

## Enhancing Social-Emotional Skills in Junior High School Students Through Project-Based Learning on Solar System Topics

Sarah Nur Fazriah<sup>1</sup>, Nanang Winarno<sup>2\*</sup>, Ratna Ekawati<sup>3</sup>, Nurwastisari Kardani<sup>4</sup>

<sup>1</sup>*Pendidikan Profesi Guru Prajabatan Universitas Pendidikan Indonesia, Bandung, Indonesia*

<sup>2</sup>*Department of Science Education Universitas Pendidikan Indonesia, Bandung, Indonesia*

<sup>3</sup>*Master of Primary Education Universitas Negeri Malang, Malang, Indonesia*

<sup>4</sup>*SMP Negeri 25 Bandung, Bandung, Indonesia*

Corresponding author. Email: nanang\_winarno@upi.edu

### ABSTRACT

Early adolescence is a critical transitional period marked by significant physical, cognitive, and socio-emotional changes. During this crucial stage, developing social-emotional skills becomes essential to help adolescents adapt to the changes and challenges they face. This study aims to analyze the improvement of social-emotional skills among students by implementing a Project-Based Learning (PjBL) model on the Solar System. This study employed a pre-experimental design with a One-Group Pretest-Posttest Design. Data was collected using a social-emotional skills questionnaire. The study was conducted at a school in Bandung, Indonesia, with 35 seventh-grade students (14 males and 21 females) as participants. The results indicated a significant improvement in students' social-emotional skills, with a mean pre-test score of 74% and a mean post-test score of 77%. The N-Gain scores for Self-Awareness, Social-Awareness, Self-Control, Relationship Skills, and Responsible Decision-Making were 0.14, 0.12, 0.08, 0.04, and 0.05, respectively. Since all N-Gain scores were below 0.3, they can be interpreted as low. The findings suggest that the PjBL model can serve as an alternative for teachers to enhance students' social-emotional skills, particularly in science education.

**Keywords :** Project-Based Learning; Social-Emotional Skills; Solar System



Pillar of Physics Education is licensed under a Creative Commons Attribution ShareAlike 4.0 International License.

## I. INTRODUCTION

Early adolescence is a critical transition period for every individual, marked by significant physical, cognitive, and social-emotional changes [1]. This brings various challenges and necessitates the development of appropriate skills to overcome them. At this crucial stage, developing social-emotional skills becomes essential to help adolescents adapt to the changes and challenges they face [2]. Social-emotional skills involve understanding and managing one's own emotions, empathizing with others, fostering healthy relationships, and making responsible choices [3]. Social-emotional learning (SEL) is relevant to the success of students not only in the educational realm but also in their overall lives. Dusenbury & Weissberg explain that in various studies examining SEL and its impact on students, "students who participate in SEL programs outperform students who do not. [4]"

Schools and other educational programs should not solely focus on preparing young people for the workforce. Schools should also strive to help students learn how to collaborate effectively with others, become critical thinkers, and contribute to a democratic society [5]. Research has shown that students' ability to understand social problems, formulate innovative solutions, and actively address social issues stems not only from their academic abilities but is also influenced by their social-emotional skills [6, 7]. Given that schools are one of the few organizations that can reach nearly all young people, schools become the primary setting for developing social and emotional skills and competencies [8]. Based on observations and interviews with several teachers at a junior high school in Bandung City, several problems faced by some seventh-graders in the learning process were identified. These problems include low levels of student concentration during learning, lack of

enthusiasm for learning, ineffective interaction between group members, lack of motivation to complete tasks, and a tendency to choose friends based on shared interests and backgrounds.

Project-Based Learning (PjBL) stands out as an effective pedagogical approach to fostering social-emotional skills among students. PjBL facilitates the development of both academic and social skills by engaging learners in real-world applications of their acquired knowledge [9]. As highlighted by Häkkinen et al. in Almulla, PjBL serves as an effective strategy for cultivating 21st-century skills in students, including critical thinking, problem-solving, interpersonal communication, information and media literacy, collaboration, leadership, teamwork, innovation, and creativity [10]. Weissberg et al. further emphasize the role of PjBL in promoting personal development and fostering interpersonal relationships [11]. Jagers et al. add that PjBL encourages students to collaborate towards shared goals, ultimately contributing to classroom well-being and positive change [12]. Additionally, Baines et al. underscore the value of PjBL as a method for nurturing social-emotional skills in learners [13]. Through PjBL, students can cultivate essential skills such as teamwork, effective communication, and ongoing reflection. However, based on an analysis of various literature on PjBL, no article has been found that investigates the effectiveness of the PjBL model in improving students' social-emotional skills in the solar system diorama making project.

