Journal of Educational Analytics (JEDA)
Vol. 3, No. 4, 2024 : 559 - 570

Validity of the Scientific Creativity Project Based Learning (SiPjBL) Model in physics learning to increase the scientific creativity of physics education undergraduate students in basic physics courses 1

Maimon Sumo[1*], Budi Jatmiko[2], Zainul Arifin Imam Supardi[3]
[1]Universitas Islam Madura, Indonesia
[1,2,3]Universitas Negeri Surabaya, Indonesia
Corresponding Author: Maimon Sumo maimonshadiyanto@gmail.com

A R T I C L E I N F O

Keywords: Validity, Sipjbl Model, Scientific Creativity

Received : 14, October
Revised : 26, October
Accepted: 25, November

©2024 Sumo, Jatmiko, Supardi : This is an open-access article distributed under the termsof the Creative Commons Atribusi 4.0 Internasional.

A B S T R A C T

This research aims to describe the validity of the SiPjBL model reviewed from the aspects of model development needs and knowledge updates. The method used is development. The data collection technique is carried out by model validation and the research instrument is a model validation sheet containing statements referring to aspects of development needs and knowledge updates. Data analysis is carried out quantitatively by calculating the score on each component of each aspect of the model. The results of the study obtained an average score of 3.92 with a very valid category and the percentage of feasibility of the SiPjBL model reached 97%. Thus, the SiPjBL model is feasible to be implemented in the learning process in higher education.

DOI prefik: https://doi.org/10.55927/jeda.v3i4.11266
ISSN-E: 2830 - 0432
https://journal.formosapublisher.org/index.php/jeda

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 is in line 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 as a result of scientific and technological innovation can become obstacles and threats to their survival (Suradika., Dwi., 2023). However, for creative individuals, each of these problems can be an inspiration in generating 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 both 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 in the form of 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 the personality of each individual. Technological development must be accompanied by human development, humans have an important role in directing technology or as holders of full authority over technological obstacles. By developing people, it will be 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). The ability to think creatively plays an important 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 physics concepts, 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 PISA results as well as the OECD 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, the results of preliminary research conducted by researchers from 2022 to 2023 were on 30 physics education students at the Islamic University of Madura (UIM) Pamekasan with results as in Figure 1.

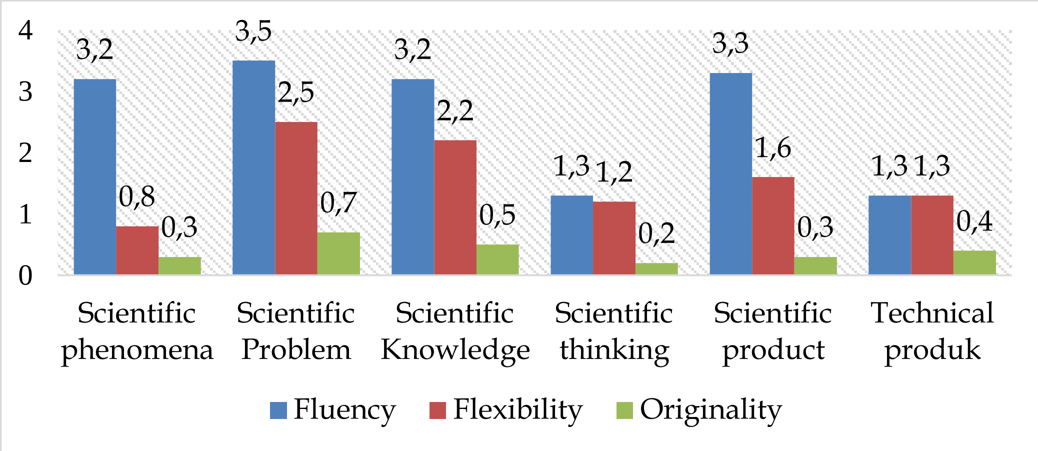

Figure 1. Prelemenary research results

Based on the results of the preliminary research 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 which is equivalent to 100 if converted into tens. The results of this research are in line with the results of research conducted by PISA which was previously explained.

