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VALIDITY OF THE SCIENTIFIC CREATIVITY PROJECT BASED LEARNING (SiPjBL) MODEL IN PHYSICS LEARNING TO INCREASE THE SCIENTIFIC CREATIVITY OF PHYSICS EDUCATION UNDERGRADUATE STUDENTS IN INTRODUCTORY PHYSICS COURSES 1

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Abstract

This study aims to describe the validity of the SiPjBL model developed from the PjBL model based on the development needs and the sophistication of science. The method in this study is the development method of Borg and Gall, which is modified according to the needs of model development. The data collection technique is carried out using the model validation method. This research instrument uses a model validation sheet. The validation sheet contains statements that refer to aspects of development needs and aspects of the sophistication of science. Three validators then fill in the validation sheet according to their respective fields of expertise. Data analysis is carried out quantitatively descriptively by calculating the score on each component of each aspect of the model. The validation results by three validators obtained an average score of 3.92 with a very valid category, and the percentage of the feasibility of the SiPjBL model reached 97%. Thus, the SiPjBL model is feasible to implement in higher education's learning process.

Keywords: validity, SiPjBL model, scientific creativity.

INTRODUCTION

Along with advances in science and technology, educators must be able to adapt and compete in creating learning innovations to solve problems, create new things, and make life easier. This aligns with the objectives of the Industrial Revolution 4.0 (Rahayu et al., 2022; Wibowo, 2023). With the advent of this era, humans are required to have various skills to produce various scientific and technological innovation products, especially in the world of education (Andres & Rosalinda, 2023). For individuals who are not creative, the complexity and diversity of problems resulting from scientific and technological innovation can become obstacles and threats to their survival (Suradika., Dwi., 2023). However, for creative individuals, each of these problems can inspire creative ideas for success in life and career. The development of scientific creativity is an alternative to facing the rapid development of science and technology in formal and non-formal institutions or on a local and global scale (Maharani Putri Kumalasani & Kusumaningtyas, 2022). The development of scientific creativity can start from within the classroom when we teach (Mukhopadhyay, 2013; Ayas et al., 2014). The products of scientific creativity can be ideas or real work (Sidek et al., 2020). The product of scientific creativity, whether in the form of technology or creative ideas, turns out to be a double-edged sword. Technology can lead to benefits or destruction or positive benefits for life; this depends on each individual's personality. Technological development must be accompanied by human development; humans have an essential role in directing technology or are holders of total authority over technological obstacles. Developing people will make it easier to welcome society 5.0 (Andayani, 2020).

Scientific creativity is one part of 21st-century skills known as the 4 C skills (Critical thinking, Creative thinking, Communication, and Collaboration) (Wahyuni & Rahayu, 2021). Among all the competencies mentioned, creative thinking is a core part of scientific creativity (Cirkony, 2023). Thinking creatively plays a vital role in learning, especially in physics learning, because this helps students analyze and solve problems related to scientific phenomena scientifically (Hu & Adey, 2010). Scientific creativity in the context of physics learning involves students' ability to analyze scientific phenomena, build in-depth scientific knowledge, solve scientific problems, the ability to think creatively, improve the ability to design products, and improve the technical quality of products. With several aspects of scientific creativity, students can better understand and apply physics concepts to the real world (Hu & Adey, 2002).

However, the research results show that students' scientific creativity is still relatively low. On a national scale, the low level of scientific creativity is shown by the 2018 and 2022 P.I.S.A. results as well as the O.E.C.D. report, which shows that Indonesian students' mastery of science is in the understanding level category (PISA, 2023; Pusat Penilaian Pendidikan Balitbang Kemendikbud, 2019). To master scientific creativity, students must at least be at the analytical level. Apart from that, preliminary research results from 2022 to 2023 were on 30 physics education students at the Islamic University of Madura (UIM) Pamekasan, with results as shown in Figure 1.

