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Validity And Practicality of The Scientific Creativity Project-Based Learning (SCPjBL) Model to Increase The Scientific Creativity of Physics Education Undergraduate Students

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ABSTRACT

Objective: Describe the validity and practicality of the SCPjBL model in terms of development needs, up-to-date knowledge, and implementation of learning and student activities. **Method:** The method in this study is a development method that has been modified and applied in universities in 2024. The sample in this study was 180 people from two different universities. Data were collected based on the validation results and observation of the implementation of the SCPjBL model. The assessment instrument uses a validation sheet that is assessed by three validators who are experts in their respective fields. The instruments used for the implementation of the model are the lesson plan and student worksheet implementation observation sheet. The observation sheet was filled in by four observers who were divided into two observers who were tasked with observing the implementation of the SCPjBL model phase and two others who observed student activities. **Results:** The results of the observations were then analyzed quantitatively. A study in the form of validation results from three validators obtained an average score of 3.92 with an average validity percentage of 98% with a very valid category. The results of the practicality of the SCPjBL model and its supporting devices obtained a score of 3.56, with an average percentage of implementation reaching 91%. **Novelty:** This research emphasizes solving physics problems by taking two approaches simultaneously. It is done by exploring students' initial knowledge as an initial check for solving complex problems presented to students in the form of scientific phenomena

INTRODUCTION

Along with the development of information technology, that changes a person's perspective in living life, such as accessing information so quickly, processing information accurately, and transferring information efficiently in various lines of life, including the world of education (Wibowo, 2023a). To prepare someone who is able to adapt to advances in science and technology in the era of the Industrial Revolution 4.0, an education system is needed that prepares an educator to quickly adapt to these advances (Andres & Rosalinda, 2023). A person who easily adapts to advances in science and information technology has critical thinking skills in problem-solving and creative thinking in innovation, collaboration, and communication well (Rosidin et al., 2019).

One of the 21st-century skills is creativity and innovation. One of the factors that encourages someone to innovate is having adequate knowledge, because the ideas that emerge must be adjusted to the basis of knowledge, theoretically and empirically (Santyasa et al., 2020). Scientific knowledge can be developed by studying material that contains concepts, facts, and laws (Cheli et al., 2023). With this scientific knowledge, students can analyze and evaluate the findings obtained during scientific investigations. Scientific knowledge can be obtained through discussion and sharing ideas with both teachers and fellow students. Scientific knowledge is essential in physics learning because it is a basis for understanding complex physics concepts (Faize, 2020). With scientific knowledge, students can understand the basics of physics, such as Newton's laws, quantum mechanics theory, relativity, and so on (Hamilton et al., 2021). In addition to functioning as a basis for knowledge, scientific knowledge is also a foundation for seeing the relationship between theory and practical results (Taibu et al., 2021). This allows students to apply it in various daily life activities, such as completing projects and practicums related to physics material (Buck-Pavlick, 2022).

Physics learning that encourages students to innovate includes learning packaged with projects. Project-based learning is oriented toward students as the center of learning (Sidek et al., 2020). Students are the main drivers of completing project assignments; lecturers, in this case, are facilitators and motivators in completing their assignments (Irma et al., 2023; Stamer et al., 2021). Student involvement in projects provides meaningful experiences in the learning process (Saepudin, 2020). In the context of learning in the industrial era 4.0, project-based learning is very relevant in developing student creativity and innovation. The relevance of learning with project-based learning includes encouraging students to collaborate and communicate, where students work together in teams to complete projects so that they can improve their ability to work together and communicate effectively (Ariandani et al., 2020; Sulisworo, 2020)

The project-based learning model involves students designing project assignments, making students the center of task completion, emphasizing collaborative systems, and investigating real and challenging problems. The syntax of the PjBL model is: 1) starting with essential questions, 2) planning project assignments, 3) making a schedule, 4) monitoring project assignments, 5) assessing results, and 6) evaluating experiences. Based on the characteristics and syntax of the PjBL model, learning will be more meaningful if integrated with scientific knowledge; students can apply the physics concepts that they have studied in depth to real tasks (Sulisworo, 2020)

