Mathematical Creative Thinking Ability Viewed from Student Self-Efficacy Through the STEAM Approach to Project-Based Learning

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Abstract

In this era of globalization, learning based on Science, Technology, Engineering, Art, and Mathematics (STEAM)-based learning is becoming more popular, especially in learning mathematics. Innovation in education must be in accordance with the times, students are currently required to have HOTS abilities, one of which is the ability to think creatively mathematically, to develop student creativity, one of which is implementing project-based learning strategies through the STEAM approach to mathematical creative thinking abilities viewed from student self -student efficacy. This research was conducted by using of Systematic Literature Review (SLR) method to articles that published in 2019-2023 regarding to creative thinking of mathematics abilities viewed from student self-efficacy through the STEAM approach to project-based learning. There are 26 national or international articles retrieved from the Google Scholar and ResearchGate databases. The results of this study indicate that the STEAM approach to project-based learning can improve students' mathematical creative thinking abilities in terms of self-efficacy.

Keywords: *Creative thinking, self-efficacy, STEAM, PjBL*

1. Introduction

In the current era of globalization, what is needed is not only knowledge, but a balance of knowledge and skills as high-quality human resources in times of change (Sakdiah et al., 2021). Education and schools are the most important elements in the process of forming human resources. The activeness of students in learning and the involvement of the values that students acquire for their lives are an important part of the quality of education (Pratiwi & Khotimah, 2022). Students' ability to think creatively mathematically can foster student activity in class. Creative thinking is not a permanent trait of a person, so that creative thinking can be taught and developed in a person (Putri et al., 2023)

The ability to think creatively mathematically is part of the skills of students who must be prepared to be able to face the challenges of the industrial revolution in the era 4.0 and society 5.0 (Hidayah et al., 2022). It can be said that the ability to think creatively is an important factor in learning objectives, because in learning to think creatively, students' attitudes and abilities can be developed in dealing with future learning (Dermawan & Andartiani, 2022). A new approach needs to be taken to improve creative thinking skills and make learning more interesting (Suganda et al., 2021).

In the experiment with student participants, Matter et al. (2013) found that creative self-efficacy has different but not convergent performance (Redifer et al., 2021). Self-efficacy plays an important role in the advancement of education because self-efficacy

will help students feel confident in their own abilities (Nurjali & Rizqi, 2022). Self-efficacy is defined as an assessment of one's ability to perform a certain task successfully, self-efficacy is also called an element of intrinsic motivation. Individuals draw on self-efficacy beliefs about specific goals. Both creativity and self-efficacy require a social environment of openness where students can experiment to explore their abilities and efficacy, to counteract trending learning can use STEAM (Conradty et al., 2020).

STEAM (Science, Technology, Engineering, Art, and Mathematics) learning offers learning that cultivates students' creative thinking (Putri et al., 2023). STEAM is a learning approach that requires students to create a product, through STEAM learning activities children are stimulated by giving them the freedom to express themselves by making works using the existing environment, so that learning is more contextual, such as giving children freedom to explore. (Habibi & Habibi, 2023).

The utilization of the STEAM oncoming integrates each STEAM component in project-based learning, the thinking process of students in completing project-based learning requires a STEAM approach (Annisa et al., 2019). STEAM provides opportunities for students to carry out the design process directly and produce products with good creativity and problem solving skills (Ayuningsih et al., 2022). Similar to STEAM learning, the project-based learning model (PjBL) also involves students in producing a product so that it can increase student productivity (Badriyah et al., 2020). Application of the right educational model is very influential on learning outcomes (Anindya & Wusqo, 2020).

Project-based learning is a strategy that can improve various competencies such as academic achievement, reasoning, critical thinking, problem-solving skills, creativity, independence and presents the ability to see situations from a better perspective (Mursid et al., 2022). Project-based learning (PjBL) is a learning model for students to construct knowledge in groups using the scientific method (Saefullah et al., 2021).

2. Method

Use a systematic literature review (SLR). Research is a process aimed at identifying, analyzing, analyzing and interpreting all available data. In this study, the researcher conducted a series of reviews and structured the literature classification and followed the steps (Triandini et al., 2019), are as follows. The first, Research Question (RQ). RQ is made according to the needs of the chosen topic. The RQ in this study includes; (RQ1) What are the objectives, types, and research methods used in the literature to assess students' self-efficacy in mathematics skills through the STEAM approach in project-based learning 2019-2023?; (RQ2) What are learning models and media have been chosen in that article analyzing mathematical creative thinking abilities from a student self-efficacy perspective through the STEAM approach in project-based learning from 2019-2023?; (RQ3) What is the research trend of the analysis of creative thinking ability in mathematics and students' self-efficacy through the STEAM approach in project-based learning from 2019-2023?.