Several efforts have been made by previous researchers, such as research conducted by Prahani et al., (2021) dan Suyidno et al., (2018), but 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, the importance of knowledge that must be mastered by students has been agreed by experts, including Arend, (2012), Moreno, (2010), dan 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 which is enhanced with the Scientific Creativity Model, hereinafter 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.

LITERATURE REVIEW

Creativity is a cognitive structure that produces new views on a form of problem, not limited to pragmatic results or always viewed according to their usefulness (Solso & Maclin, 2007) Guilford in Cohen & Ambrose, (1999) and Dunbar (2014) defines creativity as divergent thinking; involves the production of new and unusual ideas, and unique solutions to solve problems. (Hu & Adey, 2010) developed three dimensions of the Scientific Structure Creativity Model (SSCM) as the basis for scientific creativity.

Creativity in physics learning is known as scientific creativity (Mukhopadhyay, 2013). Scientific creativity includes the ability to generate new ideas or new products that are relevant to the context and have scientific utility (Ayas & Sak, 2018) Scientific creativity has similarities with creativity in general in terms of fluency, flexibility, originality. but more emphasis on creative science experiments. Thus, the development of this creativity has been carried out comprehensively, both instructionally (creative attitudes, creative products) and accompaniment (creative process) the development of this creativity is very important as a key element in equipping students to achieve career success (Raj & Saxena, 2016).

METHODOLOGY

This research was conducted on undergraduate physics education students at universities located in East Java, Indonesia. The research sample was 90 students taking basic 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.

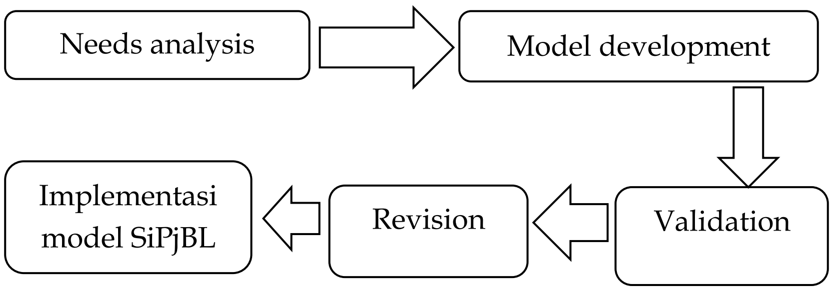

Figure 2. SiPjBL model development flow

Based on Figure 2 above, before being developed, the SiPjBL learning model carried out a learning needs analysis first, this was to find out what were the strengths in developing the model and the learning tools that accompanied the model. After obtaining data from the needs analysis, a study of the PjBL model was carried out to find the limitations of the model. After the study is carried out, the model syntax and learning tools that support the model are developed, and then in the final stage validation of the model and learning tools is carried out, including model books. In the final stage, a learning model is implemented to increase the scientific creativity of physics education students.

The instruments used 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 the field of 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:

$$Score = \frac{Score\ obtained}{Maximum\ score} \times 4 \ldots\ldots\ldots\ldots\ldots(1)$$

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)

The reliability of a learning device is said to be 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:

$$R = (1-(A-B)/(A+B)) \times 100\% \ldots\ldots\ldots\ldots\ldots(2)$$

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

RESULT

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 so that they 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 oaring validators. The results of the assessment by three validators are as in Table 3.

Table 3. Results of the SiPjBL Model Validity Assessment

Assesment of aspect		Assesment			
		Validity		Reliability	
		Score	Criteria	Koef. R	Category
Model Development Needs	1. Producing graduate competency in 21st century skills.	4.00	very Valid	100%	Reliable
	2. Support the implementation of National Higher Education Standards which emphasize the learning process with a scientific approach and provide space for the development of student creativity	3.67	very Valid	86%	Reliable
	3. Overcoming the problem of low scientific creativity in higher education today	4.00	very Valid	100%	Reliable
	4. Recommendations for improving PjBL with SSCM in terms of strengthening the project creation process using scientific thinking skills techniques.	4.00	very Valid	100%	Reliable
Kemutakhiran Pengembangan Model	1. Development of Model Goals	3.33	very Valid	86%	Reliable
	2. Use of Theoretical Foundations	4.00	very Valid	100%	Reliable
	3. Use of Empirical Foundations	4.00	very Valid	100%	Reliable
	4. Learning Planning Development	4.00	very Valid	100%	Reliable
	5. Development of Learning Implementation	4.00	very Valid	100%	Reliable
	6. Development of assessment and	3.67	very Valid	86%	Reliable

Assesment of aspect	Assesment			
	Validity		Reliability	
	Score	Criteria	Koef. R	Category
evaluation				

Note: R = inter-observer agreement coefficient.

