21st Century Skills in Project Based Learning Integrated STEM on Science Subject: A Systematic Literature Review

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ABSTRACT
21st century skills consist of 12 skills that are currently needed by students to support success in their future career paths. PjBL integrated STEM is believed to improve the 21st century skills. This research aims to overview the Project Based Learning integrated STEM and describe the 21st century skills in Project Based Learning integrated STEM on science subject. This research was a systematic literature review. The systematic literature review uses PRISMA guidelines and flowchart. The PRISMA guidelines include 27 point of checklist item and four-phase flow chart for transparency in the literature review. This research analysing 17 articles about Project Based Learning integrated STEM on 21st century skills that have been previously obtained. The syntax of PjBL-STEM consists of five steps, namely reflection, research, discovery, application, and communication. Overall, the PjBL-STEM enhanced the 21st century skills, especially on learning skills (4C) and scientific literacy skills. The effect of PjBL-STEM on media and technology literacy needs to be researched more further.

Keywords: *21st Century Skills, STEM, Project Based Learning, Project Based Learning integrated STEM.*

1. INTRODUCTION

In the 21st century, there is a shift in the values of life, such as a shift in socio-cultural, economic, demographic, political and economic values [1]. This shift in values must be responded to by schools as educational institutions that prepare students to become members of society. When children graduate from School they will become members of society who must adapt to their environment. In addition to adapting to the environment, students must be able to make ends meet.

The problem faced by the world of education today is the mismatch between school materials and the skills needed by the world of work / field [1]. In the 21st century, not only academic skills are needed but also some skills needed in an increasingly complex society. Some of the skills needed include digital literacy, inventive thinking, effective communication, and productivity [2].

Ease of accessing information and digitization make the level of competition between individuals even greater so that innovation is an important key to one's success [3]. In responding to changes that occur educational institutions have begun to make changes to the process of implementing their education[4]. The main objective of education is no longer academic success, but also to provide students with skills.

Various methods and approaches are used to change educational orientation in order to be able to prepare students to be able to adapt to life in the 21st century. One learning model that is expected to be able to provide skills to students is through Project Based Learning (PjBL) and STEM. PjBL is Student centered learning so that PjBL helps students to be able to find creative ideas and solve problems related to their social life [5], [6]

STEM (Science, Technology, Engineering, and Math) learning encourages students to learn actively. STEM learning aims to provide the main skills needed in the world of work [7], [8]. Through STEM learning students are actively involved in learning activities, solving problems, and integrating various knowledge so

that they become meaningful skills for students[9]. This paper aims to describe overview the Project Based Learning integrated STEM and describe the 21st century skills in Project Based Learning integrated STEM on science subject.

2. METHODS

This research was a systematic literature review. The systematic literature review uses PRISMA guidelines and flowchart. The PRISMA guidelines include 27 point of checklist item and four-phase flow chart for transparency in the literature review[10].

2.1. Eligibility Criteria

The eligibility criteria for include in this literature review require peer-reviewed and published in scientific journals. Research are reviewed in this systematic literature review between 2016 and 2020. Eligible studies must also be published in English or Indonesian with primary or secondary school students as participant.

2.2. Data Sources

Database search electronically and related to the field of Education and Social Science. Database searched through google scholar and ERIC. Google scholar is used to find relevant articles. Google scholar does not have the same search terms, resulting in 10.500 articles sorted by relevance. Haddaway[11] recommends listing the first 200 to 300 articles resulting from Google Scholar in order to find the appropriate literature. The last search was carried out on 26 October 2020.

The search terms used in this systematic literature review are: "STEM" AND "PJBL" OR "Project Based Learning" AND "Science Education" OR "Science Subject". All search were made against article abstract. Search restriction are performed to match the filtering criteria.

2.3. Study Selection

The screening procrress diagram can be seen in Figure 1. To select research that meets the criteria for this systematic literature review, the following criteria are needed: (1) research published between 2016 and 2020 in Indonesian and English, (2) Research published in scientific journals, (3) research participants use primary and high school students on science subject, (4) empirical research (qualitative, quantitative, or mixed method), (5) data according to the focus and questions of this research. In total, there were 17 articles that were compliant.

2.4. Evaluation

To evaluate the quality of the research in each article, an evaluation was carried out using a rubric consisting of seven criteria, namely objectives and purposes, review of the literature, theoretical frameworks, participant, method, result and conclusion. The evaluation was carried out on the full text content and the seven rubric component were measured to see that article meet the quality of reporting standards[12]. Each component consists of four scales, 1 = not meeting standard, 2 = almost meeting standard, 3 = meeting standard, 4 = exceeding standards. After adding up the seven components, the score of each article was between 7 and 28. Article that had a score less than 14 were excluded and damped not meeting the standard. After assessing the quality of each article, there was 4 articles excluded.
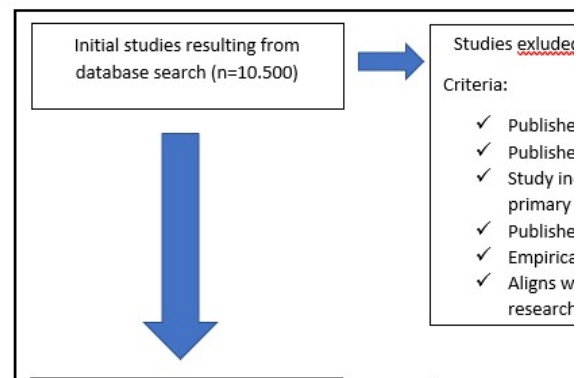

