JPPIPA 12(1) (2026)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Using the Scientific Reading-Based Project (SRBP) Model to Describe the Transformation of Hands-on Science Learning Experiences and Creative Thinking for Preservice Elementary Teachers

Kartika Chrysti Suryandari[1*], Wahyudi[1], Rokhmaniyah[1], M. Chamdani[1], Dewi Indrapangastuti[1], Murwani Dewi Wijayanti[1]

[1] PGSD Kebumen, FKIP, Universitas Sebelas Maret, Jl Kepodang no67A, Panjer, Kebumen, Jawa Tengah, Indonesia.

Received: November 25, 2025
Revised: December 23, 2025
Accepted: January 25, 2026
Published: January 31, 2026

Corresponding Author:
Kartika Chrysti Suryandari
kartika@fkip.uns.ac.id

DOI: 10.29303/jppipa.v12i1.13588

Abstract: The purpose of this research is: to describe the science learning experience in terms of creative thinking and to describe the level of students' ability to think creatively using the SRBP model. This study used Design-Based Research (DBR) to investigate the efficacy of hands-on experiments in science learning, combining qualitative and quantitative research methods. Participants were Elementary School Teacher Education students who had taken science lessons, with a total of 105 students. We have developed and examined how this approach might direct creative educational activities. This study uses the Scientific Reading-Based Project (SRBP) conceptual framework. Data collection techniques include questionnaires, observations, interviews, and student portfolios. The results showed that students' learning experience from the creativity aspect increased with each cycle. The learning participants' responses were enjoyable, stimulating students to think creatively. Students performed better because they learned and recalled information through practical experiences. This research recommends applying an innovative learning model that incorporates the principles of discovery and observation, which can stimulate students to think creatively.

Keywords: Creative; Experience; Hands-on; Science; SRBP model

Introduction

Creative thinking is a must-have 21st-century skill. It is essential for every student to develop their ability to prepare themselves as superior human resources by thinking creatively (creative thinking). Creative thinking is a method for generating ideas that can be applied to address global problems. The ability to think creatively is closely related to the process of creative thinking, which in turn is related to the process of creating (Abidin et al., 2018). Creative thinking is a process in which individuals generate new ideas or logical and rational concepts. The ideas or concepts conveyed possess novelty and certain characteristics (Ameida, 2008). New ideas or existing ideas are assessed critically to ensure they are logical and rational. Creative thinking is part of a divergent thinking process that stimulates curiosity, which includes aspects of fluency, flexibility, elaboration, and originality skills (Hu et al., 2002).

The problem in the field is that many teachers still use a one-way lecture method that quickly makes students bored, as well as an inability to develop engaging teaching methods. This can lead to a lack of communication in the classroom and a decrease in student enthusiasm for learning. Some teachers do not utilize learning technology effectively and lack knowledge of innovative teaching techniques. External factors such as substandard teacher welfare can affect

How to Cite:
Suryandari, K. C., Wahyudi, Rokhmaniyah, Chamdani, M., Indrapangastuti, D., & Wijayanti, M. D. Using the Scientific Reading-Based Project (SRBP) Model to Describe the Transformation of Hands-on Science Learning Experiences and Creative Thinking for Preservice Elementary Teachers. *Jurnal Penelitian Pendidikan IPA*, *12*(1), 256-264. https://doi.org/10.29303/jppipa.v12i1.13588

teacher focus and performance in teaching. This uncertainty can hinder teachers' creativity in creating a dynamic learning environment (Suryandari et al., 2018).

The problem is increasingly apparent because students are not accustomed to critiquing discourse and natural phenomena in everyday life. Scientific literacy activities have not yet become a culture and habit in life, which results in low creative thinking skills (Suryandari et al., 2021). Teachers do not provide problem orientation in everyday life when they only teach and give science material by rote. The results of preliminary research indicate that, based on observations from 2024 to 2025, most students are not accustomed to thinking creatively, particularly in terms of originality.