In reality, Indonesian students still have not mastered 21st-century skills, especially in scientific creativity, this can be seen from the results of PISA in 2018 and 2022, where the results show that the abilities of Indonesian students are still at level 2 with a score of 396 out of a maximum score of 600, while scientific creativity requires level 4 abilities (PISA, 2023). In addition, the results of preliminary research conducted by researchers in 2023 found that the creativity of undergraduate Physics Education students was relatively low in most aspects of scientific creativity, including in exploring knowledge through scientific phenomena (Jedaman, 2021; Şenel, 2018). Even though Physics Education students are prospective physics teachers who will later teach, guide, and direct students to master all 21st-century skills to be competitive.

Several researchers tried to overcome the problem of low scientific creativity among students. Research conducted by Dwikoranto et al. (2021), Nilada et al. (2024), and Yamin et al. (2020). From these studies, students' scientific creativity can be increased by developing learning models and approaches that contain syntax that can overcome model limitations and increase student creativity from several aspects. However, in these studies, there has yet to be a continuous study of aspects of students' mastery of physics material before the students solve real problems. Then, from the study, there is also no way to stimulate students' creative thinking with the Scamper thinking technique and listening attributes. In fact, the stimulus is the first step in generating students' creative ideas (Astutik & Prahani, 2018; Zainuddin et al., 2020). The solution to this problem is that researchers want to conduct research by developing a learning model that can overcome the limitations of previous studies. The learning model developed is a project-based learning model that is enhanced with the scientific creativity model, referred to as scientific creativity project-based Learning (SCPjBL).

This research is supported by previous research, which shows that prior knowledge can help students solve problems, especially those related to project-based learning, can improve their ability to think systematically and structure, improve their ability to make products technically, and ultimately can solve problems with scientific reasons in every activity they do. The results of previous studies also show that knowledge exploration activities in learning can provide students with opportunities to review the knowledge that has been learned, explore the depth of knowledge, and allow students to step back to review the entire learning process and recognize the value of knowledge holistically (Guasch et al., 2020). By starting from a scientific phenomenon around us or our environment, we can indirectly build new knowledge from an experience or event, even from an anomaly currently occurring as an addition to the treasure trove of knowledge (Faize, 2020). Thus, scientific phenomena are the first step in exploring scientific knowledge.

The novelty of this research is that it emphasizes the process of solving physics problems by taking two approaches at once. First, it is done by exploring students' initial knowledge as an initial check to systematically solve complex problems presented to students in the form of scientific phenomena. The knowledge obtained then becomes students' initial knowledge used to answer scientific phenomena and implemented in designing and designing an innovative product (Sukma et al., 2023; Sumo et al., 2024). Then, the product is tested to be feasible (valid and practical) for use in the ongoing learning process (Cirkony, 2023).

Second, by collaborating between students and lecturers in applying creative thinking techniques when designing products. This collaboration aims to build an attitude of mutual empathy and responsibility for the project tasks being worked on. Collaboration in scientific assignments is one way to improve creative thinking skills because there is a process of exchanging ideas to solve complex and scientific problems. Collaboration is the first step in producing creative ideas and innovative products to implement the creative idea (Arend, 2012). From the collaboration results, meaningful experience will be gained to produce creative ideas (Nilada et al., 2024; Suradika, 2023). This study aimed to determine the validity and practicality of the SCPjBL model in improving the scientific creativity of undergraduate students of Physics Education.

RESEARCH METHOD

This research was conducted at two universities in East Java, Madura Islamic University and Trunojoyo University of Madura, in 2024 in the basic physics course 1. This research emphasizes the validity and practicality analysis of the SCPjBL model integrated with Scientific Creativity to improve the scientific creativity of undergraduate Physics Education students. The analysis of the validity and practicality of the SCPjBL model was carried out by calculating the average score of the validity and implementation of learning with the SCPjBL model integrated with scientific creativity at each stage. The sample in this study was 180 undergraduate Physics Education students. The research flow can be seen in Figure 1.

