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A SYSTEMATIC REVIEW FOR CREATIVE THINKING SKILLS IN PHYSICS SUBJECTS

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Abstract :
This study aims to obtain information on efforts to improve high school students creative thinking abilities in physics learning. The review method was chosen to obtain research journals with keywords in students' creative thinking abilities in high school physics learning with Google undergraduate reference sources, hands-on science, and research gates. Twenty-five journals were reviewed based on author (year), research design, creative thinking skills, and findings. Based on a study of 15 international and ten national articles, applying the Problem Based Solving learning model is the most widely used effort to improve creative thinking skills. In addition to Problem-Based Learning, several efforts can be made to enhance creative thinking skills, including implementing Project Based Learning, Creative Problem Solving, and developing physics learning tools. This research can contribute to the world of education, especially in evaluating physics learning.

Keywords: Creative Thinking; Problem Based Solving; Project Based Learning

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INTRODUCTION

Education has an important role in the progress of a country. Through good education, the quality of human resources can improve. Currently, 4C is a competency demanded in the world of education. The 4C competencies consist of four competencies, namely creativity, critical thinking, collaboration, and communication (Bialik & Fadel, 2015; Karlina & Rita. 2022; Wicaksosno, 2022). The importance of 4C as a provision for students in the future (Priyono and Sinurat, 2020; Nurjannah, 2022; Ramadhani, 2023). Creativity is one part of 4C. One of the creativity competencies expected in physics learning is the ability to think creatively.

The ability to think creatively in learning physics is the ability to express ideas creatively in solving physics problems. The ability to think creatively in students can be seen when solving a problem. According to Torrance and Guildford, indicators of the ability to think creatively include fluency, flexibility, originality, and elaboration (Pratiwi et al., 2019, Syarkowi et al, 2023, Wulandari & Jumadi, 2023). Fluency is the ability to generate various kinds of ideas and solutions in solving problems. Flexibility is the ability to produce a variety of varied strategies. Originality is the ability to create new ideas and ideas. Elaboration is the ability to develop ideas that are owned. The ability to

think creatively can be used as a basis for solving various problems faced (Istianah, 2013, Pujiarto, 2020; Aldila et al, 2023).

The ability to think creatively is beneficial in increasing students' knowledge, both knowledge of physics and everyday life (Ummah et al., 2019; Aryani et al, 2020; Hermawati & Chen, 2023). Based on this, students need to have the ability to think creatively. The ability to think creatively can be trained through learning physics. However, currently learning physics in schools rarely trains students' creative thinking abilities (Ariandari, 2015; Ramadhanti & Simamora, 2023; Pitriyani & Fitriani, 2023). Implementation of learning that leads to the ability to think creatively needs to be improved (Fatah et al., 2016; Sihombing & Sijabat, 2023; Romiyati et al, 2023). This is because the learning process influences students' creative thinking abilities. Various efforts can be made to improve the ability to think creatively, especially in learning physics. Based on this, a study is needed regarding efforts that can be made to improve students' creative thinking skills. Various efforts in this study can be used as an alternative for teachers to improve students' creative thinking skills at school.

RESEARCH METHOD

This study uses a systematic literature review method. Systematic literature review is a research method that identifies, interprets, and evaluates findings on a research topic to answer predetermined questions (Kitchenham & Charters, 2007; Aldila & Mundarti, 2023). Systematic literature review includes three stages, namely planning, conducting, and reporting.

This stage includes the preparation of a systematic literature review protocol. At this stage the researcher determines the research topic, namely efforts to improve creative thinking skills. Then set the search criteria for the article. The search criteria for articles are based on Scopus or Google Scholar sources from 2017 to 2023. The keywords used are the ability to think creatively in physics learning.

This stage is the implementation of a systematic literature review. This stage begins with a search for articles based on the criteria set at the planning stage. Article search is done with the help of the Publish or Perish application. Next is the selection of articles. The selected articles are articles that are in accordance with the research topic.