Given the positive impacts of PjBL model on students and its ability to engage students in developing social and emotional skills, this research aims to conduct a study titled "Enhancing Social-Emotional Skills in Junior High School Students through Project-Based Learning on Solar System Topics." This study aims to determine whether there is an improvement in the social-emotional skills of middle school students after implementing a PjBL model on the Solar System topics by creating a Solar System diorama. The activity of creating a Solar System diorama was chosen because it could integrate various aspects of social-emotional skills such as collaboration, communication, and empathy. This research is expected to improve the quality of learning in middle schools, especially in developing students' social-emotional skills.

## II. METHOD

This study employed a one-group pre-experimental research method without a control group. The research design utilized a one-group pretest-posttest design. This design was employed to observe and measure the impact of the administered treatment, considering the pre-treatment conditions to allow for comparison. Creswell further explains that a pretest is an initial measurement conducted to assess specific characteristics of participants before they receive the treatment in an experiment [14]. Conversely, a post-test is a final measurement conducted to assess participants' specific characteristics after receiving the treatment in an experiment. This research design can be illustrated in Table 1.

**Table 1.** Research Design

O	X	O
Pre-test	Treatment	Post-test

The school selected as the research location is one of the schools in Bandung City that has implemented the Merdeka Curriculum. The population of this study is 35 seventh-grade students with an age range of 12-14 years, 14 of females (40%) are male, and 21 (60%) are female, were selected as samples. The sampling method used is Convenience Sampling. The sampled students were chosen because they were available to be researched. The research subjects can be seen in Table 2.

**Table 2.** Research Subjects

Research Subjects	Number	Percentage
Male	14	40%
Female	21	60%
<b>Total</b>	<b>35</b>	<b>100%</b>

This research employed questionnaires to measure students' social-emotional skills administered before and after the learning process. The questionnaire was adapted from Fernández-Martín et al., designed to assess various aspects of social-emotional skills, including Self-Awareness, Social-Awareness, Self-Control, Relationship Skills, and Responsible Decision-Making [15]. The questionnaire consisted of 10 questions for Self-Awareness, 5 for Social-Awareness, 10 for Self-Control, 6 for Relationship Skills, and 4 for Responsible

Decision-Making. Additionally, observations were conducted during the learning process to record the interactions and attitudes of students towards each other. Qualitative data from observations were analyzed descriptively to identify patterns of interaction and student attitudes.

Data analysis to measure students' social-emotional skills was conducted using Microsoft Excel and SPSS. This analysis was carried out by calculating the pre-test and post-test scores. The data analysis process was carried out in the following steps:

#### **Assessment of Test Items**

The questionnaire used to assess social-emotional skills consisted of 35 statements, with ten statements for the Self-Awareness aspect, five statements for the Social-Awareness aspect, nine statements for the Self-Control aspect, six statements for the Relationship Skills aspect, and four statements for the Responsible Decision-Making aspect. The rubric used to score the test items was a 1-4 Likert scale, resulting in a maximum possible score of 140.

Positive statement items were scored as 1 if the student responded "Strongly Disagree," 2 if they responded "Disagree," 3 if they responded "Agree," and 4 if they responded "Strongly Agree." Negative statement items were scored as 1 if the student responded "Strongly Agree," 2 if they responded "Agree," 3 if they responded "Disagree," and 4 if they responded "Strongly Disagree."

#### **Normality Test**

A normality test was conducted to determine whether the data distribution was normal or not. This test is often used in parametric statistical analysis. Since the sample size was less than 50, we used the SPSS version 27.0 program to perform the Shapiro-Wilk normality test.