Second, the search process. The search process is used to obtain relevant data to answer research questions. The process is executed using the Google Scholar, Scopus, and Research Gate databases by the keywords Creative Thinking Ability, self-efficacy, STEAM, PjBL, and creative thinking skills. Third, inclusion and exclusion criteria.

Inclusion and exclusion criteria were used to determine whether the data obtained could be used in the SLR study. Inclusion and Exclusion Criteria can be seen in Table 1 below.

Table 2. 1 Inclusion and Exclusion Criteria

Inclusion	Exclusion
National or international articles that are relevant to mathematical creative thinking abilities in terms of student self-efficacy through the STEAM approach to project-based learning	National or international articles that are irrelevant to creative thinking of mathematics abilities in terms of student self-efficacy through the STEAM approach to project-based learning
National or international articles in by title and research topic	International or national articles that do not match the title and research topic
Articles that published in 2019-2023	Articles that published before 2019
The language used is Indonesian or English	The language used is other than Indonesian or English

The fourth, Quality Assessment (QA). The data got was evaluated according to the following criteria of assessment. (QA1) Was the article published in 2019-2023?; (QA2) Does the article state the research objectives or the type of research or design research used?; and (QA3) Write the article about the learning model or learning method used? From each QA will get a yes or no answer. The fifth, Data Collection. In this study, the data collected for the review was in the form of raw data, namely data collected through interviews, observations, surveys, or according to needs. Then, data analysis. The data that has been collected is then analyzed according to the RQ. Finally, the protocol differs. During the search, a change has taken place, which is to improve the keyword equivalents for the keywords in the database.

3. Results and Discussion

A literature search was hold in March 2022, articles got based on the publication period of 2019-2023 with the keywords Creative Thinking Ability, self-efficacy, STEAM, and PjBL obtained 26 articles relevant to the keywords used. The research data related to this paper is shown in **Table 3. 1.**

Table 3. 1 Research results related to creative thinking ability in mathematics viewed from student self-efficacy through the steam approach to project-based learning

Source	Author, Year	Journal Category	Research Result
Google Scholar	(Redifer et al., 2021)	Learning and Instruction	Increased self-efficacy associated with reduced cognitive load positively influences creative thinking.
Research Gate	(Huang et al., 2020)	Thinking Skills and Creativity	Students' self-efficacy creative thinking does not show a significant difference between man and woman.
Google Scholar	(Muti'ah et al., 2022)	IJECA (International Journal of Education	High student self-efficacy will have a positive influence on students' creative thinking.

		and Curriculum Application)	
Research Gate	(Rahayuningsih, Sri. Nurasrawati. Kamarudin, 2022)	Uniciencia	Students with high self-efficacy usually have high creative mathematical thinking skills.
Google Scholar	(Mashitoh et al., 2021)	Journal of Primary Education	Students with high self-efficacy are able to meet the four qualifications of creative thinking skills, which are fluency, flexibility, originality, and elaboration..
Research Gate	(Habibi & Habibi, 2023)	Journal of Research in Science Education	There are differences in student creativity before and after being given the STEAM treatment
Research Gate	(Rahayuningsih, Sri. Nurasrawati. Kamarudin, 2022)	Jurnal Program Studi Pendidikan Matematika	There is an effect of the implementation of PjBL on students' mathematical creative thinking abilities
Research Gate	(Tee, 2022)	Asia-Pacific Journal of Research in Early Childhood Education	There is an increase in the creativity of preschoolers through creative Play-STEAM activities in Malaysia
Research Gate	(Wannapiroon & Pimdee, 2022)	Education and Information Technologies	Students using the innovative VCLE STEAM format achieve higher levels of creativity and innovation than students using traditional curricula
Google Scholar	(Sakdiah et al., 2021)	International Conference Proceeding	It has a significant impact on the creative thinking skills of students applying STEAM learning
Google Scholar	(Dermawan & Andartiani, 2022)	Journal of Mathematical Society	There is an increase in students' creative thinking for STEAM-based learning activities
Research Gate	(Badriyah et al., 2020)	Jurnal Inovasi Pendidikan IPA	The application of PjBL with a brain-based STEAM approach can improve student achievement
Research Gate	(Anindya & Wusqo, 2020)	Journal of Physics: Conference Series	The implementation of PjBL with the STEAM approach has a positive influence on students' problem-solving abilities