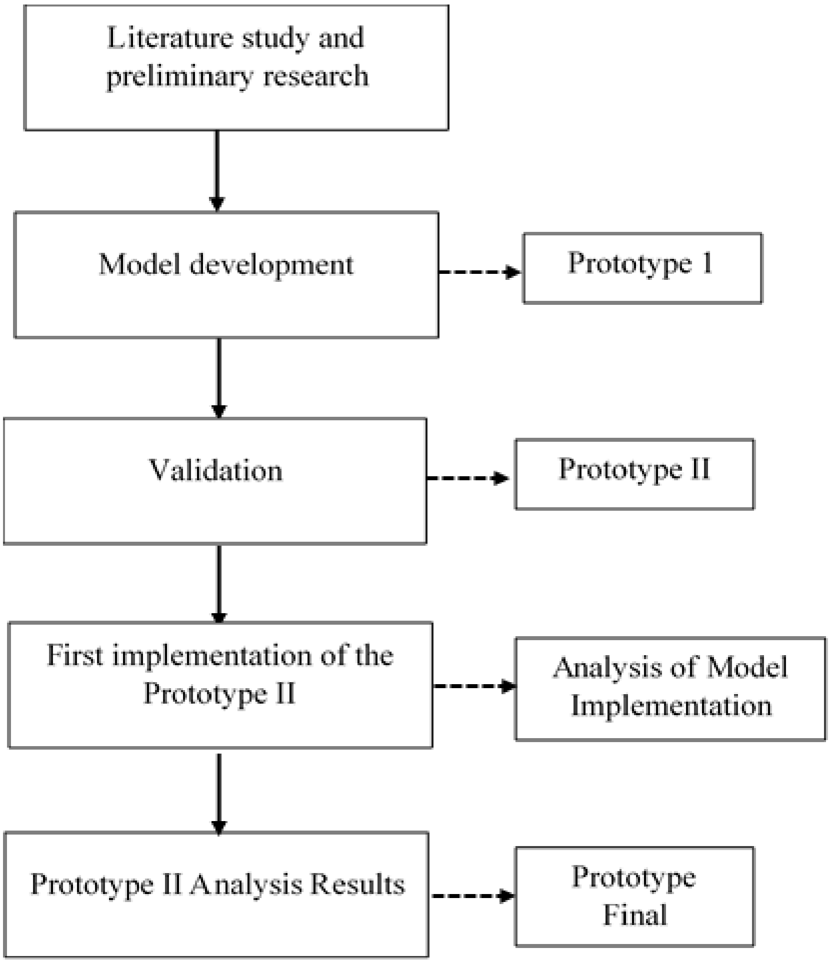

Figure 1. Research flow for model development.

The instruments in this study were the validation sheet of the physics learning model and tools, the implementation assessment sheet of the SCPjBL model, and the student response questionnaire. Three experts in their respective fields validated all of these tools. The validated tools include a lesson plan, Book Model, Student textbook, Student response questionnaire, Student worksheet, and Scientific Creativity test sheet. The collected data were then analyzed to determine the level of validity and reliability of the learning device. The results of the analysis were then interpreted according to Table 1.

Table 1. Criteria for assessing the validity of the SCPjBL Model

Score Interval	Assessment criteria	Information
$3.25 \leq P < 4.00$	Very valid	It can be used without revision
$2.50 \leq P < 3.25$	Valid	It can be used with minor revisions
$1.75 \leq P < 2.50$	less valid	It can be used with multiple revisions
$1.00 \leq P < 1.75$	Not valid	It is not yet usable and requires consultation

The validity criteria of the learning device are also used to find the reliability value (r), and then all data are calculated using SPSS 25. The results of the calculation of the validity and reliability of the learning device are compared with the r table. The invalid learning device is then revised according to the suggestions of the three experts. After being revised, it is then applied in the learning process. The calculation of the reliability of the validation instrument of the SCPjBL model and learning device is based on the interobserver agreement obtained from the statistical analysis of the percentage of agreement (R) presented below (Borich, 1994).

$$R = \left[1 - \frac{A - B}{A + B}\right] \times 100\%$$

The SCPjBL model and learning device's validation instrument are reliable if their percentage is≥75.00%. The calculation of the reliability of the SCPjBL model validation sheet instrument is strengthened by using Cronbach's Alpha analysis (Fraenkel, 2012)—the interval of the Cronbach's Alpha reliability criteria in Table 2.