#### **Homogeneity Test**

A homogeneity test was conducted to test the equality of variances between two or more groups. This test aims to ensure that the assumption of homogeneity of variances is met before performing other statistical tests, such as T-tests. The significance value used was 0.05, and the results would determine whether to accept or reject the hypothesis.

#### **Paired-Sample T-Test**

A paired-sample t-test was applied to test the significance of the difference in mean scores obtained from two paired measurements, such as before and after treatment in the same group. This test was also used to test the effectiveness of the independent variable on the dependent variable in paired conditions. The significance value was 0.05, which determined whether to accept or reject the hypothesis.

#### **N-Gain Calculation**

The N-Gain test is a method used to measure improvement based on the difference between the pre-test and the post-test results. The N-Gain test was calculated using the following formula [16]:

$$N \text{ Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}}$$

After calculating the N-Gain scores using the formula, the scores are interpreted based on the table presented below [16].

**Table 3.** Interpretation of N-Gain Scores

<b>Skor N-Gain</b>	<b>Interpretation</b>
$g < 0,3$	Low
$0,3 \leq g \leq 0,7$	Medium
$g > 0,7$	High

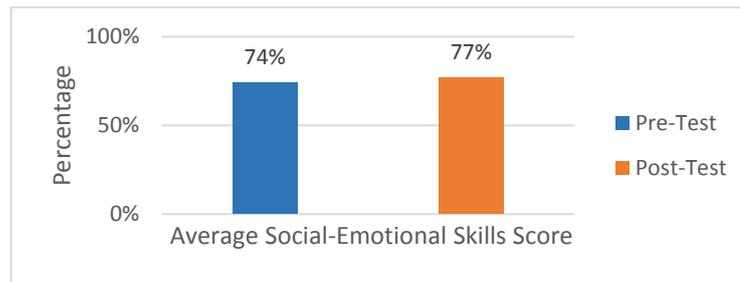
The research procedure consists of three main stages: 1) planning; 2) implementation, and reporting. In the planning stage, we first identify the research problem. Then, we determine the dependent and independent variables and prepare the necessary instruments, namely the Social-Emotional Skills questionnaire. In the implementation stage, we first administer the pre-test questionnaire to the students before implementing the Project-Based Learning (PjBL) model on the Solar System topics in the Science subject. Then, we implement the PjBL model in the learning process. After that, we administer the post-test questionnaire again at the last meeting. In the final stage of the research, we analyze the data that has been obtained and draw conclusions. This research uses the PjBL phases developed by Hugerat as presented in Table 4 [17].

**Table 4.** PjBL Phases

No.	Phase	Details
1.	<b>Pre-Preparation</b>	<ul style="list-style-type: none"> <li>• Students were provided with highlighted topics on the Solar System.</li> <li>• Students were asked to watch a video observation of the solar system and reflect on its vastness.</li> </ul>
2.	<b>Preparation for the Project</b>	Students were informed about the learning objectives, project goals, and the role of each group member.
3.	<b>Planning for the Project</b>	<ul style="list-style-type: none"> <li>• Students discussed the plan for creating a Solar System diorama, including selecting a project title, project objectives, tools and materials, project steps, product design, and the role of each group member.</li> <li>• The teacher ensured that each student in the group could choose, determine, and understand the procedures for the Solar System diorama creation project.</li> <li>• The teacher and students agreed on a schedule for the Solar System diorama creation project (stages and deadlines).</li> <li>• Considering the predetermined deadline, students created a schedule for completing the Solar System diorama creation project.</li> </ul>
4.	<b>Project Implementation</b>	<ul style="list-style-type: none"> <li>• Students carried out the project according to the schedule, recording each stage and discussing any problems that arose during the project completion with the teacher.</li> <li>• The teacher monitored the students' activity during the project implementation, monitored the project's progress, and provided guidance if the students encountered difficulties.</li> <li>• Students discussed the feasibility of the Solar System diorama they had created. Then, they compiled a simple report on their work, including all the content from the Project Planning stage.</li> </ul>
5.	<b>Post-Project</b>	<ul style="list-style-type: none"> <li>• Each group representative presented the Solar System diorama report to their classmates, providing detailed explanations of their work.</li> <li>• The teacher guided the presentation process for each group's Solar System diorama project, responded to the performance of each group by asking questions to ensure that the students understood the concept of the Solar System, and then reflected with the students.</li> <li>• The teacher opened a discussion about each group's Solar System diorama work, monitored student involvement, and measured the achievement of standards.</li> </ul>
6.	<b>Assessment and Evaluation</b>	The teacher conducted assessment and evaluation through discussions with students about the project they had carried out. Then, the students evaluated the conclusions obtained during the project implementation by filling in a number of questions on the Project Worksheet. Evaluation was carried out continuously from the preparation stage to the post-project stage.