Research Gate	(Ayuningsih et al., 2022)	Jurnal Basicedu	The application of PjBL with the STEAM approach can increase the creativity of students
Research Gate	(Burhanudin, 2021)	Junal Didaktika Pendidikan Dasar	The implementation of PjBL with the STEAM approach is very effective in increasing students' 4C activities
Google Schoolar	(Conradty et al., 2020)	Jurnal Education Sciences	The application of STEAM proves that creativity increases motivation through self-efficacy
Google Scholar	(Romero-Ariza et al., 2021)	Journal for the Study of Education and Development	Secondary school teacher self-efficacy beliefs can develop transformational teacher professionals in the STEAM environment
Google Scolar	(Filiayuk & Wardono, 2023)	International Journal of Education and Research	The implementation of PjBL through the STEAM approach with Google Classroom is very good
Google Scholar	(Jia et al., 2021)	Jurnal Frontiers in Psychology	The application of STEAM increases student self-efficacy
Google Scholar	(Noviyani et al., 2022)	Psychology, Evaluation, and Technology in Educational Research	There is an impact of PjBL on students' creative thinking and math skills
Research Gate	(Havita et al., 2019)	Jurnal Pembelajaran Fisika	There is a positive influence of PjBL on students' creative thinking abilities
Google Scholar	(Biazus & Mahtari, 2022)	International Journal of Essential Competencies in Education	The PjBL model significantly influences the creative thinking ability of high school students
Google Schoolar	(Saefullah et al., 2021)	Jurnal Ilmu Pendidikan Fisika	The practice of PjBL can improve students' creative thinking skills
Research Gate	(Anggraeni et al., 2022)	Proceeding The 4th International Conference on Elementary Education	The practice of PjBL can improve students' creative thinking skills
Google Scholar	(Mursid et al., 2022)	International Journal of Education in Mathematics, Science and Technology	The practice of PjBL may improve students' creative thinking abilities
Research Gate	(Suganda et al., 2021)	Journal of Physics: Conference Series	STEAM learning can improve students' creative thinking skills

Of the 26 articles reviewed, the authors came from Indonesia, Malaysia, Thailand, China, Brazil, Germany, Spain and the USA. STEAM research may be expand on a learning approach.

3.1. What are the objectives, types, and research methods used in the literature to assess students' self-efficacy in mathematics skills through the STEAM approach in project-based learning 2019-2023?

Figure 3. 1 below shows the 2019-2023 research on the analysis of students' self-efficacy and mathematical creative thinking ability through STEAM project-based learning. We identified 5 research flashpoints from 26 articles. The focus of the study was to determine the effect of PjBL on creative thinking, which was shown in 29%. It can be concluded that the research on project learning through STEAM method from 2019 to 2023 to analyze mathematical creative thinking skills from students' self-efficacy tends to focus on the impact of PjBL on creative thinking..