Table 2. Cronbach's alpha reliability interval.

Cronbach's Alpha (α) interval	Assessment criteria
$0.90 \leq \alpha \leq 1.00$	Very high
$0.70 \leq \alpha < 0.90$	High
$0.50 \leq \alpha < 0.70$	Moderate
$\alpha < 0.50$	Low

The practicality of the SCPjBL model is seen in the implementation of the model and student activities towards the learning process using the SCPjBL model. The implementation of the model and the implementation of student worksheets are obtained from the results of observations by two observers to observe the implementation of the model and the implementation of student worksheets carried out by two observers using the implementation observation sheet and the constraint sheet. Then, the results are analyzed using the formula:

$$Score = \frac{Score\ obtained}{Maximum\ score} \times 4$$

After being analyzed and obtaining the results of the model implementation and student worksheet implementation scores, they are then interpreted into the criteria according to Table 3.

Table 3. Practicality criteria of the SCPjBL model.

Score	Category
$3.25 \leq P < 4.00$	Very practical
$2.50 \leq P < 3.25$	Practical
$1.75 \leq P < 2.50$	Practical enough
$1.00 \leq P < 1.75$	Less Practical

Adapted from Astutik & Prahani, (2018)

RESULTS AND DISCUSSION

Results

The results of this study are valid and reliable SCPjBL model learning devices. The revisions from the three validators are in the form of suggestions and improvements.

Researchers use these suggestions and improvements as a reference to improve the learning devices so that they reach at least the valid and reliable categories. The results of the suggestions and improvements to the SCPjBL model learning devices by the three validators are presented in Table 4.

Table 4. Suggestions and improvements to the SCPjBL model.

No	Suggestions Analysis results from three experts	Recommendations
1	The goals of the SCPjBL model are outlined against both instructional goals and sender impact goals.	The objectives in the SCPjBL model have been divided into two categories: instructional objectives, which were included in the research, and companion impact objectives, which were not examined in this research.
2	It is recommended that phase 1 of the SCPjBL model syntax be able to explore student knowledge	Phase 1 of the SCPjBL syntax has been improved by exploring students' knowledge and thinking through scientific phenomena
3	In the syntax of the SCPjBL Model, it is best to write down the objectives to be achieved for each phase	Each phase in the SCPjBL model syntax has written objectives to be achieved
4	Phase 1 is changed according to previous input.	In phase 1, "presenting examples of creative products" was initially changed to "creative knowledge exploration."
5.	CPL and CPMK in RPS basic physics1 with the SCPjBL Model are formulated with operational verbs in accordance with the objectives of the model	The CPL and CPMK RPS have been improved with the SCPjBL model, which is more operational and accessible to understand
6	Student Textbook plus Glossary and Index	The design has been supplemented with a Glossary and Index
7	For scientific creativity tests, the images or phenomena presented should not be the same as in textbooks, so the impression is not like memorizing	The images in the Scientific Creativity Test have been changed to fit the same context.

The suggestions in Table 4 were used to improve the SCPjBL model and learning tools. After being improved, it was assessed by three validators who were experts in their respective fields. The results of the average calculation of the assessment by the three validators are presented in Table 5.

