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Systematic literature review: mathematical creative thinking ability reviewed from self-regulated in Project Based Learning (PjBL) Model

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Abstract

In learning mathematics to solve problems, students must own creativity and finish independently. Creativity and study in a manner independence can be increased by applying a learning model. Study This own The aim is to conduct a literature review regarding the based learning model project to improve the ability to think creatively mathematically and self-regulated or learn from students independently. The research method used is Systematic Literature Review (SLR) method. Selected articles based on quality, suitability, and suitability content so that obtained 17 articles from google scholar journals, national and international, in the range period 2017 to the year 2023. The research results obtained: (1) the PjBL learning model in learning mathematics can improve the ability to think creatively student, (2) independence influences learning on creative thinking skills.

Keywords: PjBL, mathematical creative thinking ability, self-regulated

1. Introduction

A subject that can educate students to develop perceptive, logical, and creative thinking is mathematics (Maryanti & Qadriah, 2020). Therefore, mathematics is a basic science for other sciences and plays a major role in everyday life (Atiyah & Nuraeni, 2022). The Ministry of National Education No. 41 of 2007 concerning the uniformity of learning activities in teaching units that are carried out interactively, which are inspiring, entertaining, challenging, encouraging active participation, and lots of room For can take the initiative, creative, and independent according to the abilities, interests, and physical and psychological development of students. Carrying out the learning process, according to Permendiknas No. 41 of 2007, is not an easy thing. This was reinforced by the TIMSS 2011 results, namely, in the intellectual field, students' thinking abilities were still weak in line with the opinion that Skills For think feeling creative essential apparently still relatively low (Widiyanto & Yunianta, 2021).

There are various types the resulting factors are still minimal to skills students in thinking creative math. For example, organized learning activities. Activity Study Teaching should involve students actively and provide for the use of creative thinking skills. In addition, accordingly, with the regulation no. 41 of 2007 concerning specified process standards for education elementary and intermediate that task a teacher is to plan interactive, creative, fun, and challenging activities in which students can participate as well as actively. Nanang (2016) explained that the development of creative thinking in teaching and learning requires a correlation

between students, teachers, teaching materials, and the environment so that they can independently create new knowledge.

Kurniawati et al. (Shora & Kartono, [2020](#)) emphasize that student success in learning does not always depend on determining a suitable learning model but can also be measured by the student's independence or so-called self-regulation. Studying independently or SRL appointed is one of the consequences that arise for students to try to find information independently so they can learn from learning sources other than the teacher (Fajrizal et al., [2019](#)). In learning mathematics, student independence is needed. Akhdiyat & Hidayat ([2018](#)) states that students who have high independence will also have high creative thinking skills as well. So, if the student's independence is low, then it will result in creative thinking ability is also low. Hence, independent study or self-regulated must be an aspect of student development. Chosen the learning model that is suitable as an alternative to training creative thinking skills and independent learning is the Project Based Learning (PjBL) learning model. The PjBL learning model assumes that students are able to work on complex problems shared in their own way. In other words, students must think creatively to work on problems.

The results of research conducted by Rachmantika et al. ([2022](#)), namely the Project Based Learning (PjBL) model with online settings, can improve students' creative thinking skills because the learning stages of the PjBL model introduce students to collaboration, discussion, and thinking about new issues that increase student creativity. Apart from that, the implementation of PjBL encourages students to participate actively in teaching and learning activities, to be more creative, more confident, and able to work independently in the implementation of a particular project.

2. Methods

This study adopted a systematic literature review method. That is, the method of studying the library involves the activity of identifying, interpreting, and evaluating the results of a research subject to respond to a question³ already determined (Kitchenham & Charters, [2007](#)). There are three stages of a systematic literature review among them, namely.

Planning

Activities in steps this covers making a systematic SLR plan. One of them that is a set tree from the research studied. Study these three research, namely the PjBL model for increase think creative students in matter independence learning. Next, specify characteristics and search for those items. Characteristics on exploration article sourced from Google Scholar from 2017 – 2023. Applied Keywords, namely the PjBL model, capability, thinking creatively, and learning independently.

Conducting

This step is implementation from search literature in a systematic manner. Stage this started with a search for items with use characteristics already set in stage planning. Application publish or perish is used to make it easy to search desired articles. Then, the item is selected. A defined article is something articles related to the subject under study. Search results from articles set 16 articles national and 1 article international.

After the article is selected, the step furthermore is data processing, which aims to review and examine the results of the different studies of the study different libraries. Process the data that is done in research. This form narration.

Reporting

Furthermore, stage reporting is a step ended in SLRs. In step, this, a results study literature systematic noted in a manner written in a certain format.

3. Results And Discussion

The findings of the research material contained in this literature review are reviews and summaries of documented articles regarding creative thinking skills reviewed of independent learning using the PjBL model shown in Table 1 and Table 2.