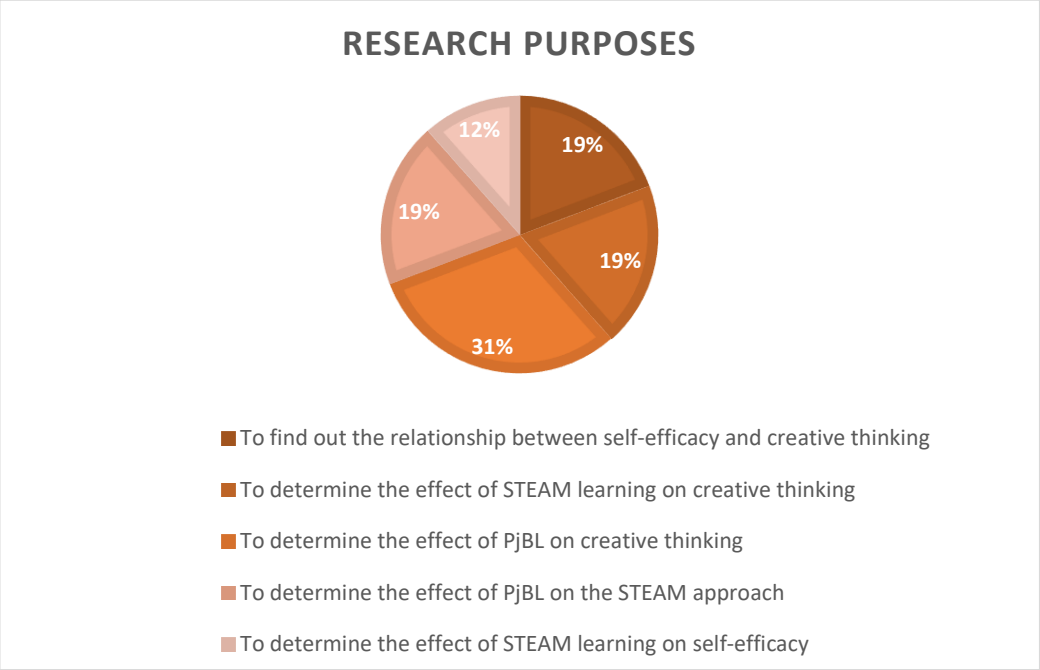

Figure 3. 1 Research Purposes

While the research focus on the relationship between self-efficacy and creative thinking, the influence of STEAM learning on creative thinking, and the influence of PjBL on the STEAM approach shows the same percentage, namely 19%. Furthermore, the research focuses on the analysis of the ability of mathematical creative thinking from the point of view of students' self-efficacy. through the STEAM approach to project-based learning has further opportunities in society 5.0.

Figure 3. 2 below shows 26 articles, 10 Types of research published 2019-2023 Project-based learning STEAM approach to analyze mathematical creative thinking skills in students' self-efficacy. Experimental types of research account for 34%, indicating that this type of research is often widely used in the analysis of mathematical creative thinking ability from the perspective of students self-efficacy through the STEAM approach to project-based learning.

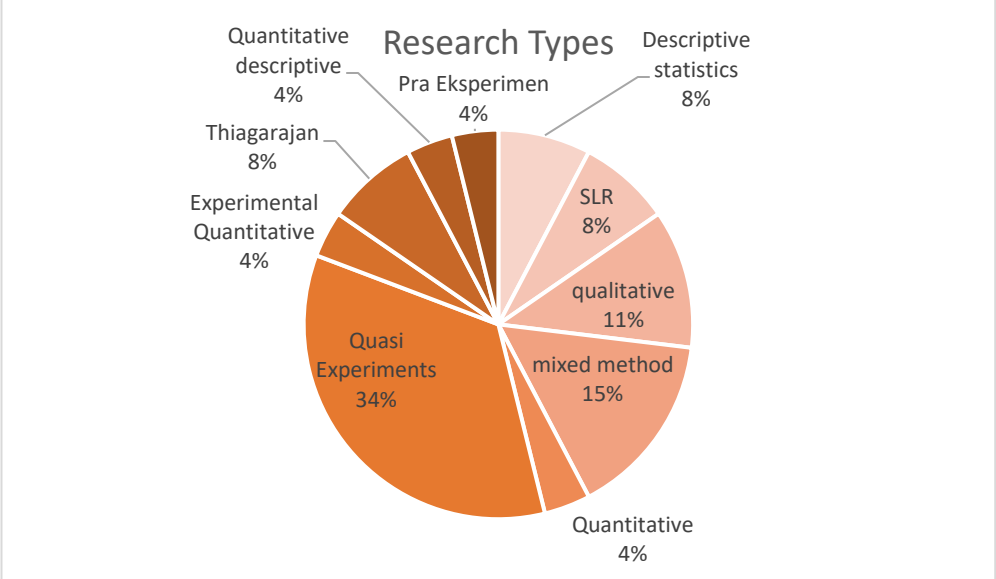

Figure 3. 2 Research Types

Then in **Figure 3. 3** below, it provides an overview of the research design used to analyze creative thinking of mathematics skills in terms of student self-efficacy through the STEAM approach in project-based learning in 2019-2023. It can be seen that the pretest posttest tends to be used in research on the analysis of creative thinking of mathematics skills in terms of student self-efficacy through the STEAM approach to project-based learning.