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	0,999	0,997	Valid
Model Development Updates	0,998	0,998	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 in the very valid category. Meanwhile, the sophistication of learning tools with the SiPjBL model is also in the very valid category. The results of calculating the reliability of learning devices are with R calculated 0.999 and R table 0.997 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 reliability of the model by obtaining a Cronbach's Alpha score of 0.857 which is greater than 0.05. This indicates that the SiPjBL model is feasible and reliable.

DISCUSSION

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 in the SiPjBL model are categorized as very valid with a validity percentage of 97% so it can be said to be very feasible. This is in accordance with the opinion expressed by (Wicaksono, 2020). that scientific creativity cannot just appear, so the role of lecturers here is very much needed both in class management and in 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 0.05. 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 in accordance with 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 have a positive impact on 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 AND RECOMMENDATIONS

Based on the results of research on the validity of the SiPjBL model in increasing the scientific creativity of physics education undergraduate students, it can be concluded that the SiPjBL model which was 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.

ADVANCED RESEARCH

The limitations of this research are: 1) This research is only limited to model development by analyzing the level of validity of the model book that has been developed; 2) the results of model development have not been researched for their practicality and effectiveness.

ACKNOWLEDGMENT

I would like to express my thanks to the Surabaya State University which has been willing to be a forum for studying and always providing support for the completion of this study.

REFERENCES

Andayani, S. (2020). The profile of critical thinking and learning outcomes of teacher candidates viewed from gender differences. In *Journal of Physics: Conference Series* (Vol. 1567, Issue 4). https://doi.org/10.1088/1742-6596/1567/4/042072

Andres, E. C. A., & Rosalinda, B. (2023). Online Flipped Learning Model in a College Physical Education Course. *European Journal of Educational Research*, *13*(1), 413–425.

Arend, R. I. (2012). Learning to Teach. In *Mc Graw Hill* (NINTH EDIT, Vol. 11, Issue 1). http://link.springer.com/10.1007/978-3-319-59379-1%0Ahttp://dx.doi.org/10.1016/B978-0-12-420070-8.00002-7%0Ahttp://dx.doi.org/10.1016/j.ab.2015.03.024%0Ahttps://doi.org/10.1080/07352689.2018.1441103%0Ahttp://www.chile.bmw-motorrad.cl/sync/showroom/lam/es/

Ayas, M. B., & Sak, U. (2018). Objective Measure of Scientific Creativity : Psychometric Validity of the Creative Scientific Ability Test Objective measure of scientific creativity : Psychometric validity of the Creative Scientific Ability Test. *Thinking Skills and Creativity*, *13*(October), 195–205. https://doi.org/10.1016/j.tsc.2014.06.001

Borg, W.R & Gall, M. . (1983). *Eucation research: an introduction.* (4th Editio). Longman Inc.

Cirkony, C. (2023). Flexible, creative, constructive, and collaborative: the makings of an authentic science inquiry task. *International Journal of Science Education*, *45*(17), 1440–1462. https://doi.org/10.1080/09500693.2023.2213384

Cohen, L. N. M., & Ambrose, D. (1999). *Adaptation and creativity. Runco, M.A. and Pritzker, S.R. (Ed.)*. Academic Press.

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

Hu, W., & Adey, P. (2010). A scientific creativity test for secondary school students. *International Journal of Science Education*, *24*(4), 389–403. https://doi.org/10.1080/09500690110098912

Maharani Putri Kumalasani, & Kusumaningtyas, D. I. (2022). 21 St Century Skill In Learning Models With A Steam Approach. *Jurnal Riset Pendidikan Dasar*, *05*(April), 74–81.