Table 1

Research results creative thinking skills through the PjBL model

Researcher	Journal	Research result
Rachmantika et al (2022)	Edukatif: Jurnal Ilmu Pendidikan (S4)	Obtained results data processing ability student in think creative meet BTA > 75%. So that can stated that learning model based project with online settings you can increase creativity students and more Good from online learning.
Muchsin & Mariati (2020)	BIRCI-Journal (S3)	Obtained the average n-gain in the class experiment I of 0.75 in characteristics high, the average n-gain in the class experiment II of 0.77 in characteristics high, and in the second class the average n-gain of 0.76 in characteristics high, because that's ability think creative student. There is enhancement after PjBL model is applied in KBM.
Ningsih et al (2020)	Universal Journal of Educational Research (Q4)	Obtained results study that There is difference ability think creative student between class experiments using PjBL and class models control using the exposure model. PjBL model can give impression to student meaningful and fun learning.
Rahmazatullaili et al. (2017)	Beta: Jurnal Tadris Matematika (S2)	Research results show that after application of learning models based project ability think creative students and abilities solving problem student more ok. Another thing, there is correlation between ability think creative and ability solving problem with that model as well as ratio between second ability the belong to category enough.
Widana & Septiari (2021)	Jurnal Elemen (S2)	Obtained results from study namely the learning model based project with simultaneous STEM approach can affect ability think creative and results Study math.
Noviyana (2017)	e-DuMath: Jurnal Pendidikan Matematika (S4)	The results showed that the value of $t_{hit} = 14.27$ was obtained from the results of hypothesis testing. It is known from the t-distribution table at a significant level of 5% that $t_{count} = 2.00$ means $t_{count} > t_{tbl}$. Based on processing of the data taken conclusion of the PjBL learning model can influence mathematical creative thinking ability's.

Elizabeth Sigahitong (2018)	&	Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram (S3)	The research results show that mark KBKM average with using the PjBL model more bigly compared to mark average ability think creative with using learning models expository ie $73.80 > 65.97$, meaning There is significant difference. Because that is, the PjBL learning model can influence students' creative thinking abilities.
Maysarah (2018)		Axiom: Jurnal Pendidikan dan Matematika (S3)	Obtained results study with analyze each indicator ability think creative that is average fluency as big 4.0 with a very good score, on average elaboration by 3.8 with very good value, on average flexibility of 4.0 with a very good value, and average originality of 2.0 in the disappointed category, so, the learning model PjBL can used for develop ability think creative mathematical student.
Hikmah Agustin (2020)	&	Prismatika: Jurnal Pendidikan dan Riset Matematika (S4)	Obtained independent t-test results, namely a t-score of 7.247 and a Sig (2-tailed) of 0.000. Because Sig. < 0.05 , then H_1 accepted, which means the PjBL model influential to ability think creative student.
Mustika (2022)		Aksioma: Jurnal Program Studi Pendidikan Matematika (S2)	Obtained results from validation expert material mathematics by 3.15 with valid criteria, results validation adli media of 3.22 with valid criteria. As well as results testing module based pjBL get mark presentation of 2.98, value presentation material of 3.08, and value attractiveness of 2.73. So got concluded PjBL-based mathematics e-module about creative thinking is very valid and effective on material wake field r money.
Fitriyah Ramadani (2021)	&	JIP: Jurnal Inspiratif Pendidikan (S4)	Obtained results data processing ie $P 0.000 < 0.005$ and $F_{count} = 35.551$ which means STEAM learning matters significant to ability think creative and $P 0.003 < 0.05$ and $F_{count} = 9.401$ which means STEAM learning matters significant to ability think critical. Because that, STEAM learning can be one solution learning For strengthen Skills 21st century.

asked on results identification and study from the above articles, concluded that definition from learning models project based learning is an engaging learning model student in a manner active Good That individual nor group in framework reach objective expected and resulting learning something product or real work. Application of learning models PjBL is one such model for develop level creativity student. It due to the PjBL model offer opportunity to student For Study in a manner independent build knowledge and create product. Creativity the built through project certain. Through given project, students can know How The method researching in a manner creative For can presented results product from work on the project, understand different problems and implements theory or essence with different way. With activity such is the ability think creative student can increase.

Table 2

Research result creative thinking ability in terms of learning independence

Researcher	Journal	Research result
(Nurhikmayati & Sunendar, 2020)	Mosharafa: Jurnal Pendidikan Matematika (S2)	The results of the study show that the PjBL-KA model meets the criteria for creative thinking namely valid, practical and effective as well as between KBKM and independence Study influential positive in a manner significant.
(Apriliyani et al., 2022)	JRPIPM: Jurnal Riset Pendidikan dan Inovasi Pembelajaran Matematika (S4)	Research results show that subject with independence tall enter the category creative Because fulfil indicator fluency, flexibility, and novelty. Subject with independence currently enter the category creative Because fulfil indicator fluency and flexibility. Temporary it, subject with independence low enter the category not enough creative Because only fulfil One indicator that is eloquence. These results complement the study on the role of independent learning in explaining variations in students' creative thinking abilities.
(Agustina al., 2023)	et Range: Jurnal Pendidikan Matematika (S4)	The results of this study indicate that the model Effective open-ended CPS For ability think creative math. Subject with score self-regulated learning tall fulfil four indicator ability think creative mathematical (fluency, flexibility, originality, and elaboration). Subject with score self-regulated learning currently only fulfil three indicator ability think creative mathematics (fluency, originality, and elaboration). Subject with score self-regulated learning low only fulfil One indicator ability think creative mathematical (fluency).
(Mualifah Ekayanti, 2022)	& Edupedia (S4)	Research results shows in online learning students who have high SRL including on category creative Because meet two indicators that is fluency and elaboration in a manner maximum. Students who have moderate SRL included in the category creative Because meet two indicators that is fluency and elaboration but There is some have maximum. Students who have low SRL meet two indicators that is fluency and elaboration However some still not yet fulfilled or not maximum .
(Suharsono al., 2021)	et Transformasi : Jurnal Pendidikan Matematika	The results of the study show that students with a high level of self-regulation have a classified KBKM good, because it is able to fulfill four indicators among them that is fluency, flexibility,