### III. RESULTS AND DISCUSSION

The social-emotional skills of the participants in this study were based on the aspects developed by CASEL, which include Self-Awareness, Social-Awareness, Self-Control, Relationship Skills, and Responsible Decision-Making [3]. The questionnaire was administered twice. First, as a pre-test before any intervention was conducted. Second, as a post-test after the implementation of PjBL. The improvement in students' social-emotional skills was shown by comparing the pre-test and post-test percentage results. An overview of the overall improvement in students' average social-emotional skills after implementing the PjBL model is shown in the graph in Figure 1.



**Fig. 1.** Average Social-Emotional Skills of Students Before and After PjBL Implementation

The data obtained was then tested for normality using the Shapiro-Wilk test. The results showed that the significance value for the pre-test was 0.566 and for the post-test was 0.222. Since both values are greater than 0.05, it can be concluded that the data is normally distributed. The results of the normality test are presented in Table 5.

**Table 5.** Normality Test

	Shapiro-Wilk		
	Statistic	df	Sig.
<i>Pre-test</i>	0.925	5	0.566
<i>Post-test</i>	0.858	5	0.222

A homogeneity test was conducted to examine the similarity of variances between two or more groups. The results showed that the significance values for the Based on Mean pre-test and post-test were 0.185 and 0.215, respectively. Since both values are greater than 0.05, it can be concluded that the data is homogeneous. The results obtained from the homogeneity test are presented in Table 6.

**Table 6.** Homogeneity Test

	Levene			
	Statistic	df	df2	Sig.
<i>Based on Mean</i>	2.107	1	8	0.185
<i>Based on Median</i>	1.812	1	8	0.215
<i>Based on Median and with adjustment df</i>	1.812	1	5.824	0.228
<i>Based on trimmed mean</i>	2.010	1	8	0.194

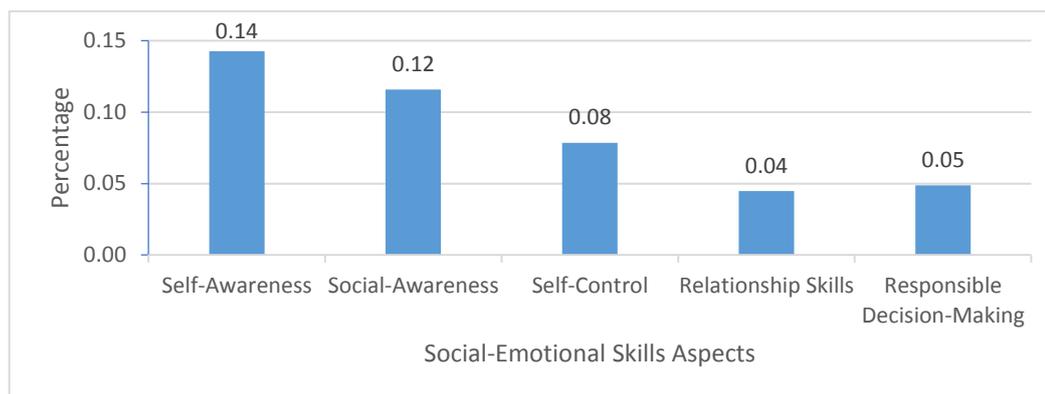
The normality test results in Table 5 indicate that the data is normally distributed, and the homogeneity test results in Table 6 indicate that the data is homogeneous. Therefore, the appropriate statistical test for this data is the Paired Sample T-Test, shown in Table 7.