Moreno, F. E. (2021). Learning electrical circuits for the development of critical thinking. In *Journal of Physics: Conference Series* (Vol. 2073, Issue 1). https://doi.org/10.1088/1742-6596/2073/1/012001

Moreno, R. (2010). *Educational psichology*. John Wiley & Sons, Inc.

Mukhopadhyay, R. (2013). *Scientific Creativity- A New Emerging Field of Research : Some Considerations*. *2*(1), 1–9.

PISA. (2023). PISA 2022 Results Factsheets Indonesia. *The Language of Science Education*, *1*, 1–9. https://oecdch.art/a40de1dbaf/C108.

Plomp, T., & Nieveen, N. M. (2010). *An introduction to educational design research*.

Prahani, B. K., Suprapto, N., Rachmadiarti, F., Sholahuddin, A., Mahtari, S., Suyidno, & Siswanto, J. (2021). Online Scientific Creativity Learning (OSCL) in Science Education to Improve Students' Scientific Creativity in Covid-19 Pandemic. *Journal of Turkish Science Education*, *18*(Special Issue), 77–90. https://doi.org/10.36681/tused.2021.73

Pusat Penilaian Pendidikan Balitbang Kemendikbud. (2019). Pendidikan di Indonesia Belajar dari Hasil PISA 2018. *Pusat Penilaian Pendidikan Balitbang Kemendikbud*, *021*, 1–206.

Rahayu, R., Iskandar, S., & Abidin, Y. (2022). Inovasi Pembelajaran Abad 21 dan Penerapannya di Indonesia. *Jurnal Basicedu*, *6*(2), 2099–2104. https://doi.org/10.31004/basicedu.v6i2.2082

Raj, H., & Saxena, D. R. (2016). Scientific creativity: A review of researches. *European Academic Research*, *4*, 112–1138.

Sidek, R., Halim, L., Buang, N. A., & Mohamad Arsad, N. (2020). Fostering Scientific Creativity in Teaching and Learning Science in Schools: A Systematic Review. *Jurnal Penelitian Dan Pembelajaran IPA*, *6*(1), 13. https://doi.org/10.30870/jppi.v6i1.7149

Slavin, R. E. (2015). Instruction Based on Cooperative Learning. *Handbook of Research on Learning and Instruction*, 388–404. https://doi.org/10.4324/9780203839089.ch17

Solso, R. L., H. Maclin, O., & Maclin, M. K. (2007). *Psikologi kognitif, edisi delapan.* Erlangga.

Sumo, M., Jatmiko, B., Supardi, Z. A. I., & Suprianto, S. (2024). The Influence Of The Project-Based Learning Model On The Scientific Creativity Of Physics Education Undergraduate Students At Madura Islamic University. *SEJ (Science Education Journal)*, *8*(1), 19–31. https://doi.org/10.21070/sej.v8i2.1651

Suradika., Dwi., N. (2023). *Jurnal Pendidikan IPA Indonesia*. *12*(1), 153–167. https://doi.org/10.15294/jpii.v12i1.39713

Suyidno, Nur, M., Yuanita, L., & Prahani, binar kurnia. (2018). Issn 1648-3898 Issn 2538-7138 Effectiveness of Creative Responsibility Based Teaching (Crbt) Model on Basic Physics Learning To Increase Student ' S Scientific Creativity and. *Journal of Baltic Science Education*, 136–151.

Test, P., Sak, U., & Ayas, M. B. (2014). *Creative Scientific Ability Test (C-SAT): A new measure of scientific creativity Creative Scientific Ability Test (C-SAT): A new measure of scientific creativity*. *September 2013*.

Wahyuni, L., & Rahayu, Y. S. (2021). Pengembangan E-Book Berbasis Project Based Learning (PjBL) untuk Melatihkan Kemampuan Berpikir Kreatif pada Materi Pertumbuhan dan Perkembangan Tumbuhan Kelas XII

SMA. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *10*(2), 314–325. https://doi.org/10.26740/bioedu.v10n2.p314-325

Wibowo, F. C. (2023). *Journal of Technology and Science Education*. *13*(1), 178–192.

Wicaksono, I. (2020). *Validity and Practicality of the Biotechnology Series Learning Model to Concept Mastery and Scientific Creativity*. *13*(3), 157–170.