Table 1. International Articles

Articles Source	Number of Article
International Journal on E-Learning	1
International Journal of Instruction	2
Journal of Turkish Science Education	1
International Journal of Social Sciences & Educational Studies	1
In Journal of Physics: Conference Series	5
International Journal of Recent Technology and Engineering (IJRTE)	1
International Journal of Social Learning (IJSL)	1
Journal of Educational and Learning Studies	1
In AIP Conference Proceedings	1
International Journal of Essential Competencies in Education	1
Total	15

Table 2. National Articles

Article Source	Number of Article
Jurnal Pendidikan Fisika dan Keilmuan (JPFK)	2
Jurnal Penelitian Ilmu Pendidikan	1
Jurnal Hasil Kajian, Inovasi dan Aplikasi Pendidikan Fisika	1
Jurnal Penelitian Pendidikan Fisika	1
Jurnal Kajian, Inovasi dan Aplikasi Pendidikan Fisika	1
Jurnal Kependidikan: Penelitian Inovasi Pembelajaran	1
Jurnal Ilmiah Pendidikan Fisika	1
Jurnal Ilmiah Profesi Pendidikan	1
JPF (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar	1
Total	10

After selecting the articles, the next step is to perform data synthesis with the aim of analyzing and evaluating various research results from various literature. The data synthesis carried out in this study is in the form of a narrative.

Reporting The reporting stage is the final stage in systematic literature review research. This stage includes writing the results of a systematic literature review in written form according to a predetermined format.

RESULTS AND DISCUSSION

Based on the results of a study of 15 international articles and 10 national articles, efforts to improve creative thinking skills can be carried out by applying learning models, approaches, methods or strategies. For more details, see table 3.

Table 3. Research on creative thinking

Author and Years	Tittle	Name of Journal	Result
Trianggono, M. M. (2017)	Analisis kausalitas pemahaman konsep dengan kemampuan berpikir kreatif siswa pada pemecahan masalah fisika	Jurnal Pendidikan Fisika dan Keilmuan (JPFK)	The results of this study are understanding concepts and creative thinking abilities that influence each other in learning physics.
Armandita, P. (2017)	Analisis kemampuan berfikir kreatif pembelajaran Fisika di kelas XI MIA 3 SMA Negeri 11 Kota Jambi	Jurnal Penelitian Ilmu Pendidikan	The result of this research is that the highest percentage of creative thinking characteristics is evaluative and the lowest is originality and flexibility.
Nurulsari, N., & Suyatna, A. (2017)	Development of soft scaffolding strategy to improve student's creative thinking ability in physics.	In Journal of Physics: Conference Series	The result of this study is that the soft scaffolding strategy is effective in increasing students' creative thinking skills in physics.
Rahman, M. H. (2017).	Using discovery learning to encourage creative thinking	International Journal of Social Sciences & Educational Studies	The results of this study are that the discovery learning model can encourage students' creative thinking skills in learning strategy subjects
Trianggono, M. M., & Yuanita, S. (2018)	Karakteristik keterampilan berpikir kreatif dalam pemecahan masalah fisika berdasarkan	Jurnal Pendidikan Fisika dan Keilmuan (JPFK)	The results of the study showed that there were differences in the characteristics of creative thinking skills in the indicators of creative thinking skills, namely fluency,

Author and Years	Tittle	Name of Journal	Result
	gender		flexibility, and elaboration, while there were no significant differences in the originality indicators.
Kuswanto, H. (2018).	Android-Assisted Mobile Physics Learning through Indonesian Batik Culture: Improving Students' Creative Thinking and Problem Solving	International Journal of Instruction	The results of this study are Android-assisted mobile physics learning supported by local batik culture suitable for high school physics learning.
Batlolona, J. R., Diantoro, M., & Latifah, E. (2019)	Creative thinking skills students in physics on solid material elasticity	Journal of Turkish Science Education	The result of this study is that PBL is recommended to develop or improve students' creative thinking
Putri, C. S., Sesunan, F., & Wahyudi, I. (2019).	Pengaruh Penerapan Model Pembelajaran Creative Problem Solving untuk Meningkatkan Kemampuan Berpikir Kreatif dalam Pemecahan Masalah Fisika Pada Siswa SMA.	JPF (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar	The results of this study are that the Creative Problem Solving model has an effect on improving students' creative thinking skills in solving physics problems
Parno, E. S., Yuliati, L., Widarti, A. N., Ali, M., & Azizah, U. (2019).	The influence of STEM-based 7E learning cycle on students critical and creative thinking skills in physics	International Journal of Recent Technology and Engineering (IJRTE)	The results of this study are that the use of STEM-7E can improve students' creative thinking abilities
Sahida, D., & Zarvianti, E. (2019).	Development of Problem Based Learning (PBL) practicum guide to improve student Creative Thinking Skills (CTS) in basic physics subject	Journal of Educational and Learning Studies	The results of this study are PBL-based practicum guidelines to improve students' creative thinking skills.
Nurfa, & Nana, (2020)	Pengaruh Model Project Based Learning Terintegrasi 21st Century Skills Terhadap Kemampuan Berpikir Kreatif Siswa SMA Fisika	Jurnal Penelitian Pendidikan Fisika	The results of this study are that the use of the integrated 21st Century Skills Project Based Learning model can influence the creative thinking abilities of physics high school students.
Damayanti, S. A., Santyasa, I. W., & Sudiatmika, A. A. I. A. R.	Pengaruh model problem based-learning dengan flipped classroom terhadap kemampuan berpikir	Jurnal Kependidikan: Penelitian Inovasi Pembelajaran	The result of this study is that active learning with flipped classroom needs to be developed in physics learning to encourage students' creative thinking skills.