Figure 1. Diagram of screening process

2.5. Data Analysis

Analysis of the data in this study using thematic analysis. Thematic analysis is a method for identifying, analysing, and reporting on themes or patterns in data. An important part of each theme is taken. Braun & Clarke[13] explained that there are six steps in thematic analysis. The first step is identifying the data, the second step is coding the data, the third step is looking for a theme and compiling the code, the fourth step is applying the code to the data, the fifth step is defining the theme and the sixth step is generating a report on the theme and linking back to the research question.

3. RESULT AND DISCUSSION

This research is a systematic literature review research by analysing 17 articles about Project Based Learning integrated STEM on 21st century skills that have been previously obtained. There are 2 articles published in 2016, 2 articles published in 2018, 3 articles published in 2019, and 10 articles published in 2020. Meanwhile, based on the research methodology,

13 articles were qualitative research. 2 articles were qualitative research, and 2 articles mixed method. A summary of the systematic literature review is presented in Table 2.

3.1. Overview of Project Based Learning (PjBL) Integrated STEM

Project-based learning is one of the learning models based on the 2013 Curriculum. Project-based learning steps consist of key questions, designing projects, making schedules, monitoring students and reporting progress, assessing results, and evaluating experiences[14]. STEM is a learning strategy. The Integrated Project Based Learning Character in STEM is almost the same as Project Based Learning. In Integrated Project Based Learning STEM emphasizes more on the design process. The process of designing a systematic approach to developing solutions to problems with well-defined results.

PjBL-STEM consists of five steps, namely reflection, research, discovery, application, and communication[15]. Reflection shows the context of the problem to the students and provide inspiration so that they can come soon. Research helps students gather relevant information in developing conceptual understanding. The invention aims to develop students' abilities in building habits of mind from the process of designing and designing. Application aims to test products or find solutions to solve problems. Communication aims to present a product or solution within the scope of the class. The syntax description of the STEM integrated PjBL is described in Table 1.

Table 1. Syntax of Project Based Learning Integrated STEM.

Stage	Description
Reflection	This stage show context of the problem to the students and intended to link what is known and what needs to be learned.
Research	Student research process. During the research phase, the teacher's role is to guide the discussion to determine whether students have developed conceptual and relevant understandings based on the project
Discovery	The discovery stage generally involves the process of bridging research and known information in project development. Some of the models from STEM PjBL divide students into small groups to present possible solutions to problems, collaborate, and build cooperation between friends in groups.
Application	At the application stage the goal is to test the product / solution in solving problems. In this stage, students test products and the results obtained are used to correct previous steps.
Communication	The final stage in each project is to create a product / solution by communicating between friends and class scope.

Table 2. A summary of systematic literature review about PjBL Integrated STEM

Author (Year)	Methodology	Findings	Dependent Variable
Triana et al., 2020 [16]	quantitative research methods with one group pretest-posttest design	STEM-PJBL-based learning environment change is effective towards student collaboration and communication skills. This is evidenced by the average score of the acquisition of collaboration and communication skills in the very good category.	Collaboration and Communication Skills
Rizkiyah et al., 2020	quasiexperimental	(a) PjBL-STEM approach influences	Collaborative Skills

[17]	study using two classes,	students' collaborative skills, (b) PjBL-STEM approach influences student learning outcomes.	and Learning Outcome
Baihaqi, et al 2020[18]	quantitative experiment using Pre-Test Post-Test in one group	PjBL-STEM improve oral and written communication of each student in the moderate category.	Communication skills
Widyasmah et al., 2020 [19]	Mixed method	STEM approach based on PJBL enhance students' creative thinking and improved the indicators of creative thinking skill	creative thinking skill
Lestari, et al, 2018 [20]	Quasi Experimental Design research method with the Non equivalent control group design	PjBL-STEM model can improve students' creativity rather than learning based project model only.	Creativity
Hanif, et al (2019) [21]	qualitative research with the narrative design.	PjBL-STEM influence students creativity skills.	Creativity
Mutakinati, et al (2018) [22]	Descriptive research design	Students critical thinking on stage of average thinker on the stage of critical thinking development.	Critical Thinking
Ariyatun, Octavianelis, (2020)[23]	control group pretest posttest design	Problem based learning integrated STEM increase students critical thinking skills	Critical thinking skills
Gandi, et al, 2019[24]	Quasi Experimental Design research method with the pretest and posttest control group design	PjBL-STEM influence students critical thinking skills	Critical thinking skills
Ridlo et al., 2020 [25]	Mixed method	PjBL-STEM enhance the students critical thinking. The PjBL-STEM is able to encourage students to be able to communicate verbally.	Critical thinking skills and communication skills
Wan Husin, et al[26]	Paired sample t-test using pretest and posttest	PjBL-STEM may increase the students' level for the five elements of the 21st century skills.	Digital age literacy, inventive thinking, effective communication, high productivity, and spiritual value

