goal of education (Nugraha & Sudiyono, 2018). Scientific creativity encompasses creative experimentation, innovative scientific activities, and the ability to identify and solve problems creatively. Students who possess scientific creativity are considered more capable of applying scientific knowledge and skills to produce meaningful and valuable outputs (Hu & Adey, 2002).

Creativity is one of the core elements of scientific knowledge (Hu et al., 2003). Aktamıs, in Ceran & Ates (2020), developed a test to measure scientific creativity and scientific process skills in elementary school students in Turkey. This study utilized the Scientific Creativity Structure Model (SCSM) proposed by Hu & Adey (2002), with slight modifications to align with the Turkish language and cultural context. The SCSM is a theoretical model consisting of three dimensions: (1) Process (thinking and imagination); (2) Traits (fluency, flexibility, and originality); and (3) Products (technical products, scientific knowledge, scientific phenomena, and scientific problems). The reliability and validity tests of this model indicated satisfactory results. Creativity can be cultivated in every individual, either through daily activities or structured learning experiences. Therefore, there is a strong correlation between creativity and science education, providing opportunities to enhance creativity through science instruction Meador in (Yildiz & Yildiz, 2021).

However, project-based learning (PjBL) encounters several challenges in its implementation. Some of these challenges include: (1) not all students can grasp the learning concepts due to the broad scope of projects (Maros et al., 2023); (2) PjBL requires more time and resources than conventional learning methods (Zahroh et al., 2023); and (3) teachers often struggle to fully understand the instructional syntax, as PjBL is often mistaken as a mere abbreviation rather than a structured learning approach. To address these limitations, the C-R-E-A-T-E (Connecting-Restructuring-Elaborating-Applying-Tasking-Evaluating) learning model was developed in Indonesia. This model was first introduced by Wahyu, Oktiani, & Komalia (2020) and is structured based on a constructivist learning approach (Wahyu & Kusrijadi, 2024). According to Parker & Thomsen (2019), fostering scientific creativity requires a student-centered learning model that stimulates curiosity through scientific problems relevant to students' daily lives. This approach encourages students to explore multiple alternative solutions and conduct experiments using locally available materials while keeping the learning process up-to-date.

Environmental issues pose significant risks both in the present and the future (Al Idrus et al., 2020). As the world's largest producer of young coconuts, Indonesia recorded a national coconut production of 2.85 million tons in 2021, reflecting a 1.47% increase from the previous year's 2.81 million tons (Badan Pusat Statistik, 2021). Consequently, Indonesia also ranks first in coconut waste production worldwide. However, the efficient and effective management of coconut waste remains a challenge. In reality, coconut waste can be repurposed into valuable by-products such as coconut fiber and coconut husk (cocopeat). Cocopeat is commonly used as a planting medium during the germination stage, but before use, it must undergo basic organic material processing through fermentation, soaking, or alkali treatment (Augustien & Suhardjono, 2023). These processing techniques aim to eliminate growth-inhibiting contaminants, such as tannins. Tannins are polar compounds, and their removal from cocopeat can be facilitated using polar solvents such as water (Verdiana et al., 2018).

Based on these considerations, this study explores the implementation of the CREATE learning model on the topic of planting media derived from organic waste to foster students' scientific creativity. This research focuses on evaluating the feasibility of the designed learning model using the Teaching of Creativity Observation Form (TCOF) and assessing the improvement of students' scientific creativity after the learning process.

B. METHOD

This study employs the Design and Development Research (DDR) approach, categorized as Product and Tool Research. This type of DDR focuses on the development and evaluation of practical products and tools that are directly applied as solutions to real-world problems (Rischer & Klein, 2014). The DDR research design consists of four phases: Analysis, Design, Development, and Evaluation. In the Analysis phase, researchers identified the product to be developed based on a needs analysis of the feasibility of the CREATE learning model design on the topic of planting media from organic waste. This feasibility assessment was conducted using the TCOF to determine its potential in fostering scientific creativity. The Design phase involved the development of the CREATE learning model design and its corresponding learning instruments. In the Development phase, the learning design and instruments underwent validation by five experts in content and pedagogy. The collected validation data were used to revise and refine the learning model and instruments based on expert feedback. During the Evaluation phase, researchers assessed the learning design, instructional materials, and test instruments. The evaluation process was based on recommendations and feedback, followed by a comprehensive analysis and discussion of the findings.

The research instruments used in this study aimed to collect essential data to address the research questions. The TCOF was utilized to evaluate the feasibility of the CREATE learning model, as it had been previously validated by Al-Abdali & Al-Balushi (2016). To measure students' scientific creativity improvement, pretests and posttests were conducted. The validation data from the CREATE learning design were processed using the TCOF observation rubric, and the obtained scores were interpreted according to predefined categories, as shown in Table 1.