**Table 7.** Paired Sample T-Test

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
<i>Pretest-Posttest</i>	-.08800	.04868	.02177	-.14845	-.02755	-4.042	4	.016

Decision-making in statistical tests is based on the significance value (Sig.). If the Sig. value (2-tailed) is smaller than 0.05, then the null hypothesis ( $H_0$ ) is rejected, and the alternative hypothesis ( $H_a$ ) is accepted.  $H_0$  states that there is no effect of using the PjBL Model on improving students' social-emotional skills, while  $H_a$  states that there is an effect of using the PjBL Model on improving students' social-emotional skills.

The results of the statistical test show that the Sig. value (2-tailed) is 0.016. This value is smaller than 0.05, so it can be concluded that learning using the PjBL Model significantly improves students' social-emotional skills. Furthermore, the results of the Paired-Samples T-Test are reinforced by the N-Gain score comparison between pre-test and post-test. The N-Gain score obtained shows a significant increase in students' social-emotional skills as shown in Figure 2.



**Fig. 2.** Comparison of N-Gain Scores for Social-Emotional Skills in Each Aspect

Figure 2 presents a comparison of the N-Gain scores obtained for each aspect of social-emotional skills. The N-Gain scores obtained for each aspect were then interpreted using established criteria. All five aspects obtained N-Gain scores lower than 0.3, indicating that all five dimensions achieved low N-Gain scores. The Self-Awareness aspect had the highest N-Gain score, at 0.14. The Self-Awareness aspect relates to the ability to understand and experience one's own emotions, thoughts, and values, as well as their influence on behavior in various situations. This ability includes the capacity to recognize one's strengths and weaknesses confidently. Previous research has shown that Self-Awareness is a fundamental aspect of social-emotional skill development. Research by Grundmeyer et al. has shown that PjBL can enhance the Self-Awareness aspect in learners [18]. This study found that learners who engaged in PjBL showed significant improvement in their success in building relationships with peers and adults, producing good project work, and actively participating as members of project teams.

Social-Awareness aspect experienced an increase with an N-Gain score of 0.12. The Social-Awareness aspect of Social-Emotional Skills encompasses the ability to understand and appreciate the perspectives of others, including those from different backgrounds, cultures, and contexts. This ability includes empathizing with others, understanding social norms and values that apply in various situations, and utilizing resources and support available in the family, school, and community environments. The results of this study are supported by research by Juniar et al. which states that applying the PjBL model can provide opportunities for students to develop good social skills [19]. Research by Thomas also states that "students involved in PjBL often show greater empathy and social awareness due to the collaborative nature of the projects. [20]"

The research findings indicate that the Self-Control aspect experienced an improvement with an N-Gain score of 0.08. This suggests that PjBL effectively enhances students' ability to effectively manage their emotions, thoughts, and behaviors in various situations. This Self-Control ability is a crucial component of Social-Emotional Skills. Baines et al. support these findings by stating that PjBL provides opportunities for students to express what they know, are capable of doing, and think and feel [13]. This ability to express oneself effectively is essential for project-based learning and developing SEL competencies.

The Relationship Skills aspect experienced an increase with an N-Gain score of 0.04. Despite this improvement, Relationship Skills became the aspect with the lowest N-Gain. This occurred because, in its implementation, students were grouped randomly with different cognitive abilities and with members who were not in their previous study groups, so they needed to adapt again to communicate and collaborate effectively. Relationship Skills in Social-Emotional Skills is building and maintaining healthy and supportive relationships and interacting effectively in various environments with diverse people and groups. According to Baines et al., collaboration is important in SEL and PjBL [13]. In PjBL, students must work with their peers when working on projects. Through this process, students can apply the concepts they have learned to complete tasks and make appropriate decisions during the project.

The Responsible Decision-Making aspect demonstrated an improvement with an N-Gain score of 0.05. This aspect encompasses the ability to make thoughtful and constructive decisions in social behaviors and interactions across various situations. Chiu states that PjBL is a teaching method that incorporates problem-solving, decision-making, investigation, and open-ended tasks to achieve the desired learning objectives [21].

In this study, PjBL involved discussions on determining project design, identifying problems in the designed project, refining the project design, and presenting project outcomes. These activities were conducted in groups, encouraging students to contribute more to group work through activities of sharing knowledge, ideas, and experiences. This aligns with Culclasure's assertion that the PjBL model can enrich students' creativity while enhancing their ability to collaborate in trusting relationships with peers [22].