Author and Years	Tittle	Name of Journal	Result
(2020).	kreatif		
Satriawan, M., Rosmiati, R., Widia, W., Sarnita, F., Suswati, L., Subhan, M., & Fatimah, F. (2020).	Physics learning based contextual problems to enhance students' creative thinking skills in fluid topic	In Journal of Physics: Conference Series	The results of this study are that the use of contextual questions in physics learning can help improve students' creative thinking skills
Zarvianti, E., & Sahida, D. (2020).	Designing Comics By Using Problem Based Learning (PBL) to Improve Student's Creative Thinking Skills.	International Journal of Social Learning (IJSL)	The result of this study is that designing PBL-based SMA/MI physics comics is able to improve students' creative thinking abilities because it ultimately has an impact on student grades
Widyasmah, M., & Herlina, K. (2020)	Implementation of STEM Approach Based on Project-based Learning to Improve Creative Thinking Skills of High School Students in Physics	In Journal of Physics: Conference Series	The results of this study are that the application of the STEM learning approach to Pascal's law has increased creative thinking skills and there are differences in the increase in students' creative thinking abilities before and after the application of the STEM learning approach.
Astutik, S., & Mahardika, I. K. (2020)	HOTS student worksheet to identification of scientific creativity skill, critical thinking skill and creative thinking skill in physics learning	In Journal of Physics: Conference Series	The results of this study are very important for developing appropriate physics learning designs that can develop scientific creativity, critical thinking and creative thinking skills
Asy'ari, M., Prayogi, S., & Mirawati, B. (2021)	Development of physics learning tools based on inquiry to increase creative thinking skills.	In Journal of Physics: Conference Series	The results of this study are valid, practical, and effective inquiry-based physics learning tools to improve students' creative thinking skills on heat material.
Ridwan et al, (2021)	Pengembangan Media Pembelajaran Interaktif Berbasis Model Problem Based Learning Untuk Meningkatkan Kemampuan Berpikir Kreatif Fisika Peserta Didik	Jurnal Hasil Kajian, Inovasi dan Aplikasi Pendidikan Fisika	This research is development research with the conclusion that interactive media based on problem-based learning models to improve students' creative thinking skills are valid, effective and efficient to use in learning.
Maysyaroh, & Dwikoranto, (2021)	Kajian Pengaruh Model Project Based Learning Terhadap Keterampilan Berpikir Kreatif Peserta Didik	Jurnal Kajian, Inovasi dan Aplikasi Pendidikan Fisika	The results showed that the Project Based Learning model could improve students' creative thinking skills in physics learning.