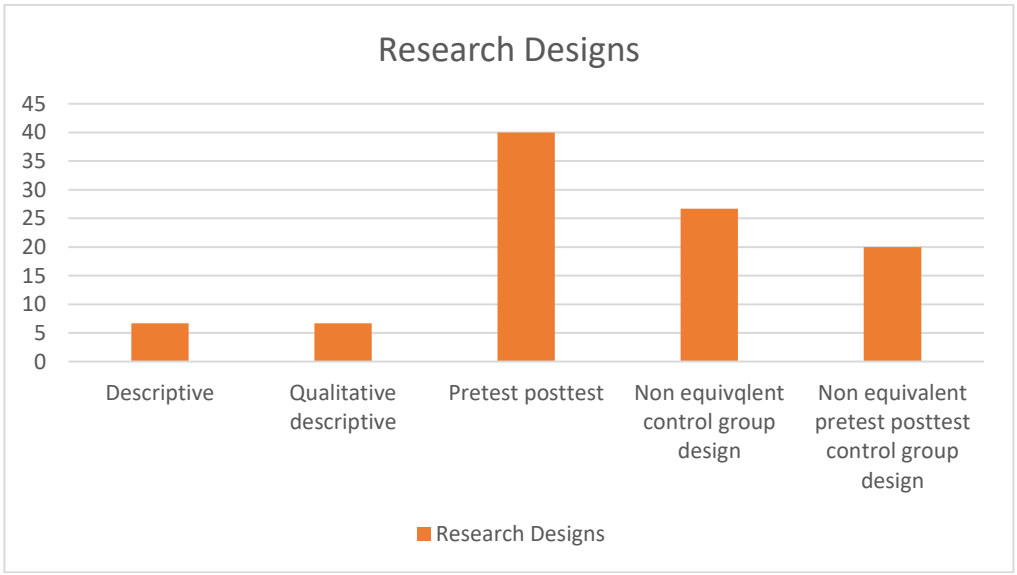

Figure 3. 3 Research Designs

3.2. What are learning models and media have been chosen in that article analyzing mathematical creative thinking abilities from a student self-efficacy perspective through the STEAM approach in project-based learning from 2019-2023?

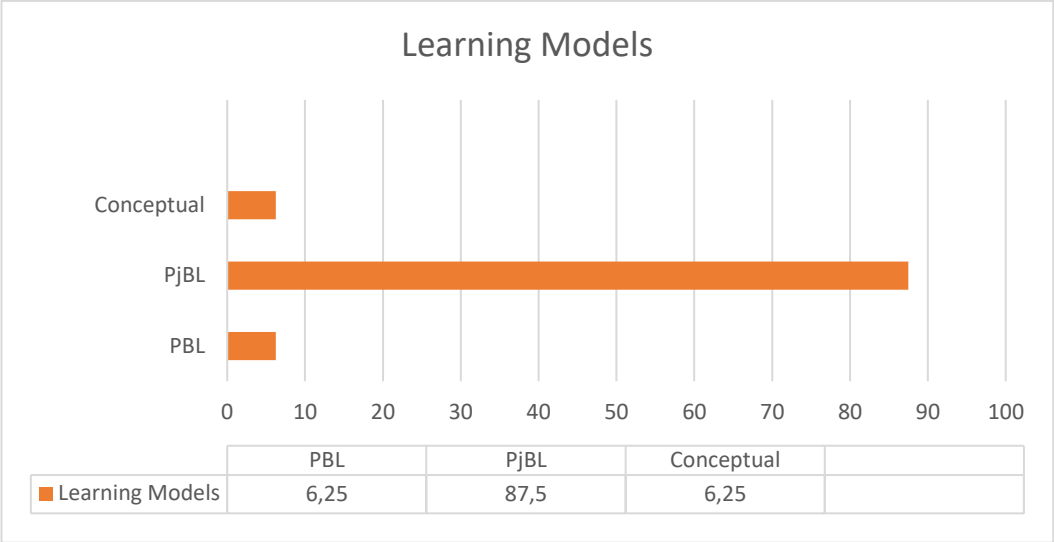

Figure 3. 4 Learning Models

The **Figure 3. 4** presents the learning model for analyzing the connection between the ability for mathematical creative thinking and students' self-efficacy through the STEAM method in project-based learning in 2019-2023. For research published from 2019-2023.