	dan Matematika (S4)	originality, and elaboration. Students with moderate and low self-regulation have less creative thinking because they can only meet the requirements of two indicators that is fluency and flexibility just.
(Fajrizal et al., 2019)	e-DuMath: Jurnal Pendidikan Matematika (S4)	Obtained results study show that exists enhancement ability think creative student after apply the JUCAMA model. Besides That There is positive impact about learning independent against the KBKM. However, no there is interaction between model and SRL to KBKM.

Based on the identification results and from the articles above, it is concluded that ability think creative, that is ability student put forward idea creative must developed with method invite they think about idea or different opinion with a friend's suggestion (Sani, [2014](#)). Creative thinking represents the ability to create and optimize original ideas. Creative thinking can be represented by divergent thinking, which is a thinking process that is oriented towards good and correct answers (Asmara et al., [2015](#)). Someone who has the ability to think creatively to create something original through the production of results or products. The ability to achieve original results is called creativity. Anyone who wants to assess students' creative thinking skills needs a meter as an indicator of their performance. There are four indicators of the ability to think creatively (Widiyanto & Yuniata, [2021](#)) that is can be seen in the following table.

Table 3

Indicators of Creative Thinking Ability

Indicator	Ability Student
fluency	Ability to generate multiple ideas to solve problems
originality	the ability to provide unusual or unique feedback
elaboration	the ability to develop ideas or idea
flexibility	flexible thinking skills

Research conducted by Suharsono et al. ([2021](#)) showed that students with high independence own the ability to think classified as creative good because they are capable of fulfilling four indicators: fluency, flexibility, originality, and elaboration. Temporarily, students with independence medium and low own less thought creative because they only can develop Skills of fluency and flexibility.

Students with KBKM with the criteria for high learning independence can fulfill eight parameters: (1) Students can solve math problems by giving lots of ideas or generating ideas by giving answers in more than one way. (2) Students can solve math problems correctly and smoothly. The purpose of being able to solve math problems correctly and smoothly is that students can solve problems creatively in various ways smoothly. (3) Students can express various strategies for solving mathematical problems or provide answers differently. (4) Students can create several ideas or answers that vary and can see problems from different perspectives. (5) Students are expected to be able to provide ideas that are relatively new and rarely given to most people in solving mathematical problems. (6) Students

can solve problems using their own or an unusual way. (7) Students can expand the answers to mathematical problems in detail. (8) Students can solve math problems by detailing answers in detail.

Students who have KBKM with the criteria for moderate learning independence can fulfill six parameters: (1) Students can be able to give many ways or think of answers to more than one solution. (2) Students can solve math problems starting from writing a mathematical model of the problem and finding the value of x to the number of transports of boxes. (3) Students can solve mathematical problems starting from determining the land's shape to calculating the land's price. (4) Students can solve math problems, from determining inequalities to determining the number of boxes that can be transported. (5) Students can solve the problem by finding the value of x and substituting it until the area of the field is found. (6) Students can meet the indicators of solving mathematical problems in detail.

Students with KBKM with the criteria for learning independence are low and able to meet several parameters, namely (1) Students can solve math problems starting from writing a mathematical model of the problem, finding the value of x to transporting lots of boxes. (2) Students who cannot have been able to provide answers unusually, that is, the subject has yet to describe the experiment in answering the question. (3) Students can write down the inequality of word problems and determine the boxes most can be transported. (4) Students can calculate the area of the field, starting from finding the value of x and substituting it until the field area is found, namely 31. (5) Students can write down what is known in the problem and determine the formula, but it could be more precise in determining the final result.

4. Conclusion

Based on the presentation of project-based learning, teachers can use project-based learning models to improve the ability to think creatively in mathematics learning. Four possible parameters measure creative thinking skills in mathematical students, among others, namely (1) significant fluency, (2) flexibility which means flexibility, (3) originality which means authenticity; and (4) elaboration, which means detail. Project-based learning models can encourage skills students to think creatively because this model provides opportunities for students to form understanding and create their products. There are differences in the management of indicators between students who can think creatively mathematically according to each criterion from self-regulated, among them high, medium, and low.

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