Table 5. Results of the validity assessment of the SCPjBL model, learning tools, and response questionnaires

Rated aspect	Validity Assessment	
	Average Score	category
SCPjBL Model: Model Development Needs	3.92	Very Valid
The latest scientific knowledge	3.83	Very Valid

Rated aspect	**Validity Assessment**	
	Average Score	category
Learning tools: Content suitability	3.67	Very Valid
Use of language	3.92	Very Valid
Device design	4.00	Very Valid
Completeness of required information	4.00	Very Valid
Response questionnaire:		
New learning models	4.00	Very Valid
Clarity of lecturers in teaching with the SCPjBL model	3.83	Very Valid
Ease of understanding lessons	4.00	Very Valid
Completeness of test instructions	4.00	Very Valid

Table 5 shows the validation results. The reliability coefficient, d, is then calculated, and the calculation results are shown in Table 6.

Table 6. Reliability results of the SCPjBL model.

Aspect	$\mathbf{R}_{count}$	$\mathbf{R}$ $_{table\ (0,05)}$	**Category**
SCPjBL model	0.99	0.98	Reliable
Learning tools	0.95	0.94	Reliable
Student response questionnaire	0.99	0.98	Reliable

After calculating the reliability of the model, learning tools, and student response questionnaires, a Cronbach's Alpha statistical test was conducted to strengthen the results in Tables 5 and 6. The results of Cronbach's Alpha statistical test, which had ten assessment items, obtained a score of 0.85, which was more significant than 0.05. Thus, the SCPjBL learning model, tools, and response questionnaires based on the development needs and the sophistication of science are categorized as very reliable. The percentage of the validity results of the model, learning tools, and student response questionnaires to the SCPjBL model is presented in Figure 1.

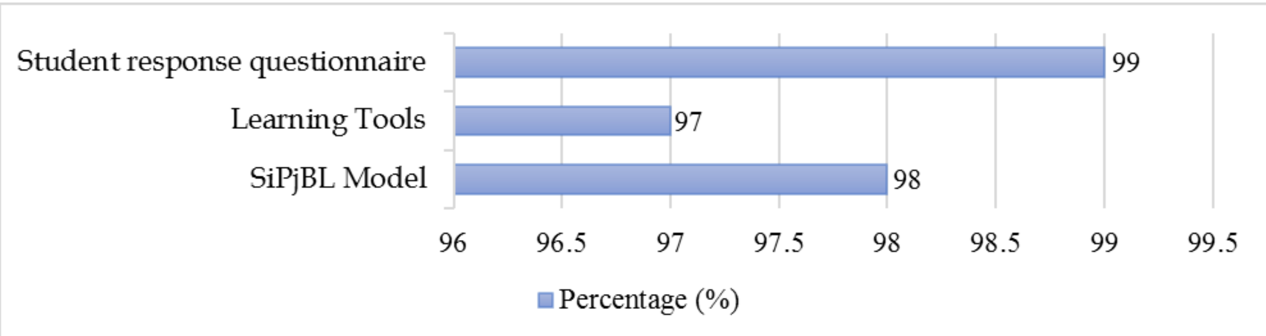

Figure 2. Percentage validity of the model, learning tools, and response questionnaires.

Based on Figure 2, the percentage of the SCPjBL learning model reviewed from the content and construction aspects meets the needs of development and scientific knowledge updates by 98.00% in the very valid category. While the learning tools that support the SCPjBL model were reviewed from the language, suitability of content, design, and completeness of information were 97.00% in the very valid and reliable category. The results of the student response questionnaire on the learning process with the SCPjBL model reviewed from the aspect of the model's novelty, the clarity of the lecturer teaching, and the ease of students doing the test are 99.00% in the very valid and reliable category.

Tables 7 and 8 show the practicality of the SCPjBL model in improving students' scientific creativity based on its implementation in each phase.