The PjBL model is implemented by investigating a specific problem related to a project that has been agreed upon by the teacher and the student. Students are given clear information about the learning objectives to

be achieved, design the steps for the project of making a solar system diorama, determine the tools and materials to be used, schedule the project implementation, and evaluate the project.

Through PjBL, students can gain experience in developing product design skills to solve existing problems. This learning approach guides students to think like designers who create products. According to Bozkurt Altan & Tan, a creative and problem-solving designer should adopt various approaches and generate applicable solutions to address similar problems [23]. After planning, scheduling, and determining the procedures for the Solar System diorama creation project, students implemented the project while discussing any issues that arose during project completion. Next, students presented their project products by explaining their work. The results of the student project in the form of a Solar System diorama are shown in Figure 3.



**Fig. 3.** Diorama Project of the Solar System

The assessment phase is conducted after the project is completed to determine the extent of students' understanding of the Solar System. Students then evaluate their project by communicating the challenges or problems that occurred during the product creation process so that students are trained in identifying problems and finding appropriate solutions to improve the project they have made. In addition, students are also directed to analyze what needs to be done to improve the diorama product they have made. According to Purnama et al., careful analysis is an important element in the design process that helps students identify shortcomings and improve the effectiveness of their designs [24]. Through careful analysis during evaluation, students can deeply examine each design element, find parts that need improvement, and optimize the overall design. Thus, careful analysis plays an important role in producing quality and effective designs, meeting learning objectives, and providing maximum benefits.

This engaging learning process fosters dynamic interactions among students within their groups. These interactions enhance their understanding of the subject matter and cultivate empathy and initiative to assist one another in completing tasks. Aligned with the research conducted by Putri et al., PBL has proven effective in boosting student engagement and creative thinking skills [25]. Through project work, students are encouraged to exchange ideas, opinions, and experiences, fostering connections and mutual trust among them. This triggers the emergence of empathy, where they understand and appreciate each other's perspectives. In addition to enhancing creativity, PBL also aims to teach children the process of social interaction [26]. Furthermore, project implementation promotes the initiative to help each other complete tasks. Each group member has the opportunity to contribute and support one another, creating a collaborative and mutually reinforcing learning environment. Therefore, project-based learning has demonstrated effectiveness in enhancing students' social-emotional skills through peer interaction, fostering empathy and initiative, and improving teaching and learning quality.

#### IV. CONCLUSION

This study demonstrates that there was a significant improvement in students' social-emotional skills after participating in Project-Based Learning (PjBL). This improvement is evidenced by the difference in students' social-emotional skills levels before and after the implementation of PjBL. The average pre-test score was 74%, and the average post-test score was 77%, providing concrete evidence of this improvement. Furthermore, each aspect's improvement in social-emotional skills was examined after implementing PjBL in science learning on the Solar System material. This is evidenced by the N-Gain score. The Self-Awareness aspect experienced the highest increase with an N-Gain score of 0.14, the Social-Awareness aspect experienced an increase with an N-Gain score of 0.12, the Self-Control aspect experienced an increase with an N-Gain score of 0.08, the Relationship Skills aspect experienced the lowest increase with an N-Gain score of 0.04, and the Responsible Decision-Making aspect experienced an increase with an N-Gain score of 0.05. Based on the interpretation of the N-Gain scores, all five aspects are categorized as having a low N-Gain.

To strengthen the findings of this study, several recommendations are proposed for future research endeavors. Firstly, longitudinal studies with extended durations should be conducted to examine the long-term effects of Project-Based Learning (PjBL) on students' social-emotional skills. Secondly, the effectiveness of PjBL in enhancing social-emotional skills should be investigated across diverse subject matter to gauge its broader applicability. Finally, future studies should involve participants with more varied backgrounds and characteristics to enhance the generalizability of the research findings.

## ACKNOWLEDGMENT

The author would like to thank Pendidikan Profesi Guru Prajabatan Universitas Pendidikan Indonesia for the support provided so that the study can be completed on time.