According to Hadzigeorgiou et al. (2012) and Holland et al. (2016), creative thinking is the process of obtaining alternative solutions or new solutions to problems. In order to obtain alternative solutions, proper problem identification and analysis are required (Mumford, 2003; Susilawati et al., 2023). Creative thinking involves knowledge associated with divergent, novel ideas. Isabekov et al. (2018) state that if a creative person has sensitivity to the situations and conditions around them, they can generate several solutions to unusual problems. Everything new can be achieved through creative thinking and the acquisition of related knowledge. According to Kashani-Vahid et al. (2017), a creative person is one who has sensitivity to circumstances and surrounding conditions, as well as the ability to solve unusual problems. Torrance (2012) defines creativity, as stated in the Torrance Tests of Creative Thinking (TTCT), as the ability to detect problems, propose solutions to problems, generate new ideas, and combine ideas into new theories. Scientific creativity in science learning is the result of a variety of different factors. These factors result in: 1) scientific theory being considered a creative product of scientists; 2) new ideas and concepts emerging from the cooperation of scientists over a long time to produce theories and laws; 3) scientists always working together to increase knowledge; and 4) scientific creativity remaining rational and applicable in practice (Kind, 2016).

The importance of this research lies in emphasizing the importance of reading scientific articles as a foundation for students to develop products through innovative models. Through reading activities, students can analyze their strengths and weaknesses, and develop plans in a more targeted manner. Previous research has primarily focused on developing products to enhance thinking skills (Chrysti et al., 2020; Soyadı, 2015; Syahrin et al., 2019). One of the learning models to increase product creativity is the Scientific Reading Based Project (SRBP) model. The novelty of this study is the use of the SRBP model, a relatively recent learning model, to be applied to prospective elementary school teachers. The SRBP model is a derivative of the project-based learning model that emphasizes reading scientific literature as a basis for developing projects. Previous studies used project-based learning but did not emphasize scientific reading activities. In addition, students created products based on the local potential of Kebumen Regency, Central Java, Indonesia. The SRBP model is characterized by constructivism, authentic learning, inquiry, hands-on and minds-on approaches, and problem-solving. The following syntax constitutes the SRBP model: 1) orientation, 2) scientific reading, 3) design and manufacture, 4) project progress, 5) analysis, and 6) discussion and communication (Figure 1). Scientific reading activities can be conducted before or during science learning, meaning they are not limited by space or time. The SRBP model helps students become good problem solvers (Suryandari et al., 2021).

Figure 1. Syntax of the scientific reading-based project (SRBP) learning model

The teaching model, developed by Joye et al. (2011), consists of a Teaching Structure/Syntax component. This model illustrates the structure of a learning model that comprises stages or steps. Orientation activity means observing and experiencing natural phenomena with the five senses and then making them the subject of the lesson. Observation is a basic process skill that is first introduced in science learning (McNew-Birren et al., 2017; Pedaste et al., 2015). Brainstorming or brainstorming activities are carried out to motivate and explore students' prior knowledge. Scientific reading is a reading comprehension skill closely related to the project being worked on. Reading is conducted using various media sources of information from the internet, reference books, scientific articles, and research journals. Design & create activities involve planning and creating projects in the form of learning artifacts based on supporting literature. The rules of the game have been mutually agreed upon, and the project is carried out collaboratively by students and lecturers. The project progress stage is obtained through integrated monitoring of collaboratively developed student projects. At this stage, the process requires oversight and thorough research to determine the advantages and disadvantages of the project. In this phase, the data must be analyzed and interpreted. Outstanding thinking skills are required for this activity, including critical, creative, and logical thinking, as well as analysis, evaluation, and synthesis, to solve problems and draw conclusions. Students work in groups and exchange ideas to solve problems as part of the project being implemented. The purpose of this study is to analyze creative thinking skills through transforming hands-on science learning experiences that are creative thinking-oriented, based on the SRBP Model, in students of the Elementary School Teacher Education Study Program, and to measure the level of students' ability to think creatively by working on creative thinking test questions.

Method

Research Procedures

The Design Based Research (DBR) research methodology employed in this study comprises of 4 steps, namely: (1). Problem analysis, design and innovation development, repetition and implementation in cycles, evaluation to derive "design principles," and reflection are the four steps in the process. The DBR technique is run repeatedly to create a unique output in the form of a novel hypothesis (Figure 1) (J. Creswell et al., 2011; J. W. Creswell, 2008).