Author and Years	Tittle	Name of Journal	Result
	Pada Pembelajaran Fisika		
Simanjuntak, M. P., Hutahaean, J., Marpaung, N., & Ramadhani, D. (2021).	Effectiveness of Problem-Based Learning Combined with Computer Simulation on Students' Problem-Solving and Creative Thinking Skills.	International Journal of Instruction	The results of this study are the application of PBL combined with computer simulations in the high school curriculum to improve students' problem solving abilities and creative thinking
Mubarok, A. Z. Z., Ismet, I., & Kistiono, K. (2022)	Pengembangan Modul Elektronik Fisika untuk Meningkatkan Kemampuan Berpikir Kreatif Peserta Didik Pada Materi Hukum Newton	Jurnal Ilmiah Pendidikan Fisika	The results of this study are that electronic modules can be easily used in learning physics.
Nursiddieq, M. H., Wahyudi, W., & Hikmawati, H. (2022).	Pengembangan perangkat pembelajaran fisika model blended learning berbantuan phet melalui smartphone untuk meningkatkan kemampuan berpikir kreatif peserta didik	Jurnal Ilmiah Profesi Pendidikan	The results of this study are learning tools with a PhET-assisted blended learning model via smartphones that improve students' creative thinking skills.
Serevina, V., Koul, R., Morales, M. P., & Nugroho, D. A. (2022).	Influence of Website-Based E-Learning in the Pandemic Era: Improving Students' Creative Thinking Skills through Educational Management.	International Journal on E-Learning	The results of this study are that using "web-based e-learning" is indicated to be able to improve students' creative thinking abilities in the pandemic era
de Oliveira Biazus, M., & Mahtari, S. (2022)	The impact of project-based learning (PjBL) model on secondary students' creative thinking skills	International Journal of Essential Competencies in Education	The results of this study are that the PjBL model significantly influences the creative thinking skills of high school students in the matter of temperature and expansion.
Hasanah, S. U., Parno, P., Hidayat, A., Supriana, E., Yuliati, L., Latifah, E., & Ali, M. (2023)	Building students' creative thinking ability through STEM integrated project-based learning with formative assessment on thermodynamics topics	In AIP Conference Proceedings	The result of this study is that PjBL-STEM with AF has a significant influence on the development of students' creative thinking abilities

Based on the table, it can be seen that Problem Based Learning is the most widely used effort to improve creative thinking skills based on the 25 articles reviewed. In addition to Problem Based Learning, there are several efforts that can be made to improve creative thinking skills in physics learning based on the results of the study, namely, Problem Based Learning, Project Based Learning,

Creative Problem Solving, development of learning tools. The following describes each effort to improve creative thinking skills.

One of the efforts used to improve students' creative thinking skills is to use the Problem Based Learning learning model (Tan et al, 2020; Aafrijhon, 2022). Based on the studies that have been carried out, the Problem Based Learning learning model can improve creative thinking skills because the learning model is oriented towards giving problems to students. Through problems, students can express their creative ideas to find solutions to these problems. Through the solution of the problem, students' creative thinking abilities can be seen. The fluency aspect can be seen when students provide various solutions. The flexibility aspect can be seen when students provide solutions in various ways and discuss various methods. The novelty aspect can be seen when students check answers and then make new solutions for them (Ardeniyansah & Rosnawati, 2018).

The application of the Project Based Learning model in learning is an effort that can be made to improve students' creative thinking skills (Ningsih et al., 2020; Muchsin & Mariati, 2020). Based on the studies that have been conducted, the Project Based Learning learning model can improve creative thinking skills because this model provides opportunities for students to work independently in building knowledge and making products. This learning model facilitates the creativity of students through a given project. Through a given project, students can explore creatively to present project results, interpret various problems, apply concepts or principles in different ways. Thus, students' creative thinking skills will be better.

One of the efforts that can be made to improve creative thinking skills is by applying the Creative Problem-Solving model in learning (Septian et al, 2020; Wasiran & Andinasari, 2019). Based on the studies that have been conducted, the Creative Problem-Solving learning model can improve creative thinking skills because it focuses on problem solving abilities followed by strengthening skills. In addition, the main component in the Creative Problem-Solving model is about how students are required to look for various kinds of ideas that will be used at the decision making stage. Thus, students' creative thinking abilities can be facilitated through this model.

CONCLUSION

The ability to think creatively can be trained through learning physics. Based on a study of 15 international articles and 10 national articles, the application of the Problem Based Solving learning model is the most widely used effort to improve creative thinking skills. In addition to Problem Based Learning, there are several efforts that can be made to improve creative thinking skills, including applying it in physics learning. Each has its own advantages and characteristics so as to increase the ability to think creatively.

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