

STEAM-Integrated Project Based Learning Models: Alternative to Improve 21st Century Skills

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ABSTRACT

Education in Curriculum 2013 has to create and design learning for the 21st century. 21st-century skills have to possess critical thinking, problem-solving, creativity, collaboration, communication, science literacy, etc. STEAM-integrated project-based learning consists of five aspects, namely science, technology, engineering, art, and mathematics, implemented with project-based teaching and learning activities. The research's objective is to observe the STEAM-integrated project-based learning model's effectiveness in improving students' 21st-century skills. The research method is qualitative-descriptive by reviewing twenty journals as the literature. Study shows that there are many Project Based Learning (PjBL) models built into STEAM that effectively enhance one of the skills in the 21st century. Therefore, future research must explore the implementation of STEAM-integrated project-based learning during the Covid-19 pandemic by developing e-learning material based on STEAM-PjBL that can be used in online learning.

Keywords: STEAM, Project-based learning, 21st-century skills.

1. INTRODUCTION

The development of 21st-century education has undergone many changes in line with the development of technology. These developments cause the turning up of various expectations and new demands to adapt to this era. Education is the main point that must develop in the face of change in the 21st century. Education requires learning designed not only to understand concepts but also to use concepts in everyday life for survival in society. Education in Indonesia responds to the development of 21st-century education with the 2013 curriculum. Students are given the freedom to solve problems on their own and trained to understand the various problems that arise faced in the implementation of the 2013 curriculum. Characteristic 2013 curriculum is students' ability to understand the concepts by working together to implement real-life situations [1]. Therefore, education in the 2013 curriculum has to create and design learning activities to meet the demands of the 21st century.

Based on the results of observations at As-Sirajul Munir Middle School, it shows that the 21st century skills of students are still low. Teachers are still not

applying learning that trains 21st-century skills for students. 21st-century skills are needed in every area of life. Reports from 400 stakeholders in the world of work agree that 21st-century skills are required for work [2]. Learning in the 21st century requires innovation, creativity, and teacher sensitivity in designing teaching and learning activities. Learning must be student-centered because 21st-century skills are not the ability to memorize but the ability to solve various kinds of real-life problems. The skills that must be possessed in this 21st century include critical thinking, problem-solving, creativity, science literacy, communication, collaboration, etc.

Learning with STEAM-integrated project-based learning can be one solution to improve 21st-century skills. STEAM is a learning approach containing five components: science, technology, engineering, art, and mathematics [3, 4]. STEAM comes from the development of STEM by incorporating art into the learning component [5, 6, 7]. STEAM aims to prepare students to solve problems with innovative, creative, critical thinking, collaboration, and communication to gain new information or knowledge [8].

A learning model that involves students in learning activities and gives more time to solve problems in the form of working on projects individually or in groups is Project-based learning (PjBL) [9, 10]. The PjBL is learning that encourages students to be active, capable of implementing their knowledge, and develop various thinking skills and concrete skills [11].

STEAM-integrated project-based learning guides students in doing learning by completing one or several projects that are very relevant and related to everyday life [12]. STEAM-PjBL gives a start for students to integrate various disciplines in an application of concepts in the form of project assignments so that in the end, they can improve multiple 21st-century skills. 21st-century skills are needed to face today's world that demands solutions, not just theories. STEAM-PjBL learning will allow students to experience directly how the world works. The research's objective is to observe the STEAM-integrated project-based learning model's effectiveness in enhancing students' 21st-century skills.

2. METHODS

The type of research used is a literature study by reviewing several national and international journals as literature that can be accounted for the truth. A systematic and structured literature review is used to analyze the influence of STEAM-integrated project-based learning to improve 21st-century skills. The researcher conducted an article search process with search engines Scholar, Eric, and Elsevier. This study only concerned the last five years of research, namely 2017 to 2021. The journals used as data are 20 related to STEAM-integrated project-based learning and improving 21st-century skills. The data that has been collected is analyzed using qualitative-descriptive.