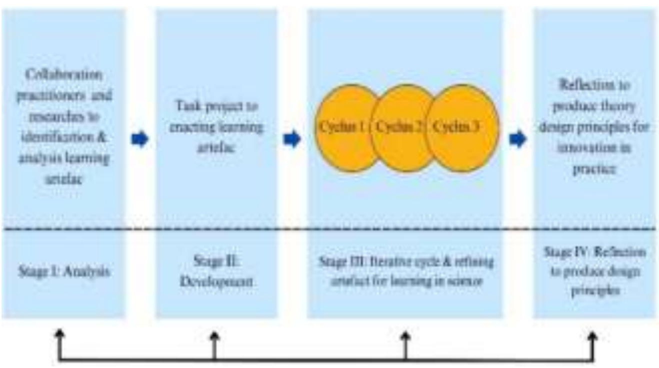

Figure 2. Four stages of DBR in research (Euler, 2017; Herrington et al., 2014)

In Stage 1, to identify and assess needs, the analysis is conducted by examining the literature and collaborating with researchers and practitioners. In Stage 2 of development, constructivism is employed to explore concepts and ideas for enhancing creative thinking skills as a more effective educational tool. Stages one and two last for eight weeks. Stage three involves iterative cycles and refinement to improve the learning process. Stage three, with a learning implementation duration of four to six weeks, culminates in Stage four, which has a duration of two weeks. The total learning period is 16 weeks, or four months (Figure 2).

Setting and Participant

The sample of the study consisted of 105 students from the Primary School Teacher Education Study Program at Sebelas Maret University, Indonesia, in their fourth semester, divided into two groups: a control group of 37 students and a treatment group of 68 students. The students had participated in learning the Basic Concepts of Science. This research was conducted over a one-semester period, from February to July 2025. The learning of basic science concepts was conducted over 12 meetings, each lasting 150 minutes.

In the treatment class, communication between students and lecturers was conducted through face-to-face learning using the SRBP model. Students were divided into six groups, each consisting of five members. Each group had a moderator who acted as a group coordinator. The group coordinator and the lecturer met face-to-face. Students used the group during both in-class and out-of-class learning activities to ask lecturers for clarification on assignments, share ideas about science concepts, and discuss topics. In the control class, learning took place face-to-face using the scientific approach and experimental method, without emphasizing scientific reading.

Teacher Evaluation Instrument

The instruments used for the purposes of this research were: student portfolios, including planning, implementation, and packaging. Measuring Product Creativity with a Portfolio Rubric. Observations to gauge cooperation skills, originality, flexibility, elaboration, and fluency are quantifiable aspects of creative thought. Discussion activities that facilitate the exchange of thoughts and questions about current scientific issues, promoting the development of creative thinking abilities. To measure creative thinking skills, Torrance creative thinking tests were used, consisting of both visual and verbal tasks. The visual tasks involved creating as many images as possible from a given shape, while the verbal tasks required students to generate creative words. Collaboration was measured through observation and compared between the control and treatment groups. Collaboration was measured using a questionnaire adapted from Questionnaire II. Detailed information about the preparation, implementation, and evaluation of the assessment tools used in data collection is provided below.

Data Collection and Analysis Procedures

Data collection and analysis were carried out qualitatively and quantitatively. Qualitative data were transcribed and analyzed descriptively. Following the fundamental principles of qualitative content analysis, the open questions and interview data were analyzed. The open-ended responses were classified and tallied in accordance with categories deduced inductively from the data. Later, replies from the follow-up interviews were used to illustrate and further interpret the questionnaire data. Quantitative data in multiple-choice test questions refer to numerical data obtained from the test participants' answers, which were then analyzed to measure the quality of the questions and the students' ability levels using the Rasch Model analysis. The analysis of the Rasch model with a variable map was used to see the distribution of respondents across each question item. The indicators observed included the level of validity of responses to items based on the value of Outfit Mean Square (MNSQ), with acceptable values of $0.5 < MNSQ < 1.5$, Outfit Z-Standard (ZSTD) with acceptable values of $-2.0 < ZSTD < +2.0$, and Point Measure Correlation (Pt Mean Corr) with acceptable values of 0.4 < Pt Mean Corr < 0.85 (Sumintono et al., 2015).