## REFERENCES

- [1] J. W. Santrock, *Child Development*, 15th ed. McGraw-Hill Education, 2018.
- [2] J. A. Durlak, R. P. Weissberg, A. B. Dymnicki, and R. D. Taylor, "The Impact of Enhancing Students' Social and Emotional Learning Skills on Their Academic and Cognitive Development," *Child Dev*, vol. 82, no. 1, pp. 405–432, 2011.
- [3] CASEL, "What Is the CASEL Framework?," <https://casel.org/sel-framework/>. Accessed: Jun. 18, 2024. [Online]. Available: <https://casel.org/fundamentals-of-sel/what-is-the-casel-framework/>
- [4] L. Dusenbury and R. P. Weissberg, "Social emotional learning in elementary school: Preparation for success," *The Education Digest*, pp. 36–43, 2017, Accessed: Jun. 02, 2024. [Online]. Available: <https://prevention.psu.edu/publication/social-emotional-learning-in-elementary-school-preparation-for-success/>
- [5] M. T. Greenberg, C. E. Domitrovich, R. P. Weissberg, and J. A. Durlak, "Social and emotional learning as a public health approach to education," *Future of Children*, vol. 27, no. 1, pp. 13–32, 2017, doi: 10.1353/FOC.2017.0001.
- [6] E. Dereli and A. Aypay, "The Prediction of Empathetic Tendency and Characteristic Trait of Collaboration on Humane Values in Secondary Education Students and the Examining to Those Characteristics.," *Educational Sciences: Theory and Practice*, vol. 12, no. 2, pp. 1262–1270, 2012, Accessed: Jun. 12, 2024. [Online]. Available: [www.edam.com.tr/estp](http://www.edam.com.tr/estp)
- [7] A. Gokalp and Y. Inel, "View of The Mediation Role of Responsibility and Benevolence between Eighth Grade Secondary School Students' Empathy Skills and the Value of Justice," *International Journal of Psychology and Educational Studies*, vol. 3, no. 9, pp. 633–643, 2022, Accessed: Jun. 15, 2024. [Online]. Available: <https://ijpes.com/index.php/ijpes/article/view/711/365>
- [8] S. Hymel, A. Low, L. Starosta, R. Gill, and K. Schonert-Reichl, "Promoting Mental Well-Being Through Social-Emotional Learning in Schools: Examples from British Columbia," *Canadian Journal of Community Mental Health*, vol. 36, no. 4, pp. 97–107, Dec. 2017, doi: 10.7870/cjcmh-2017-029.
- [9] K. Kilby, "Project-Based Learning and Social-Emotional Learning in the Elementary Classroom: A Qualitative Study on Potential Opportunities for Student Self-Awareness and Social Awareness," *MSU Graduate Theses/Dissertations*, Jan. 2022, Accessed: Jun. 06, 2024. [Online]. Available: <https://bearworks.missouristate.edu/theses/3818>
- [10] M. A. Almulla, "The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning," *Sage Open*, vol. 10, no. 3, Jul. 2020, doi: 10.1177/2158244020938702.
- [11] R. P. Weissberg, J. A. Durlak, and C. Domitrovich, "Social and emotional learning: Past, present, and future," The Guilford Press. Accessed: Jun. 20, 2024. [Online]. Available: [https://www.researchgate.net/publication/302991262\\_Social\\_and\\_emotional\\_learning\\_Past\\_present\\_and\\_future](https://www.researchgate.net/publication/302991262_Social_and_emotional_learning_Past_present_and_future)