Data analysis in qualitative research generally has

Table 1. Journal review results

No.	Journal	Review The Journal
1.	Jurnal Didaktia Pendidikan Dasar, Vol.3, No. 2, 2019: 499-518. E-ISSN: 2746-0525 [13].	Author: Firmansyah Journal Results: The implementation of PjBL-STEAM assisted by Camtasia video media affects increasing student learning activities, as evidenced in the first cycle, 60% of the good enough category increases in the second cycle, 84% of the good category and has an effect on increasing student learning outcomes, which can be seen in the first cycle 63% of the moderate category good increased 77% good category. Study Results: The application of PjBL-STEAM is suitable to 21st-century learning because student-centered learning can be seen from increased student learning activities, and learning outcomes also increase.
2.	AIP Conference Proceedings 2330, 030060, 2021 [14].	Author: Ni Komang Dina Suciari, Ibrohim, Hadi Suwono Journal Results: Biology learning based on STEAM PjBL can improve students' communication skills ($p = 0,003 < \alpha (0,05)$) with a mean correction of 80,13 in the experimental class and 75,48 in the control class. Biology learning based on STEAM PjBL have positive effect on the students' mastery of concepts ($p = 0,002 < \alpha (0,05)$) with a mean correction of 84,38 in the experimental class and 75,38 in the control

the following steps according to Miles and Huberman, namely: 1) Data collection is the process of collecting information either through journal reviews or experiments that are needed to answer research objectives. 2) Data reduction simplifies data to get a clear picture of research results and meaningful information. Data reduction steps include summarizing the article, focusing on the main topic, and removing unnecessary data. 3) Data Display is the step to present data and information obtained from qualitative research, most often written in narrative text. Data display can be in charts, brief descriptions, the correlation between subjects, etc. 4) Conclusions and verification are the results of new findings from the analysis of a study that has never existed before. For more details, see Figure 1.

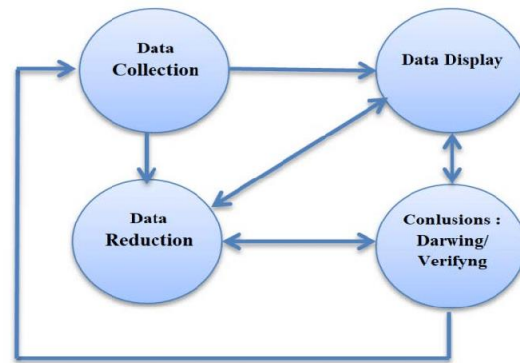


Figure 1 Data analysis steps in qualitative research.

3. RESULTS AND DISCUSSION

An overview of the analysis of several national and international research journals related to the relationship between project-based learning integrated with STEAM and 21st-century skills improvement can be seen in Table 1.

No.	Journal	Review The Journal
2.		Study Results: STEAM integrated PjBL has a significant effect on improving 21st-century skills that are indicated by enhancing students' communication skills.
3.	Jurnal Pendidikan Sains Indonesia, Vol. 9, No. 3, 2021: 512-527. p-ISSN: 2338-4379 [15].	<p>Author: Anik Anekawati, Jefri Nur Hidayat, Nabila Abdullah, Hellyyatul Matlubah</p> <p>Journal Results: The difference in the influence of the learning design using the PjBL model integrated with STEAM occurs between students with right- and left-brain dominance. The science skill process affects cognitive learning outcomes.</p> <p>Study Results: The application of the PjBL model integrated with STEAM affects the science skill process that can improve cognitive learning outcomes by comparing the experimental and the control class. It can be concluded that the research indirectly proves that STEAM-integrated PjBL can improve 21st-century skills.</p>
4.	Journal of The Indonesian Society of Integrated Chemistry, Vol. 10, No. 2, 2018: 42-46. E-ISSN 2621-554 [16].	<p>Author: Rifka Annisa, M. Haris Effendi Hsb, Muhammad Damris</p> <p>Journal Results: There is a real difference in students' creative thinking skills by implementing the project-based learning model with STEAM on acid and base materials in SMAN 11 Jambi. It can be seen in the paired sample test with a 2-tailed significance value of $0.000 < 0.05$.</p> <p>Study Results: Creative thinking skills improve after the project-based learning model with STEAM is applied. Creative thinking is one of the skills that must be trained in improving 21st-century skills.</p>
5.	Bioeducation Journal, Vol. 4, No. 2, 2020: 94-102. e-ISSN 2615-5451 [17].	<p>Author: Ika Priantari, Aulya Nandha Prafitasari, Dwi Retno Kusumawardhani, Siti Susanti</p> <p>Journal Results: The experimental class implemented the STEAM approach, and the PjBL model showed a significant effect. The results of data analysis showed that the value of Sig. (2-tailed) of 0.046, the value is smaller than 0.05. It indicates that H1 is accepted, students' critical thinking skills between the experimental and control classes obtained different results.</p> <p>Study Results: The use of the STEAM approach combined with the PjBL model effectively increases students' critical thinking skills, which is one part of 21st century skills.</p>
6.	Jurnal Pendidikan MIPA Pancasakti (JPMP), Vol. 5, No. 2, 2021: 110-117. ISSN 2597-9582 [18].	<p>Author: Desta Alvionita, Joko Sudomo, Purwanti Widhy H</p> <p>Journal Results: The development of STEAM-oriented student worksheets with the PjBL model on environmental pollution materials to improve creative thinking skills is feasible in terms of validity, practicality, and effectiveness. The increase in the average N-gain score is a sign of the effectiveness of the results after the pre-test and post-test of creative thinking skills with a very high category.</p> <p>Study Results: The development of STEAM-oriented student worksheets with the PjBL model on environmental pollution material is effective to improve 21st-century skills because it is proven to increase students' creative thinking skills.</p>
7.	Jurnal Inovasi Pendidikan IPA, Vol. 6, No. 1, 2020: 88-100. ISSN 2477-4820 [19].	<p>Author: Nur Lailatul Badriyah, Anik Anekawati, Lutfiana Fazat Azizah</p> <p>Journal Results: The results of the N-Gain score can be seen that both learning outcomes and science process skills in experimental class 1 have higher scores than experimental class 2. Experimental class 1 uses the PjBL model with the brain-based STEAM approach in learning activities. It means that the implementation of PjBL with STEAM positively affects learning outcomes and science process skills.</p> <p>Study Results: Implementation of PjBL with the brain-based STEAM approach is suitable for improving 21st-century skills in line with increasing learning achievement.</p>