Table 7. Results observations of the implementation of the lesson plan models of SCPjBL

Phase	Observer 1	Category	Observer 2	Category
Starting with a scientific phenomenon	3.80	Very good	3.50	Very good
Planning a physics project assignment	3.90	Very good	3.00	Good
Exploration of scientific knowledge	4.00	Very good	3.80	Very good
Designing and planning project tasks	3.67	Very good	3.50	Very good
Monitor project tasks	4.00	Very good	3.55	Very good
Assessing the results	3.50	Very good	3.80	Very good
Evaluating experience	3.67	Very good	3.67	Very good
Average	**3.79**	**Very Practical**	**3.54**	**Very Practical**

Meanwhile, the results of student activities based on the student worksheets can be seen in Table 8.

Table 8. Results of observations of student activities in the student worksheet SCPjBL model.

Phase	Observer 1	Category	Observer 2	Category
Scientific phenomena	3.40	Very good	3.25	Very good
Scientific Knowledge	4.00	Very good	3.80	Very good
Problem-solving ability	3.67	Very good	3.40	Very good
Creative design product ability	3.70	Very good	3.60	Very good
Technical product	3.52	Very good	3.67	Very good
Product analysis	3.80	Very good	3.50	Very good
Conclusion	4.00	Very good	3.80	Very good
Average	**3.72**	**Very Practical**	**3.58**	**Very Practical**

Based on Table 7 and Table 8. The practicality of the SCPjBL model reviewed from the model implementation in each phase of the model syntax reached 3.79 from observer 1. In contrast, the second observer scored 3.54, with a very practical category. While the results of student activities are based on performance on the Student Worksheet. The observations made by Observer 1 obtained a score of 3.72 in the convenient category, and the observations from Observer 2 reached a score of 3.58 in the very practical category.

Discussion

Based on the validation results from three validators as listed in Table 5, all are categorized as valid with the following details: The validation results of the SCPjBL model got an average score of 3.87 both in terms of content validity and construct validity so that the percentage of model validity reached 98.00% in the very valid category. The validation results of the supporting learning devices for the SCPjBL model got an average score of 3.89, with a percentage of learning device validity reaching 97.00%. The results of the validity of the student response questionnaire to the learning process with the SCPjBL model got an average score of 3.96 with a percentage of validity reaching 99.00% in the very valid category. Learning must adapt to the development of science and development needs. This opinion is also reinforced by (Siagian et al., 2023). who stated that a successful learning process can increase students' interest in the material.

The validation results of the learning device, including lesson plan, student worksheet, observation sheets, test assessment sheets, and student response questionnaires, have met the eligibility, namely very valid with a score of 3.67 in the content aspect of the learning device, this score is the average score of the assessment results by three validators. In this aspect, there are shortcomings, namely, the contents of the lesson plan in the learning indicators and competencies components still need to be by the objectives of developing the model; based on input from the validator, the lesson plan was then improved. This is in accordance with the opinion of (Ismail et al., 2020). Which states that the preparation of a good learning plan will impact a more effective learning process. Furthermore, the language use component received an average score of 3.92, a very valid category. In this aspect, there are suggestions for improvement from the validator regarding writing sentences that must be adjusted to the improved spelling. Language is an essential aspect of interaction and a means of communication so that it is easy to understand and information is conveyed well (Wicaksono, 2020).

The results of the validation of the student response questionnaire on the learning process with the SCPjBL model got an average score of 3.95 with a very valid category, meaning that the questionnaire that will be given to students after the learning process with the SCPjBL model has met the validity criteria, namely very valid with a validity rate percentage reaching 99.00%. However, there is still input from the third validator, namely the component of the clarity of the teaching lecturer, which should be clarified so that it is easy for students to understand the statement's meaning. This is the opinion put forward by Chin and Siew (2015). Which states that the delivery of sentences that need to be corrected will cause errors in interpreting the sentence. The data from the model's validity, learning devices, and student response questionnaires were then calculated for their reliability level using the Cronbach's Alpha statistical test. The results were 0.85, with a very reliable category. This means that the model, learning devices, and student response questionnaires are consistent in their validity levels. Instruments with consistent validity will be a characteristic of learning devices that are suitable for use in the learning process.