Result and Discussion

The experience of learning science in everyday life leads to creative products that are often achieved in groups. The development of product creativity is based on field observations and reading scientific references from journals, providing a foundation for thought. The results of the research on the science learning experience, conducted using the SRBP model and the Design-Based Research approach through three cycles, are presented in Table 1.

Table 1. Observation of Creativity Hands-on Transformation in Each Cycle in the Experimental Class through the SRBP Model

Cyclus	Project invoice	Creativity Task Design
1	Project design	-Designing science teaching aids from used goods such as plastic bottles, used cardboard, and paper. The product design is based on reference journal articles that explore the concepts of electricity and magnetism. Several groups make the same design with the action.
	Hands on	- Develop learning aids from used goods from electricity and magnets in the form of flood alarms, fire alarms, electric bells etc
	Creativity	-Designing and forming used goods into science teaching aids -Creative ideas for turning used goods (plastic bottles, cardboard, paperboard, etc.) into meaningful science teaching aids -Creativity is observed from the benefits, practicality, and quality of learning media
	Practicum report	-Students prepare practicum reports by hand, starting from the title, background, objectives, hypotheses, used materials and working methods, tables of observations, discussion, and conclusions. -Not all students are able to make good titles, so then should describe each topic
2	Project design	-Designing the practice of making soybean-based tempeh. Reflecting on the various literature -Designing ways to package products and make delicious tempeh characteristics
	Hands on	-Making fermented food products, peanut tempeh, purple sweet potato tape, watermelon nata, de pina nata, banana skin waste nata, etc.
	Creativity	-Innovation of product packaging from various packages, for example, banana leaves, teak leaves, and plastic, to observe the quality of the product. -Innovations in variants of basic nata ingredients, for example, from banana peel waste, rice washing waste, various fruits
	Practicum report	-The title of the practicum report is better, connecting the independent and dependent variables -More creative in specifying material tools according to the unit
3	Project design	-Designing non-fermented food products with physical and chemical processing without involving microbes
	Hands on	-Making non-fermented food, namely food processing products through heating, cooling, salting, sugaring, pickling (eg, banana chips, spinach chips, candy, etc.)
	Creativity	-Flavor innovations, for example, banana chips with Balado flavor and sweet and sour taste -Creativity in product packaging using paper, plastic, or banana leaves
	Practicum report	-The title contains the relationship between the independent and dependent variables -The implementation method uses control and experimental treatments, for example, variations in the addition of sugar or salt -In a more detailed implementation method for using consumables according to standard units -Detailed discussion in detail and reflected from various sides, for example, the concept of science, economics, and art.

Cycle I

In Cycle I, learning used the theme of Electricity and Magnetism and its application through the SRBP model. The first syntax was problem-oriented, as it displayed a video or image of an alarm that sounds during an emergency. After observing the video, the teacher provided trigger questions to stimulate critical thinking skills, for example, "Why does the alarm go off during an emergency? How does the alarm work?" The next step was scientific reading, where students deepened the concept of electricity and magnetism by reviewing scientific articles for reflection. The third step involved designing the project, where students created learning aids related to the concepts of electricity and magnetism, such as earthquake alarms, flood alarms, simple compasses, and electric bells. The product design was then consulted with the lecturer in charge of the course. The fourth stage involved the progress of the product-making project, carried out in groups within a specified timeframe, as agreed upon. The fifth stage was analysis, where students analyzed the product results, including their advantages and disadvantages. The sixth stage was discussion and communication, where the project results were discussed in groups and then presented.

Cycle II

In Cycle II, the theme was "Processing and Preservation of Non-Fermented Foods Based on Local Potential." The problem orientation stage was conducted by students carrying out outing classes based on local potential, namely home industry craftsmen of non-fermented food processing and preservation. Non-fermented food products based on local potential in Kebumen, Kedu, Central Java, and surrounding areas included, for example, local banana chips, cassava chips, banana sale, jipang, lanting, tofu, and one cake, etc. Students observed the process of food processing and preservation, as well as identified the problems experienced by entrepreneurs in the home industry. The scientific reading syntax was carried out by reviewing articles with the aim of constructing knowledge about the processing and preservation of non-fermented foods. Next was the design of the project, which involved creating a practicum for making non-fermented food. The project's progress was then achieved through practice sessions, each lasting two hours, during which participants produced banana chip products, spinach chips, jelly candy, and coconut jam. Creativity was assessed based on product originality, taste variations, and packaging. Furthermore, in the analysis syntax, students analyzed the weaknesses and strengths of food products, then carried out discussion and communication. At each stage of the cycle, students worked in groups, using student worksheets as a support tool.