No.	Journal	Review The Journal
8.	Journal of Physics: Conference Series, 1567, 042054, 2020. ISSN 17426596 [20].	<p>Author: F A U Anindya, I U Wusqo</p> <p>Journal Results: This study was designed by comparing students' problem-solving skills between the experimental class using PjBL-STEAM and the control class using conventional learning. The results showed that problem-solving skills in the experimental class were higher on the three indicators that had been measured, namely understanding the problem, compiling and displaying problem-solving steps, re-checking the problem-solving results. These results can be concluded that PjBL-STEAM is very effective to improve problem-solving skills.</p> <p>Study Results: The PjBL-STEAM greatly influences problem-solving skills (part of 21st-century skills).</p>
9.	Ide guru: Jurnal Karya Ilmiah Guru, Vol. 6, No. 3, 2021: 272-279. e-ISSN 2722-2195 [21].	<p>Author: Sri Lestari</p> <p>Journal Results: There is an increase in scientific critical thinking skills in research results. It can be indicated from a normalized gain score of 0,54 and creative thinking with a gain score normalized 0,65 after the implementation of STEAM-integrated PjBL learning with spectra-plus in the medium category. From the observation sheet, collaboration skills get 73% to belong high category, and communication skills get 77% to belong high category— student responses to the application of learning by 78.21%. Student responses are quite positive towards the implementation of STEAM-integrated PjBL learning.</p> <p>Study Results: STEAM-integrated PjBL learning by linking science, technology, engineering, arts, and mathematics packaged in the form of student projects can improve 21st-century skills because students are given a comprehensive understanding of connecting various fields of knowledge during the learning process.</p>
10.	Jurnal Pendidikan Biologi Biosfer, Vol. 13, No. 2, 2020: 183-200. E-ISSN: 2614-3984 [22].	<p>Author: Siti Nur Mufida, Diana Vivanti Sigit, Rizhal Hendi Ristanto</p> <p>Journal Results: The study offers several implications, namely: (1) the PjBeL-STEAM learning model has potential as an alternative learning model that could facilitate senior high school students in improving science process skills, and (2) the PjBeL-STEAM learning model facilitates students to think independently, to explore, create, and observe.</p> <p>Study Results: The experimental class had a more positive effect on science process skills than the control class using PjBeL-STEAM learning. It means that PjBeL-STEAM can develop 21st-century skills.</p>
11.	Atlantis Press, Vol. 503, 2020: 81-86 [23].	<p>Author: Indah Nopiyanti, Nahrowi Adjie, Suci Utami Putri</p> <p>Journal Results: The research proves that STEAM-PBL effectively develops children's speech skills. Because of STEAM-PBL learning, children are given more stimulation in pronunciation, vocabulary, and sentence formation through conversation, question and answer, and discussion activities integrated into the STEAM PBL stages, including reflection, research, discovery application, communication.</p> <p>Study Results: STEAM-PBL as a relevant strategy to the characteristics of 21st century learning able to develop basic science process skills, one of which is communication skills, so that 21st-century skills can also develop.</p>
12.	Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, Vol. 6, No. 2, 2022: 856-867. ISSN: 2549-8959 [24].	<p>Author: Suci Utami Putri, Abdurrohman Ahmad Taqiudin</p> <p>Journal Results: Children's problem-solving abilities in PAUD, which were originally generally in the criteria of "Not yet Developed" and "Starting to Develop", increased to "Developing as Expected" and "Developing very Good" after applying STEAM-Project Based Learning (STEAM-PBL). Reflection, research, discovery, application, and communication are the steps carried out by implementing STEAM-PBL.</p> <p>Study Results: STEAM-Project Based Learning (STEAM-PBL) improves one of the 21st-century skills, namely students' problem-solving skills.</p>