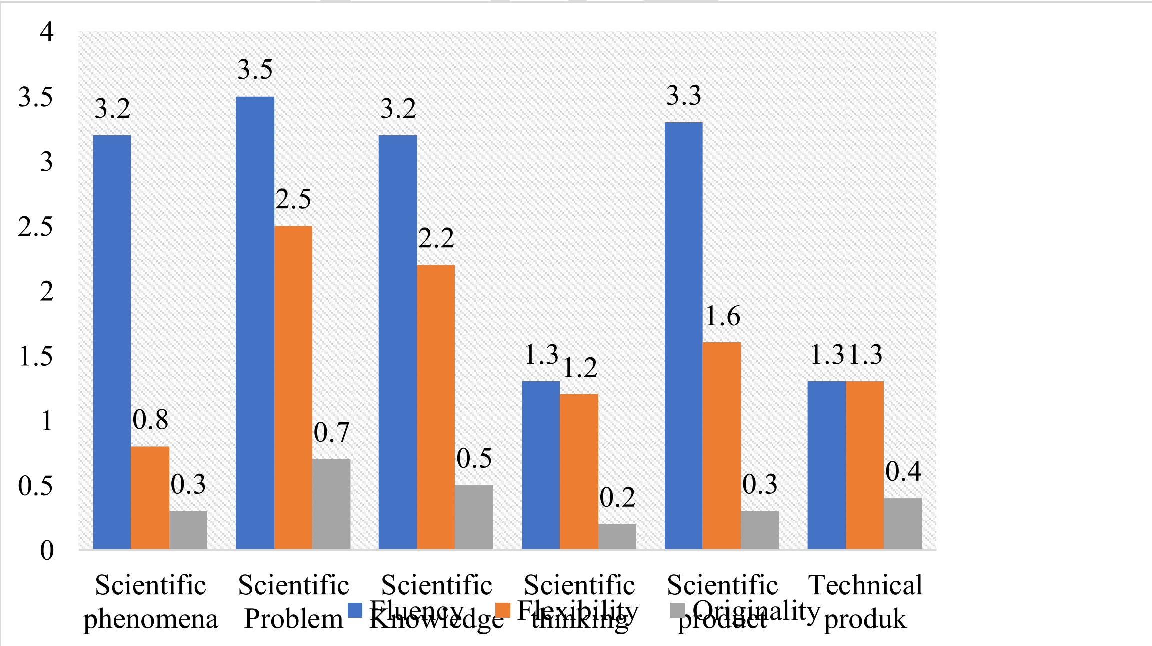

Figure 1. Initial research results diagram

Based on the preliminary research results above, the indicators of scientific creativity, especially flexibility and originality, are relatively low, with an average score of 9.1 and 2.0 from a maximum score of 4.0, equivalent to 100 if converted into tens. This research's results align with the study conducted by P.I.S.A., which was previously explained.

Previous researchers have made several efforts, such as those conducted by Prahani et al., (2021) and Suyidno et al., (2018) However, there are still limitations, including that students have not been taught how important it is to master knowledge before solving problems and the importance of management—the time during the scientific investigation. Based on the results of the study, experts have agreed upon the importance of knowledge that students must master, including Arend, (2012), Moreno, (2010), and Slavin, (2015). Several experts recommend a meaningful learning process, while a meaningful and authentic learning process can be built from the learning model used. In this research, we develop a learning model as a solution to the problem of students' low scientific creativity. The learning model developed is a project-based learning model that is enhanced with the scientific creativity model, called scientific creativity project-based Learning (SiPjBL).

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, can improve their ability to make products technically, and ultimately can solve problems with scientific reasons for every activity they do. This research aims to produce a valid and reliable SiPJBL model learning tool.

METHOD

This research was conducted on undergraduate physics education students at universities in East Java, Indonesia. The research sample was 90 students taking introductory physics courses. The development of the SiPjBL model is based on adopting the development model of Borg & Gall, (1983). The development flow is as in Figure 2.

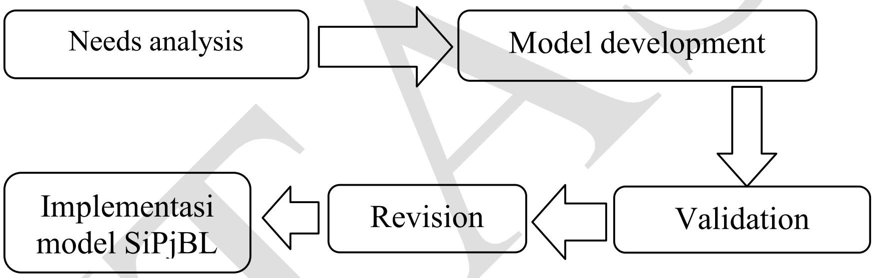

Figure 2. SiPjBL model development flow

Based on Figure 2 above, before being developed, the SiPjBL learning model first carried out a learning needs analysis. This was done to discover the strengths of creating the model and the learning tools that accompanied the model. After obtaining data from the needs analysis, a PjBL model was studied to find its limitations. After the survey, the model syntax and learning tools that support the model are developed after the study. The model and learning tools, including model books, are validated in the final stage. In the final stage, a learning model is implemented to increase the scientific creativity of physics education students.

The instruments to validate the SiPjBL model are model validation sheets and learning tools. The feasibility of the model and learning tools was assessed by three validators who are experts in physics learning and learning tool development. The validity assessment of learning models and tools uses a scale range of 1 to 4 with minimum valid criteria at a score of 2.5 from a maximum score of 4.0. The data analysis technique in this research is collecting model validation data and supporting devices. After validation, the data is analyzed by calculating the score obtained using the formula:

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

The results of the validation score calculation are then adjusted to the validity score criteria as in Table 1.