Cycle III

The theme of Cycle III was "Making Fermented Products from Local Potential." Product creativity continued to be explored in Cycle III, starting with an outing class that involved observing home industries of fermented products (tempeh, tofu, and manure). The problem orientation step began with observing the home industry process of local fermented product artisans and conducting interviews about the constraints of making the product. The second stage was scientific reading by reading articles or journal references about fermented food products to strengthen conceptual knowledge. Then, participants designed project plans and practicums for fermented food products based on local potential, for example, purple sweet potato tape, black sticky tape, mung bean tempeh, koro tempeh, nata de leri, etc. Product creativity stemmed from variations in flavor and packaging options. The fourth stage of project progress involved practicing the production of fermented food under sterile conditions, incubating it for 2–3 days for tape and tempeh, and 7–10 days for nata products. The fifth stage of analysis involved observing the results of fermentation, including color, taste, and texture, followed by group and class discussions led by the course lecturer. Students conducted group work with the assistance of student worksheets.

Figure 3. Creativity in hands-on science learning from students

Based on qualitative data from interviews in the control and experimental classes, various answers were given. For example, with the question "what is the design form in making the product? Explain the types of fermented products in your environment! Is it the same type of microbes for each fermented product and others? The answers to the questions differed between the control and experimental classes (Table 2).

The forms of answers in the control and experimental classes demonstrated a range of creative thinking skills. In the control class, the preparation of the title did not reveal a clear relationship between variables, whereas in the experimental class, a relationship was observed between the independent variables and the dependent variable. Regarding creativity, students in the experimental class wrote details of the materials used for practicum more thoroughly using standard units. Product creativity was observed in various flavored innovations of fermented food products, for example, flavor variants in cassava chips. Variations in making tempeh are generally made from soybeans, but they can also be made using basic ingredients such as red beans, green beans, and corn.

Table 2. Interview Results and Answer Forms

Question Form	Answer form Control class	 Experiment class (SRBP model)
How does the design shape the product?	-The title is not clear on the variable being measured - The background has not been fully described -The creativity of the product design has not been fully detailed, for example, the fermentation time	-The title has linked the independent and dependent variables -The background explains the relationship between the independent variable and the dependent variable - Product creativity includes details on the amount of seeds for fermentation -Creativity of various raw materials in making tempeh, tape and nata
Explain the types of fermented products in your environment!	-Understanding of fermentation only from soybean tempeh	Fermentation consists of various products, such as nata, rice washing waste, and various fruits
Is it the same type of microbes for each fermented product?	-Multiple fermented products with the same microbial species.	-Each fermented product has special microbes, for example, tempeh with Rhizopus orizae
Are the benefits of sterilization particularly important during the preparation, implementation, and immersion stages?	-Some answers are considered not very important and do not affect product failure	-Stages of sterilization are very important at each stage of manufacture
What is the level of understanding of science from these three projects?	-Understand a little because it has never been practiced before, and scientific reading activities are not emphasized	-Understand more about science concepts, especially physics, chemistry, and biology, especially after carrying out the practice

Likewise, the basic ingredients for making nata are generally from coconut water waste to become nata de coco. The creativity of this product uses various fruit-based ingredients, namely mango, pineapple, rice washing water, soybeans, and others. Several aspects were identified from student experiences to inform the creation of learning artifacts, namely that learning outside the classroom provides students with real-life experiences. Experience in the real world serves as training or input in making artifacts to make them more meaningful. Learning in the real world trains students to think contextually (Dabbagh et al., 2010; Januarti et al., 2024; Quintana et al., 2015).