- [12] R. J. Jagers, D. Rivas-Drake, and B. Williams, “Transformative Social and Emotional Learning (SEL): Toward SEL in Service of Educational Equity and Excellence,” *Educ Psychol*, vol. 54, no. 3, pp. 162–184, Jul. 2019, doi: 10.1080/00461520.2019.1623032.
- [13] A. M. Baines *et al.*, “Why Social and Emotional Learning Is Essential to Project-Based Learning - Lucas Education Research,” Lucas Education Research. Accessed: Jun. 20, 2024. [Online]. Available: <https://www.lucasedresearch.org/publication/why-social-and-emotional-learning-is-essential-to-project-based-learning/>
- [14] J. W. Creswell, *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. New Jersey: Pearson Education Ltd., 2008.
- [15] F. D. Fernández-Martín, A.-J. Moreno-Guerrero, J.-A. Marín-Marín, and J.-M. Romero-Rodríguez, “Adolescents’ Emotions in Spanish Education: Development and Validation of the Social and Emotional Learning Scale,” *Sustainability*, vol. 14, no. 7, p. 3755, Mar. 2022, doi: 10.3390/su14073755.
- [16] D. E. Meltzer, “The relationship between mathematics preparation and conceptual learning gains in physics: A possible ‘hidden variable’ in diagnostic pretest scores,” *Am J Phys*, vol. 70, no. 12, pp. 1259–1268, Dec. 2002, doi: 10.1119/1.1514215.
- [17] M. Hugerat, “How teaching science using project-based learning strategies affects the classroom learning environment,” *Learn Environ Res*, vol. 19, no. 3, pp. 383–395, Oct. 2016, doi: 10.1007/s10984-016-9212-y.
- [18] T. Grundmeyer, J. Urich, J. Olson, S. Brown, and S. Gentz, “Project-Based Learning Influence on Self-Awareness of High School Students,” *Education Journal 2022, Volume 11, Page 355*, vol. 11, no. 6, pp. 355–365, Dec. 2022, doi: 10.11648/J.EDU.20221106.17.
- [19] D. T. Juniari, A. Suherman, B. Tarigan, and A. Mahendra, “Effects of Project-Based Learning Model and Cooperative Learning Model in Improving Student Social Skills in Physical Education,” *Jurnal Pendidikan Jasmani dan Olahraga*, vol. 8, no. 1, pp. 49–57, May 2023, doi: 10.17509/jpjo.v8i1.56156.
- [20] J. W. Thomas, “A Review of Research on Project-Based Learning,” *The Autodesk Foundation*, 2000.
- [21] C.-F. Chiu, “Facilitating K-12 Teachers in Creating Apps by Visual Programming and Project-based Learning,” *International Journal of Emerging Technologies in Learning (iJET)*, vol. 15, no. 01, p. 103, Jan. 2020, doi: 10.3991/ijet.v15i01.11013.
- [22] B. T. Culclasure, K. C. Longest, and T. M. Terry, “Project-Based Learning (Pjbl) in Three Southeastern Public Schools: Academic, Behavioral, and Social-Emotional Outcomes,” *Interdisciplinary Journal of Problem-Based Learning*, vol. 13, no. 2, Aug. 2019, doi: 10.7771/1541-5015.1842.
- [23] E. Bozkurt Altan and S. Tan, “Concepts of creativity in design based learning in STEM education,” *Int J Technol Des Educ*, vol. 31, no. 3, pp. 503–529, Jul. 2021, doi: 10.1007/s10798-020-09569-y.
- [24] A. N. Hasanah Purnama, N. Winarno, E. C. Prima, and N. J. Ahmad, “FOSTERING STUDENTS’ CONCEPT MASTERY THROUGH STEM-ENGINEERING DESIGN PROCESS IN THERMAL ENERGY AND HEAT TRANSFER TOPIC,” *INSECTA: Integrative Science Education and Teaching Activity Journal*, vol. 4, no. 2, pp. 209–230, Nov. 2023, doi: 10.21154/insecta.v4i2.7240.
- [25] L. T. Putri, H. Nuroso, and N. Khoiri, “EFEKTIVITAS MODEL PEMBELAJARAN BERBASIS PROYEK (PROJECT BASED LEARNING) TERHADAP KEAKTIFAN DAN KEMAMPUAN BERPIKIR KREATIF SISWA KELAS X SMA N 2 SEMARANG,” *Jurnal Penelitian Pembelajaran Fisika*, vol. 6, no. 2, Jul. 2018, doi: 10.26877/jp2f.v6i2.2590.
- [26] I. Nopiyanti, N. Adjie, and S. U. Putri, “STEAM-PBL in Early Childhood Education: Optimization Strategies for Developing Communication Skills,” in *Proceedings of the 1st International Conference on Early Childhood Care Education and Parenting (ICECCEP 2019)*, Paris, France: Atlantis Press, 2020. doi: 10.2991/assehr.k.201205.090.