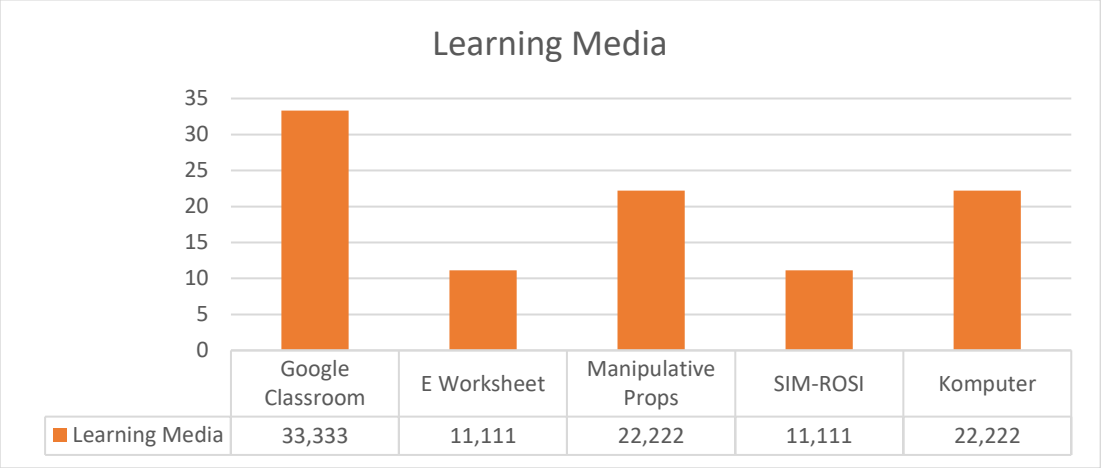

Figure 3. 5 Learning Media

Furthermore, **Figure 3. 5** depicts the learning media maked in research regarding the analysis of creative thinking of mathematics skill in terms of student self-efficacy through the STEAM approach in project-based learning in 2019-2023. The figure indicates that learning media using Google Classroom is choosen selected in the study of creative thinking in mathematics skills in terms of student self-efficacy through the STEAM approach to project-based learning.

3.3. How is the research trend of analyzing mathematical creative thinking abilities in terms of student self-efficacy through the STEAM approach in project-based learning from 2019-2023?

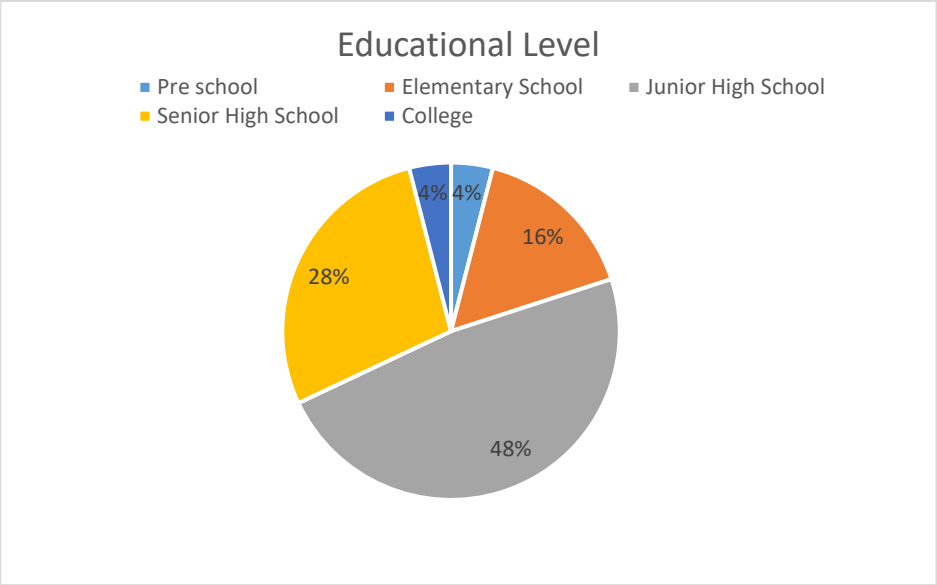

Figure 3. 6 Educational Level

Figure 3. 6 indicates the 2019-2023 research in the analysis of creative thinking, mathematical skills of students' self-efficacy through the STEAM project-based learning method. The survey at the higher education level shows 4 percent for college, 28 percent for high school, 48 percent for junior high school, 16 percent for elementary school and 4 percent for preschool. It can be seen that the research on mathematical creative thinking skills is analyzed from the students' self-efficacy perspective. through the STEAM approach to project-based learning tends to be carried out in junior high schools.

4. Conclusion

Such conclusions can be drawn based on the results of the literature review and discussion of 26 articles published in 2019-2023. First, research that analyzed students' self-efficacy for creative mathematical thinking through the STEAM approach to project-based learning was found to be valid. Second, "Research on analyzing the mathematical ability of creative thinking from students' self-efficacy in project-based learning through STEAM Methodology" published in 2019-2023 revealed that they tend to use the PjBL model and the media used in learning in Google Classroom. 3. Analysis and research on students' self-efficacy and creative thinking mathematical ability of the STEAM method in project-based learning is more often done at the junior high school level.

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