No.	Journal	Review The Journal
13.	Journal of Physics: Conference Series, Vol. 1402 055049, No. 5, 2019 [25].	<p>Author: Y Rahmawati, M A Agustin, A Ridwan, E Erdawati, D Darwis, R Rafiuddin</p> <p>Journal Results: In this study, students learn to design an innovative project by incorporating a STEAM component into the project creation process. The concepts that students learn are electrolyte and non-electrolyte solutions in chemistry. Students make a miniature LED using lemon as a natural electrolyte solution. This project can be an alternative to producing light without using a power source. The STEAM-PjBL learning design can develop 21st-century skills because it provides direct experience to students on how to implement material concepts into real problems. Some of these skills include collaboration, communication, innovation, creative thinking, and critical thinking.</p> <p>Study Results: By implementing STEAM project-based learning, students' 21st-century skills can be trained in chemistry learning. Students are given a chance to understand various problem solutions and work in real life during learning activities.</p>
14.	Jurnal Pendidikan Indonesia, Vol. 2, No. 6, 2021: 1097-1111. e-ISSN: 2746-1920 [26].	<p>Author: Siti Suryaningsih, Fakhira Ainun Nisa</p> <p>Journal Results: STEAM Project Based Learning showed positive results on science process and creative thinking skills. Science process skills got 4,164 scores, including in the high percentage, 83.3%. Creative thinking skills got good results, namely 4.134 scores classified in the high category, 82.7%.</p> <p>Study Results: Innovation of the integration of STEAM project-based learning gets good responses from students in science process skills and creative thinking skills. Based on that, STEAM PjBL can train 21st-century skills.</p>
15.	AIP Conference Proceedings, 1868, 030008, 2017 [27].	<p>Author: Tritiyatma Hadinugrahaningsiha, Yuli Rahmawati, Achmad Ridwan</p> <p>Journal Results: The conclusions of this study, many skills can be trained in chemistry learning, some of which are students' problem solving, critical, creative, collaboration, argumentation, leadership, and literacy skills. Furthermore, some of these skills experienced positive changes after the implementation of the modified project-based learning model by integrating STEAM.</p> <p>Study Results: Integrating STEAM-project based learning into chemistry learning improves students' 21st-century skills.</p>
16.	Universal Journal of Educational Research, Vol. 8, No. 5, 2020: ISSN: 1863-1873 [28].	<p>Author: Adriyawati, Erry Utomo, Yuli Rahmawati, Alin Mardiah</p> <p>Journal Results: The study results show that the STEAM-PjBL can be applied in elementary school to develop student scientific literacy. The majority of students had reached the competent level. It indicates that students have been able to see the importance of scientific knowledge to explain the phenomena in everyday life (science in context). Analysis of scientific ideas aspect shows that students' curiosity increases, and students can make simple scientific investigations. Students have dared to ask questions.</p> <p>Study Results: Implementation of STEAM-PjBL in elementary school can be a solution to develop 21st-century skills because it can increase scientific literacy.</p>
17.	AIP Conference Proceedings 2331, 040010, 2021. ISSN: 15517616 [29].	<p>Author: Sukro, Afrizal, Rifai</p> <p>Journal Results: Students' critical thinking skills are a very important ability in overcoming environmental problems. This research provides a solution in training students' critical thinking skills in learning chemistry in senior high school, namely by integrating STEAM learning into an environmental project.</p> <p>Study Results: The STEAM integration of the environmental-based project in chemistry learning improves one of the 21st-century skills, namely critical thinking skills.</p>