Collaboration activities, such as discussing and communicating with group members, can empower them to design and create artifacts that enhance their performance. Lecturers and students work together to monitor the progress of artifacts. According to constructivist theory, students are actively involved in building knowledge based on their experiences (Ke et al., 2015; Pan et al., 2016). The activeness of students in being involved in making artifacts from start to finish helps them construct knowledge (Hsu, 2015). Students act like scientists and conduct scientific investigations to gather data.

Students read information from various scientific reference sources to prepare artifacts that serve as the basis for natural science concepts. The need to create these artifacts aligns with the skills required to seek knowledge from online research results obtained from web journals on the internet, serving as a source of information (Wolmarans, 2016). The information obtained is then analyzed and discussed to collaboratively construct artifacts.

The level of students' ability to think creatively can be seen in Figure 4. After being evaluated using the Rasch model, students' ability to think creatively through test items in the SRBP learning model demonstrated very strong performance. Figure 4 illustrates the positive outcomes of learning science using the SRBP model. Ninety-five percent of students agreed that reading scientific articles increases their knowledge of science concepts. Students felt happy, and students were challenged in their creativity. They were challenged by project performance based on scientific reading. Interaction between students became more cohesive when completing projects because of their encouragement to work in groups and study together. Learning with the SRBP model was opposed by only 5% of students, who felt pressured, generally exhibiting passive characteristics and being less concerned about group togetherness. The lecturer gave a positive response to the implementation of the SRBP model. Students were very receptive to scientific reading-based projects because they were required to read and study extensively to avoid being left behind in information. Lecturers must be proficient in materials and technology. The role of the lecturer must include motivating students to read scientific articles independently. By using the SRBP model, the learning process can enhance students' ability to think creatively, increase their confidence in expressing their opinions and ideas, and increase student engagement during the learning process.

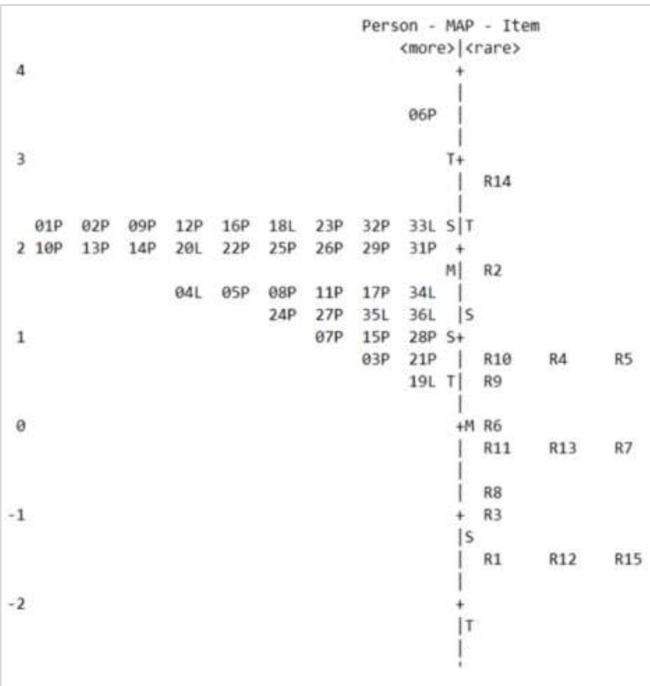

Figure 4. Students' level of creative thinking ability

According to the data from student responses on creative ability, all aspects fall into the very good category (Sumintono et al., 2015). Student response questionnaires were administered shortly after the introduction of learning using the SRBP model. Data on the results of student responses are presented in the map variable shown in Figure 4. The distribution of students is above logit 1, indicating that students are capable and active in creative thinking skills with the application of the SRBP model. Project response indicators based on readings from scientific literature were useful for understanding science concepts. Science projects in science learning were perceived as fun, encouraged the generation of new ideas, improved group work, supported project design time, and facilitated funding management to complete the project.