Based on the results of practical observations carried out by two observers, the implementation of the learning process is shown in Table 7. The SCPjBL model is categorized as very practical with a score from observer 1 reaching 3.79 and from observer 2 getting a score of 3.54 with a convenient category with a percentage of implementation of the SCPjBL model reaching 91%. This indicates that physics learning using the SCPjBL model will be more effective in increasing students' scientific creativity; this can also be seen based on the implementation of each phase of the SCPjBL model. The SCPjBL learning model can please students in learning activities. Learning models that are packaged with authentic learning can help students and lecturers solve problems in a fun way (Prahani et al., 2021). The same statement was also put forward by Arend (2012), who stated that authentic learning is meaningful learning and increases students' learning motivation. The results of this study are also supported by the results of previous studies conducted by Sidek et al. (2020), Suyidno et al. (2018), and Wibowo (2023a), which stated that a good learning model is a learning model that increases students' effort in learning, this can be obtained from the interaction process between students and lecturers through a learning process that provides new experiences for students.

Based on the results of observations of the implementation of each phase of the SCPjBL model, we can see that in the knowledge exploration phase, the first observer gave an implementation score of 4.00 with a very good category. The second observer scored 3.80, which is a very good category. Based on the results of the implementation of knowledge exploration, the scores from the other phases of the SCPjBL model are also in the very good category. This indicates that students who master good initial knowledge will positively impact the process of subsequent learning activities so that they can solve scientific problems well. Good initial knowledge will be the main capital in achieving learning goals and consistently increasing students' scientific creativity (Cirkony, 2023; Sukma et al., 2023). Other opinions also state that students' scientific creativity will be good if they master good initial knowledge.

The practicality of the SCPjBL model was reviewed from student activities during the scientific investigation process, as shown in Table 7. Based on the results of observations of the scientific investigation process from observer 1, an average score of 3.72 was obtained. From observer 2, a score of 3.58 was obtained in the very practical category, with a practicality percentage reaching 91.00%. Student activities in writing scientific knowledge scored 4.00 and 3.80 in the practical category. This score is high because students have mastered initial knowledge at the stage of deepening physics material through the scientific knowledge exploration phase. Scientific investigations will be successful if students already know the methods and concepts of physics well (Dwikoranto et al., 2021). According to Sujarwanto et al. (2022), the level of student literacy in scientific knowledge will positively impact the problem-solving process. This opinion is also reinforced by Sumarni and Kadarwati (2020), who state that scientific product designs based on sound scientific project assignments will provide new experiences for students in the learning process. Based on the explanation above, scientific investigations are feasible and practical.

The obstacles in implementing learning with the SCPjBL model are related to technical problems such as insufficient time during scientific investigations, student discipline yet to reach 100.00% discipline fully, and limited space during the learning process. These obstacles will be fixed as input from the learning process results with the SCPjBL model to be fixed in further research.

CONCLUSION

Fundamental Findings: Based on the results of the SCPjBL model development research reviewed from the validity and practicality aspects, the SCPjBL model and its supporting devices are categorized as valid and reliable. As for its practicality, the SCPjBL model is very practical for improving students' scientific creativity. Based on the results of observations of the practicality of the SCPjBL model, an average percentage of 91% was obtained with an average score of the SCPjBL model's practicality of 3.66 in the very practical category. This study was limited to undergraduate physics education students who took fundamental Physics 1 courses, and this study was only conducted at two universities in East Java. so based on the limitations of this research with the SCPjBL model, further research needs to be conducted on a broader scale. **Implication:** The application of the SCPjBL learning model is valid and practical, so it impacts increasing students' scientific creativity. Scientific creativity positively impacts solving problems in everyday life in a scientific and systematic way. **Limitation**: The limitations of this research lie in 1) research on the development of the SCPjBL model is limited to validation and practicality of the SCPjBL model, 2) The research was conducted at two regional universities, namely tertiary institutions in Madura, 3) this research is only limited to students in the age range 19 to 21 years. **Future Research:** Further research is needed to optimize the SCPjBL learning model with a broader research area and more varied material to maintain the level of effectiveness of the SCPjBL model.

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