Apriyani, et al (2019) [27]	the pre-experimental method with one group pretest-posttest design	Project-based Learning models in STEM-based learning as a whole have improved both overall in the value of the pretest, posttest, and worksheets as well as the indicator of problem-solving.	Problem Solving Abilities
Yuliati et al., 2020 [28]	Quasi-Experimental Nonrandomized Control Pretest-Posttest Design	PjBL-STEM increase the problem solving skills.	Problem Solving Skills
Bhakti, et al, 2020 [29]	The Static Group Pretest-Posttest Design	The PJBL integrated STEM influence student's science process skills	Science Process Skills
Lestari dan Rahmawati, 2020 [30]	The research method was a quasi-experiment method with the-factorial 3x2 design. Data analysis was performed with the two-way Anova test	PjBL-STEM enhance students scientific literacy.	Scientific literacy
Afriana, et al (2016) [31]	The static group pretest-posttest design	Students science literacy improve when studying with PJBL integrated STEM. All of students give positive respon when study with PJBL integrated STEM	Scientific literacy
Yuliati, et al (2020) [32]	Quasi-Experimental Nonrandomized Control Pretest-Posttest Design	The PjBL-STEM model enhance the students' scientific literacy	scientific literacy

3.2. 21st Century Skills in Project Based Learning (PjBL) Integrated STEM

21st century skills consist of 12 skills that are currently needed by students to support success in their future career paths. There are three categories of 21st century skills including study skills, literacy skills and life skills [33]. Learning skills consist of the four C's, namely critical thinking, creativity, collaboration, and communication. Literacy skills consist of information, media and technology literacy. Meanwhile, life skills consist of flexibility, leadership, initiative, productivity and social skills.

Project-based learning integrated STEM is very supportive of the development of learning skills (four C's). In the learning phase PjBL-STEM allows interaction, collaboration and collaborative interaction between students in analyzing problems and designing projects. The application of STEM-based learning requires changing the learning model from teacher-centered to student-centered learning, as well as individual learning to collaborative learning and emphasizing creativity, and problems in scientific knowledge applications [34].

Project-based learning integrated STEM affects collaborative skills [16], [17], [35]–[37]. Triana's research [16] states that in integrated PjBL-STEM students can work together in effective groups and also respect other groups. In addition, students can also be responsible in groups and each individual can also contribute to the group[38]. This is due to complex

activities such as project work and practicum, students can learn to respect others to find the best solution [17].

Several previous studies [16], [18] also showed that PjBL-STEM can affect students' communication skills. Triana's research [16] shows that PjBL-STEM learning encourages students to articulate thoughts and ideas effectively using spoken and written communication in group work and project and product presentations, making students learn effectively, communicating for various purposes effectively. This is based on PjBL-STEM learning train students to develop communication skills through project activities, implementing projects, to presenting projects that require students to perform and explore their communication skills [39], [40].

PjBL-STEM can affect students' creative thinking skills [19]–[21]. In PjBL-STEM learning, students can realize their ideas by building and building products in STEM project-based learning. Thus, students are given the opportunity to develop their ideas using several tools and materials that can improve product quality [21]. This can indicate that students who learn science using STEM project-based learning have good creativity [41].

PjBL-STEM affects students' critical thinking skills [22]–[25]. Students who learn using PjBL-STEM can think critically at the average thinker stage. The average thinker is in the critical thinking stage, this means that students have sufficient ability to criticize their planning and build critical reasons to build the right questions [22]. PjBL - STEM facilitates students to understand the concept, so that students will feel confident to test the products they make and present them in class [24], [25].

In the aspect of literacy skills, PjBL - STEM has been widely studied in relation to scientific literacy. PjBL - STEM has optimal effect on scientific literacy [30]–[32]. Afriana [31] shows that both male and female students show a positive response and are happy with the application of PjBL STEM in air pollution learning. According to students, learning is interesting and motivating; can help understand teaching material, form creative attitudes, and students are increasingly aware of the importance of protecting the environment. Thus, it can conclude that PjBL-STEM support student's science literacy. In science subjects, the literacy skills component studied was only limited to scientific literacy. Meanwhile, the relationship between PjBL - STEM and media and technology literacy has not been studied much. In addition, the relationship between life skills components in 21st century skills and PjBL has also not been discussed much.

4. CONCLUSION

21st century skills consist of 12 skills that are currently needed by students to support success in their future career paths. There are three categories of 21st century skills including study skills, literacy skills and life skills. Overall, PjBL-STEM enhanced the 21st century skills, such as four-C skills and scientific literacy. The effect of PjBL-STEM on media and technology literacy needs to be researched further.

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