Conclusion

Through hands-on activities, students are directly involved in conducting experiments, making observations, and solving problems, thereby stimulating their creativity through real-life experiences. The quality of the creative results shows a diversity of products based on more innovative local potential. The practicum report shows more detail and concrete clarity in the discussion, which reflects aspects of creative thinking skills. The syntax of the SRBP model, namely 1) orientation, 2) scientific reading, 3) design and manufacture, 4) project progress, 5) analysis, and 6) discussion and communication, can stimulate creative thinking skills. The level of product creativity ability increases with each cycle as measured using the Rasch Model. It is recommended that the SRBP model be appropriately applied to learning that emphasizes project-oriented scientific reading activities.

Acknowledgments
The authors would like to thank the Institute of Research and Community Services at Universitas Sebelas Maret for the financial support Group Grant Research No: 369/UN27.22/PT.01.03/2025.

Author Contributions
For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used: "Conceptualization, data curation, methodology, resources and Instrumen, Kartika Chrysti Suryandari; writing—original draft preparation, Wahyudi; software & writing—review and editing, Murwani Dewi Wijayanti; visualization, validation & project administration, Rokhmaniyah and M. Chamdani; supervision, formal analysis & investigation, Dewi Indrapangastuti. All authors have read and agreed to the published version of the manuscript.

Funding
This research was funded by the Institute for Research and Community Service at Sebelas Maret University under Group Research Grant No: 369/UN27.22/PT.01.03/2025.

Conflicts of Interest
The authors declare no conflict of interest.

References

Abidin, J., Rohaeti, E. E., & Afrilianto, M. (2018). Analisis

Kemampuan Berfikir Kreatif Matematis Siswa Smp Kelas Viii Pada Materi Bangun Ruang. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *1*(4), 779. https://doi.org/10.22460/jpmi.v1i4.p779-784

Chrysti, K. S., Rokhmaniyah, & Chamdani, M. (2020). Enhancement of Artifact Based Activities Learning in Natural Science Through Scientific Reading Based Project (SRBP) Model for Preservice Teacher Using Design Based Research (DBR). *Proceedings of the 4th International Conference on Learning Innovation and Quality Education*, 1–5. https://doi.org/10.1145/3452144.3452210

Creswell, J., & Clark, P. V. (2011). *Designing and conducting mixed methods research*. Sage Publications.

Creswell, J. W. (2008). *Educational Research : Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. Sage Publications.

Dabbagh, N., & Williams Blijd, C. (2010). Students' Perceptions of Their Learning Experiences in an Authentic Instructional Design Context. *Interdisciplinary Journal of Problem-Based Learning*, *4*(1), 6–29. https://doi.org/10.7771/1541-5015.1092

Euler, D. (2017). Design principles as bridge between scientific knowledge production and practice design. *EDeR. Educational Design Research*, *1*(1). https://doi.org/10.15460/eder.1.1.1024

Hadzigeorgiou, Y., Fokialis, P., & Kabouropoulou, M. (2012). Thinking about Creativity in Science Education. *Creative Education*, *03*(05), 603–611. https://doi.org/10.4236/ce.2012.35089

Herrington, J., McKenney, S., Reeves, T., & Oliver, R. (2014). Summary for Policymakers. In *Climate Change 2013 – The Physical Science Basis* (Vol. 2007, Issue 2007, pp. 1–30). Cambridge University Press. https://doi.org/10.1017/CBO9781107415324.004

Holland, C., & Ulrich, D. (2016). Critical thinking cards: An innovative teaching strategy to bridge classroom knowledge with clinical decision making. *Teaching and Learning in Nursing*, *11*(3), 108–112. https://doi.org/10.1016/j.teln.2016.01.005

Hsu, Y.-S. (2015). *Development of Science Teachers' TPACK*. Springer Singapore. https://doi.org/10.1007/978-981-287-441-2

Hu, W., & Adey, P. (2002). A scientific creativity test for secondary school students. *International Journal of Science Education*, *24*(4), 389–403. https://doi.org/10.1080/09500690110098912

Isabekov, A., & Sadyrova, G. (2018). Project-Based Learning to Develop Creative Abilities in Students. In *Technical and Vocational Education and Training* (Vol. 28, pp. 43–49). https://doi.org/10.1007/978-3-319-73093-6_4

Januarti, I. M., & Muliyadi, L. (2024). Development of Ethnoscience-Based Student Worksheet Using the Guided Inquiry Learning Model to Increase Students' Learning Motivation and Scientific Literacy: A Review. *International Journal of Science Education and Science*, *1*(1), 13–18. https://doi.org/10.56566/ijses.v1i1.109