Table 1. Data validity criteria

Score Intervals	Assessment criteria
3,25 - 4,00	Very valid
2,50 - 3,25	Valid
1,75 - 2,50	Poor Valid
1,00 - 1,75	Not valid

Adapted from Sumo et al., (2024)

A learning device's reliability is valid if the reliability value reaches a minimum of 60% (Prahani et al., 2021). After obtaining data on the validity of the model and supporting devices, the reliability percentage is calculated using the formula:

$$R= (1-(A-B)/(A+B)) \times 100\%$$

Information:
R: Percentage of instrument reliability
A: Highest score
B: Lowest score

RESULTS

The results of this research are a valid and reliable SiPjBL model learning tool. The results of the revisions from the three validators are in the form of suggestions and improvements. These suggestions and improvements are used as a reference for researchers to improve learning tools to reach a minimum valid and reliable category. The results of suggestions and improvements to the SiPjBL model learning tools by the three validators are presented in Table 2.

Table 2. Suggestions and Improvements to the SiPjBL model

No	Suggestions Analysis results from three experts	Repair
1	The goals of the SiPjBL model are outlined against both instructional goals and sender impact goals.	The objectives in the SiPjBL model have been described into two objectives, namely 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 SiPjBL model syntax be able to explore student knowledge	Phase 1 of the SiPjBL syntax has been improved by exploring students' knowledge and thinking through scientific phenomena
3	In the syntax of the SiPjBL Model, it is best to write down the objectives to be achieved for each phase	Each phase in the SiPjBL model syntax has written objectives to be achieved
4	Phase 1 is changed according to previous input.	In phase 1, initially "presenting examples of creative products" was changed to "creative knowledge exploration".
5.	CPL and CPMK in RPS basic physics1 with the SiPjBL Model are formulated with operational verbs in accordance with the objectives of the model	The CPL and CPMK RPS have been improved with the SiPjBL model, which is moreoperational and easy 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 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 2 are used to improve the SiPjBL model learning tools. Once corrected, it is then assessed by three operating validators. The results of the assessment by three validators are as in Table 3.

Table 3. Results of the SiPjBL Model Validity Assessment

Rated aspect	Validity Assessment	
	Average Score	category
SiPjBL Model: Model Development Needs	3,92	Very Valid
The latest scientific knowledge	3,83	Very Valid
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 SiPjBL model	3.83	Very Valid
Ease of understanding lessons	4.00	Very Valid
Completeness of test instructions	4.00	Very Valid

The validation results are in Table 3. Then the reliability coefficient is calculated and the calculation results can be seen in Table 4 and Table 5.

Table 4. Learning device reliability results

Aspect	R_{count}	$R_{table\ (0,05)}$	Category
Model Development Needs	.999	.997	Valid
Model Development Updates	.998	.998	Valid

Table 5. Results of reliability statistical calculations

Cronbach's Alpha	N of items
.857	10

Based on the results of the validity analysis of learning tools in Table 5. Learning tools in terms of model development are very valid. Meanwhile, the sophistication of learning tools with the SiPjBL model is also very valid. The results of calculating the reliability of learning devices are as follows: R calculated .999, and R table .997, where R calculated is greater than the table. This indicates that the SiPjBL learning model has proven to be up-to-date in meeting model development needs. This is confirmed by the results of statistical tests on the model's reliability by obtaining a Cronbach's Alpha score of .857, more significant than .05. This indicates that the SiPjBL model is feasible and reliable.

DISCUSSION and CONCLUSIONS

Based on the validation results from three validators, the SiPjBL model seen from the content and construct aspects has met aspects of development needs, while the average score is 3.92 with very valid criteria. Meanwhile, the model's sophistication aspect has fulfilled the validity aspect with an average score of 3.83 in the very valid category. Based on this data, all aspects of the SiPjBL model are categorized as very valid with a validity percentage of 97%, so it is very feasible. This is the opinion expressed by (Wicaksono, 2020) that scientific creativity cannot just appear, so the role of lecturers here is very much needed in class management and designing the learning process.

Meanwhile, the reliability of the model and supporting devices is categorized as reliable and valid; this can be seen from the results of the R count, which is greater than or equal to the R table. This result is strengthened by the results of statistical tests, which obtained a Cronbach's Alpha value of

0.857, which is greater than .05. This means that the SiPjBL model is suitable both in content and construct to be implemented in the physics learning process to increase scientific creativity. This is the opinion of Arend, (2012) and Moreno, (2021), Which states that valid and reliable learning instruments or tools will make it easier for lecturers to practice so that they positively impact improving students' high-level thinking. This opinion is in line with (Plomp & Nieveen, 2010) who stated that instruments that meet the validity aspect will always make it easier for teachers to carry out the task of the learning process in the classroom.

Conclusions

Based on the results of research on the validity of the SiPjBL model in increasing the scientific creativity of undergraduate students in physics education, the SiPjBL model developed from the PjBL model has fulfilled valid aspects. With a validity score reaching 97%, it is very valid. This can be seen from content validity and construct validity. Together, this development research only reaches the validity of the model that has been developed; therefore, it is necessary to test the level of practicality and effectiveness of this SiPjBL model.

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