Table 1. Table of TCOF Score Interpretation

Score Range	Level
1,00 – 1,66	Low
1,67 – 2,33	Moderate
2,34 – 3,00	Very Good

Al-Badali & Al-Balushi (2016)

The Pre-Test and Post-Test questions consisted of five open-ended questions, developed based on the mapping of scientific creativity indicators aligned with the research objectives. The students' average scores were obtained by dividing the total score by the number of students, which was then processed into N-gain values. A total of 45 students participated in this study. The scientific creativity data were collected using the Scientific Creativity Test (SCT), adopted from Aktamis & Ergin (2015). The SCT is a combination of the Torrance's Test of Creative Thinking (TTCT) and the Scientific Creativity Structure Model (SCSM) developed by Hu & Adey (2002). The interpretation of student scores is categorized as follows:

Table 2. Table of SCT Score Interpretation

Score Range	Level
$15 \leq x \leq 31$	Very Less Creative (VLC)
$31 < x \leq 47$	Less Creative (LC)
$47 < x \leq 63$	Creative Enough (CE)
$63 < x \leq 79$	Creative (C)

Fadlan et.al (2018)

C. RESULTS AND DISCUSSION

1. Feasibility of Learning Design Based on TCOF

The Teaching Creativity Observation Form is an observation sheet used to assess teachers' creativity-focused teaching practices. This instrument has been validated by 12 experts, including three professors specializing in curriculum and instruction, two psychology professors, and seven science supervisors working at the Ministry of Education. The instrument consists of four categories and 23 items (Al-Badali & Al-Balushi, 2015). The four categories in TCOF are Questioning Strategies, Teacher Responses to Student Ideas, Classroom Activities Supporting Creativity, and Lesson-Wide Methods Encouraging Creativity. The first category evaluates how teachers use divergent, problem-solving, and follow-up questions to stimulate student thinking. The second assesses how teachers respond to students' answers, questions, and requests in ways that reinforce creative thinking. The third focuses on student-centered activities such as designing experiments, presenting findings, and applying knowledge in innovative ways. The last category measures whether the lesson structure incorporates teaching methods that foster creativity and imagination.

The learning design in this study was developed to enhance students' creativity, ensuring alignment with the CREATE model syntax and the creativity indicators in TCOF. The CREATE model phases are implemented as follows: the Connecting phase links prior knowledge to new concepts, the Restructuring phase allows students to clarify their understanding with teacher support, and the Elaborating phase engages students in deeper exploration of environmental problems. In the Applying phase, students refine their ideas to develop well-structured solutions, followed by the Tasking phase, where they implement these solutions. Finally, in the Evaluating phase, students' work is assessed based on their outcomes and processes. The learning design was evaluated by five TCOF raters, all of whom are experts in content and pedagogy. The evaluation results showed that the learning model obtained high ratings in the Restructuring, Elaborating, Applying, and Tasking phases, with scores of 2.53, 2.52, 2.47, and 2.42, respectively. Meanwhile, the Connecting and Evaluating phases received moderate ratings with scores of 2.35 and 2.30. These results indicate that the CREATE learning design is feasible for use based on TCOF criteria, as shown in Table 3.

Table 3. TCOF Levels for Each Learning Step

TCOF Categories	Scores for Each Phase of the CREATE Model					
	C	**R**	**E**	**A**	**T**	**E**
A (Strategies)	2,65	2,75	2,70	2,25	2,45	2,55
B (Responses)	2,15	2,25	2,40	2,35	2,25	2,05
C (Activities)	2,28	2,52	2,36	2,60	2,44	1,92
D (Models)	2,33	2,60	2,60	2,67	2,53	2,67
Average Score for Each Learning Step	2,35	2,53	2,52	2,47	2,42	2,30
TCOF Level	Moderate	High	High	High	High	Moderate

C: Connecting; R: Restructuring; E: Elaborating; A: Applying; T: Tasking; and E: Evaluating.