Kashani-Vahid, L., Afrooz, G., Shokoohi-Yekta, M., Kharrazi, K., & Ghobari, B. (2017). Can a creative interpersonal problem solving program improve creative thinking in gifted elementary students? *Thinking Skills and Creativity*, *24*, 175–185. https://doi.org/10.1016/j.tsc.2017.02.011

Ke, F., & Hsu, Y.-C. (2015). Mobile augmented-reality artifact creation as a component of mobile computer-supported collaborative learning. *The Internet and Higher Education*, *26*, 33–41. https://doi.org/10.1016/j.iheduc.2015.04.003

Kind, V. (2016). Preservice Science Teachers' Science Teaching Orientations and Beliefs About Science. *Science Education*, *100*(1), 122–152. https://doi.org/10.1002/sce.21194

McNew-Birren, J., & van den Kieboom, L. A. (2017). Exploring the development of core teaching practices in the context of inquiry-based science instruction: An interpretive case study. *Teaching and Teacher Education*, *66*, 74–87. https://doi.org/10.1016/j.tate.2017.04.001

Mumford, M. D. (2003). Where Have We Been, Where Are We Going? Taking Stock in Creativity Research. *Creativity Research Journal*, *15*(2–3), 107–120. https://doi.org/10.1080/10400419.2003.9651403

Pan, X., & Li, S. (2016). Dynamic optimal control of process–product innovation with learning by doing. *European Journal of Operational Research*, *248*(1), 136–145. https://doi.org/10.1016/j.ejor.2015.07.007

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A. N., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*, 47–61. https://doi.org/10.1016/j.edurev.2015.02.003

Quintana, M. G. B., & Fernández, S. M. (2015). A pedagogical model to develop teaching skills, The collaborative learning experience in the Immersive Virtual World TYMMI. *Computers in Human Behavior*, *51*, 594–603. https://doi.org/10.1016/j.chb.2015.03.016

Soyadı, B. B. Y. (2015). Creative and Critical Thinking Skills in Problem-based Learning Environments. *Journal of Gifted Education and Creativity*, *2*(2), 71–71. https://doi.org/10.18200/JGEDC.2015214253

Sumintono, B., & Widhiarso, W. (2015). *Aplikasi*

pemodelan RascH Pada Assessment Pendidikan. Trim Komunikata Publishing House.
Suryandari, K. C., Rokhmaniyah, R., & Wahyudi, W. (2021). The Effect of Scientific Reading Based Project Model in Empowering Creative Thinking Skills of Preservice Teacher in Elementary School. *European Journal of Educational Research*, *volume-10-*(volume-10-issue-3-july-2021), 1329–1340. https://doi.org/10.12973/eu-jer.10.3.1329
Suryandari, K. C., Sajidan, S., Rahardjo, S. B., Prasetyo, Z. K., & Fatimah, S. (2018). Project-Based Science Learning And Pre-Service Teachers' Science Literacy Skill And Creative Thinking. *Jurnal Cakrawala Pendidikan*, *37*(3), 345–355. https://doi.org/10.21831/cp.v38i3.17229
Susilawati, Doyan, A., Rokhmat, J., & Muliyadi, L. (2023). Analysis Validation of Modern Physics Learning Media Based on Smartphone Integrated Project Based Learning to Improve Students' Creativity and Scientific Literacy. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 7888–7892. https://doi.org/10.29303/jppipa.v9i10.5404
Syahrin, A., Dawud, Suwignyo, H., & Priyatni, E. T. (2019). Creative Thinking Patterns In Student's Scientific Works. *Eurasian Journal of Educational Research*, *19*(81), 1–16. https://doi.org/10.14689/ejer.2019.81.2
Torrance, E. P. (2012). *Torrance Tests of Creative Thinking*. PsycTESTS Dataset. https://doi.org/10.1037/t05532-000
Wolmarans, N. (2016). Inferential reasoning in design: Relations between material product and specialised disciplinary knowledge. *Design Studies*, *45*(2015), 92–115. https://doi.org/10.1016/j.destud.2015.12.003