No.	Journal	Review The Journal
18.	Sustainability, Vol. 12, No. 9696, 2020: 1-21. ISSN: 20711050 [30].	Author: Francisco Ruiz Vicente, Alberto Zapatera Llinares, Nicolás Montés Sánchez Journal Results: The problem of climate change is getting closer to primary school students. After comparing the results of the pre-test and post-test, it was found that the students' skills and motivation increased because the post-test results were higher than the pre-test. It is an implication of implementing The "Sustainable City", which integrates elements of STEAM learning with Project-based on educational robotics. Study Results: The STEAM project (Sustainable City) can improve skills in the 21st century.
19.	IOP Conference Series: Journal of Physics: Conf. Series, 1156, 012033, 2019. ISSN: 17426596 [31].	Author: Y Rahmawati, A Ridwan, T Hadinugrahaningsih, Soeprijanto Journal Results: Creativity and critical thinking skills are part of 21st-century skills developed in the research by the STEAM combination with a project-based learning model on acids and bases. The application of STEAM-PjBL is explored to integrate chemistry with problems in Indonesia that are commonly found in everyday life. Study Results: The STEAM-integrated project-based learning model can train 21st-century skills (critical thinking and creativity).
20.	MIER Journal of Educational Studies, Trends & Practices, Vol. 7, No. 2, 2017: 184-194 [32].	Author: Achmad Ridwan, Yuli Rahmawati, Tritiyatma Hadinugrahaningsih Journal Results: High-order thinking skills consisting of critical thinking, creative thinking, problem-solving, collaboration, and argumentation can be trained by applying a combination of STEAM with a modified project-based learning model. In this study, STEAM principles were integrated into chemistry lessons by including learning activities in project creation. As a result, students become trained in creating or designing projects by paying attention to the concepts that have been learned. Study Results: 21st-century skills can be improved by using The STEAM combination with modification of the project-based learning model.

Based on data and analysis, STEAM-integrated project-based learning makes students try to integrate the concepts of science, technology, engineering, art, and mathematics in doing a project collaboratively. It produces a product in the end. Students' practice finding solutions to problems in the surrounding environment and are given freedom in the learning process. Learning using STEAM-integrated project-based learning is student-centered. It involves students obtaining deeper knowledge through active exploration of real-world challenges. It discusses learning material in more detail to produce a product as a solution to several problems in learning material. The results of the research support idea that the STEAM-integrated project-based learning education is interesting and challenging. Students allow explore, analyze, create, discover and draw conclusions related to the important application in real-life [33].

The STEAM-integrated project-based learning has more value in its implementation, namely containing real problems, providing an appreciation of student work, student autonomy in the learning process, and supporting learning based on learning by doing. It will be better to improve students' critical thinking skills and scientific performance [17]. STEAM-PjBL learning can lead students to develop creative thinking skills,

problem-solving, and communication skills. Based on the previous explanation, many advantages can be obtained, especially in improving 21st-century skills by implementing STEAM-integrated project-based learning, besides understanding the concept of deeper knowledge. Students can collaborate in solving a problem with critical thinking skills. But more time must be spent in implementing the learning design.

However, all journal results stated that 21st-century skills could be improved by the implementation of STEAM-integrated project-based learning [32]. The latest challenge in education is changing the learning process into an online system due to the Covid-19 pandemic. Learning using STEAM-integrated project-based learning, which is proven to improve 21st-century skills, needs to be tested its influence in learning during the Covid-19 pandemic again. It is hoped that STEAM-integrated project-based learning can be an alternative learning solution, both offline and online.

4. CONCLUSION

Implementation of STEAM-integrated Project-Based Learning has a positive effect in improving students' 21st-century skills. STEAM-integrated PjBL provides a

real learning experience for students in applying the concepts that have been learned in a project activity by integrating various disciplines of knowledge. The learning activities provide space for students to train 21st-century skills, including critical thinking skills, creative thinking skills, science process skills, communication, scientific literacy, and others. The limitation of this research is STEAM-PjBL during the Covid-19 pandemic is still lacking to test its effectiveness in improving one of the 21st-century skills, considering that learning in the pandemic era prioritizes the online system. Future research must explore the implementation of STEAM-integrated project-based learning during the Covid-19 pandemic by developing e-learning material based on STEAM-PjBL that can be used in online learning.

AUTHORS' CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: Zayyinah, Erman, Zainul Arifin Imam Supardi; data collection: Zayyinah, Eko Hariyono, Zainul Arifin Imam Supardi; analysis and interpretation of results: Zayyinah, Binar Kurnia Prahani, Erman; draft manuscript preparation: Zayyinah, Erman, Zainul Arifin Imam Supardi, Eko Hariyono, Binar Kurnia Prahani. All authors reviewed the results and approved the final version of the manuscript.

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