Based on Table 3, the designed learning model achieved a high level in the Restructuring, Elaborating, Applying, and Tasking (R-E-A-T) phases across all TCOF categories, with scores of 2.53, 2.52, 2.47, and 2.42, respectively. Meanwhile, the Connecting and Evaluating phases were rated at a moderate level in all TCOF categories. These results indicate that the learning design is feasible for implementation based on the TCOF review. The next step is the implementation of the learning model to assess the improvement of students' scientific creativity on the topic of growing media from organic waste

2. Scientific Creativity Profile of Students

According to Rhodes (as cited in Astuti et al., 2023), the definition of creativity can be categorized into four dimensions: person, process, product, and press, which he refers to as "The Four P’s of Creativity." Creativity in the person dimension focuses on defining creativity in terms of the characteristics of a creative individual, while creativity in the process dimension emphasizes the cognitive processes involved in generating unique or creative ideas. The press dimension highlights motivational and supportive factors, both internal, such as personal desires and aspirations to create or engage in creative activities, and external, such as social and psychological influences. The person dimension, as a criterion of creativity, is closely linked to the concept of creative personality. According to Guilford (Nugraha et al., 2023), a creative personality consists of both cognitive and non-cognitive aspects, including interests, attitudes, and temperamental qualities. Creative individuals exhibit significantly different personality traits compared to those who are not considered creative. These personality characteristics serve as criteria for identifying creative individuals.

Creativity is distinct in different fields. Creativity in science differs from creativity in art and language. Scientific creativity, often referred to as "scientific creativity," involves unique cognitive processes specific to scientific inquiry. Moravcsik (Ha & Ha, 2022) defines scientific creativity as the achievement of novel steps in advancing scientific knowledge. It manifests in the formulation of new scientific ideas that contribute to the body of scientific knowledge, the development of new scientific theories, the design of innovative experiments to explore natural laws, and the application of scientific concepts to practical fields of interest.

Several studies have been conducted on instruments or tests designed to assess scientific creativity among school students. Aktamıs Ceran & Ates (2020) developed a test to measure scientific creativity and science process skills in elementary school students in Turkey. Aktamıs adapted the Scientific Creativity Structure Model (SCSM) proposed by Hu & Adey (2002), with minor modifications to align with Turkish language and culture. SCSM is a theoretical model consisting of three dimensions: the process dimension, which involves thinking and imagination; the trait dimension, which includes fluency, flexibility, and originality; and the product dimension, which encompasses technical products, scientific knowledge, scientific phenomena, and scientific problems.

In this study, students' scientific creativity improvement was measured using a validated and reliable written essay test in the form of pretests and posttests. The pretest was administered before the learning process began, while the posttest was conducted after the learning session ended. The results of these pretest and posttest assessments yielded average pretest and posttest scores, as well as N-gain values for each indicator of scientific creativity, which are presented in Table 4.

Table 4. Student Scientific Creativity Leve

Aspects Assessed				Average Score		N-Gain	Kt
Indikacators	**Domain**			**Pre**	**Post**		
	Trait	**Process**	**Product**				
Generating multiple ideas regarding the properties of tannin compounds	*Fluency*	*Thinking*	*Scientific Knowledge*	2,50	2,99	0,33	S
Generating multiple ideas regarding the extraction of tannin compounds							
Having multiple ideas about the effects of tannins on plants	*Fluency*	*Thinking*	*Scientific Problem*	2,47	2,73	0,50	S
Recognizing organic waste that can be used as a planting medium	*Fluency*	*Thinking*	*Scientific Phenomena*	2,40	2,84	0,74	T
Able to combine various types of knowledge and procedures for making planting media from agricultural waste	*Originality*	*Thinking*	*Technical Product*	2,20	2,44	0,14	R

Description: T (High); S (Medium); R (Low)

Based on Table 4, the highest increase in the scientific creativity (SC) indicator was observed in the domain of Fluency × Thinking × Scientific Phenomena, with an N-gain score of 0.74. This indicates that students were able to easily identify various phenomena related to the utilization of organic waste as a planting medium. However, the domain of Originality × Thinking × Technical Product showed the lowest increase, with an N-gain score of 0.14. One contributing factor to this low improvement is the students' lack of experience in processing waste using a scientific approach, making it difficult for them to integrate various types of knowledge and procedures for creating a planting medium from waste, ultimately resulting in a product free of growth-inhibiting substances such as tannins. According to student interviews, they admitted that their prior experience with processing organic waste into a planting medium was limited to simple composting without any further refinement. Meanwhile, the remaining two domains showed moderate increases, with N-gain scores of 0.33 and 0.50.

D. CONCLUSIONS AND SUGGESTIONS

Based on the validation results of the instructional design, it was found that the CREATE model lesson plan on the topic of planting media from organic waste is suitable for implementation as a learning approach aimed at enhancing creativity. After limited implementation, it was observed that students' creativity showed a significant increase in the domain of Fluency × Thinking × Scientific Phenomena. However, further development is needed in the domain of Originality × Thinking × Technical Product.

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