THE EFFECTIVENESS OF PROJECT BASED LEARNING MODEL FOR SELF REGULATED LEARNING: A CASE STUDY OF POST-PANDEMIC ELEMENTARY SCHOOL SCIENCE LEARNING

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ABSTRACT

After the COVID-19 Pandemic, face-to-face (FTF) learning was implemented in elementary schools in the province of the special region of Yogyakarta. However the implementation of online learning has left its own problems, especially related to self-regulation in student learning. Students need readaptation again after they are used to studying online for at least two years. This research aims to determine the effectiveness of the Project Based Learning (PjBL) model for Self Regulated Learning (SRL) students in science learning at Post-COVID-19 pandemic. This study uses the experimental method of Pretest-Posttest Control Group Design. The research was conducted at a Islamic elementary school in Yogyakarta in the 2021/2022 school year. The population of this study were students of class IV consisting of 4 classes namely A, B, C, and D. The samples of this study were students of class IV A, totaling 23 students as the control class and IV C, totaling 21 students as the experimental class. Selection of control and experimental classes using cluster random sampling technique. The research findings show that the PjBL model is effective in improving students' SRL in science subjects after the pandemic.

Keywords: post-pandemic; project based learning; self-regulated learning

INTRODUCTION

The COVID-19 pandemic is currently starting to fade away, and this includes the educational sector. FTF learning has been gradually introduced into classrooms. In the Special Region of Yogyakarta, a number of elementary schools are now holding FTF on a limited basis. FTF learning allows interaction between educators and students.[1] FTF learning allows for two-way active communication, so students can be more active.[2] For elementary school pupils and their parents, this is unquestionably wonderful news. 90% of eelementary school pupils in the Special Region of Yogyakarta responded happily of the limited FTF learning, according to the findings of a poll that researchers conducted on those students. They have hope that with this FTF learning they will better understand in learning process.

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[1] Rio Erwan Pratama and Sri Mulyati, "Pembelajaran Daring Dan Luring Pada Masa Pandemi COVID-19" 1, no. 2 (2020): 49–59, https://doi.org/10.30870/gpi.v1i2.9405.

[2] Satriani, "Pengaruh Pelaksanaan Pembelajaran Tatap Muka Terbatas Berbasis Kontekstual Pada Pembelajaran Biologi Terhadap Hasil Belajar Peserta Didik" 3, no. 2 (2022): 232–39, https://doi.org/10.37478/jpm.v3i2.1746.

FTF learning has been implemented in Yogyakarta's elementary schools, although online learning has its own challenges[3]. Field facts show that elementary school students experience a decrease in cognitive understanding[4;5]. In addition, students who started doing FTF learning seemed not ready for the FTF being implemented. It can be seen that the ability to self-regulate in learning is low.

Post-COVID-19 pandemic learning shows student learning demotivation[6; 7]. This is due to habitual actions that are still attached to students' self-carrying from online learning. From the results of interviews with the teacher of class IV at Islamic Elementary School in Yogyakarta, it was found that students had difficulty managing their study hours. Students are used to using gadgets at home, so when FTF is in class they are not enthusiastic. When learning students do not have the initiative to record important teacher explanations. Some students also did not do the homework given by the teacher. When held daily tests, students do not prepare as well as possible. This is of course very influential with student learning outcomes.

Science learning requires students to be active in the learning process[8]. Science invites students to discover and acquire their own knowledge[9]. Learning that is done contextually and actively will foster fun learning for students[10]. However, the facts found that many students do not understand science. Various factors include the lack of

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[3] Jamila Mila, Ahdar Ahdar, and Emmy Natsir, "Problematika Guru Dan Siswa Dalam Proses Pembelajaran Daring Pada Masa Pandemic COVID-19 Di UPTD SMP Negeri 1 Parepare," AL MA'ARIEF: Jurnal Pendidikan Sosial Dan Budaya 3, no. 2 (2021): 101–10, https://doi.org/10.35905/almaarief.v3i2.2346.

[4] Veny Iswantiningtyas, "Perkembangan Kognitif Anak Selama Belajar Di Rumah," Efektor 8, no. 1 (May 27, 2021): 9–20, https://doi.org/10.29407/e.v8i1.15835.

[5] Dewi Niswatul Fithriyah et al., "Dampak Pembelajaran Daring Selama Pandemic Terhadap Kemampuan Kognitif Peserta Didik," Jurnal Riset Madrasah Ibtidaiyah (JURMIA) 2, no. 1 (February 2, 2022): 173–80, https://doi.org/10.32665/jurmia.v2i1.275.

[6] Muhammad Fillah Kurniawan and Rudi Salam, "Analisis Keaktifan Belajar Siswa dengan Peristiwa Learning-Loss Pasca Berakhirnya Pembelajaran Online Penuh," Epistema 3, no. 2 (October 26, 2022): 59–66, https://doi.org/10.21831/ep.v3i2.50645.

[7] Aisah Safa Nadhira, Zerri Rahman Hakim, and Indhira Asih Vivi Yandari, "Adaptasi Kebiasaan Baru Pasca Pandemi pada Pembelajaran Tatap Muka di SD Islam Al-Husna," SAP (Susunan Artikel Pendidikan) 7, no. 2 (December 5, 2022): 221–28, https://doi.org/10.30998/sap.v7i2.13957.

[8] Fita Nelyza, Ruslaini Ruslaini, and Trisnia Novika, "Penerapan Active Learning Pada Pembelajaran IPA Untuk Meningkatkan Kemandirian Belajar Peserta Didik," *Jurnal Tunas Bangsa* 9, no. 2 (December 21, 2022): 64–77, https://doi.org/10.46244/tunasbangsa.v9i2.1850.

[9] Pramita Sylvia Dewi, "Perspektif Guru Sebagai Implementasi Pembelajaran Inkuiri Terbuka Dan Inkuiri Terbimbing Terhadap Sikap Ilmiah Dalam Pembelajaran Sains," *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah* 1, no. 2 (December 19, 2016): 179–86, https://doi.org/10.24042/tadris.v1i2.1066.

[10] Nana Setiana, "Penerapan Model Pembelajaran Kontekstual Untuk Meningkatkan Hasil Belajar IPS Siswa Kelas IV Sekolah Dasar," *EduHumaniora | Jurnal Pendidikan Dasar Kampus Cibiru* 5, no. 1 (2013), https://doi.org/10.17509/eh.v5i1.2834.

enthusiasm of students in learning, students are less prepared when participating in learning, are less able to analyze the assignments given by the teacher and lack of student responsibility.

SRL is one of important factor in determining student learning outcomes[11]. SLR is the ability of students to determine appropriate learning strategies independently, so as to obtain maximum learning results[12]. SRL has a significant influence on learning outcomes[13; 14]. Academic emotions are impacted by SRL, which has an effect on raising academic achievement. [15]. Students' level of SRL will reveal whether they are more independent and less dependent on others when learning new content [16]. Students who have better SLR become more optimal in academic achievement[17]. SRL includes aspects of metacognitive, motivational, emotional learning,[18] cognitive and behavioral[19].

The appropriate learning model to be applied to improve students' SRL is the PjBL. PjBL is a concept that implements learning through projects and student-centered learning, student independence, as well as group/team learning and through

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[11] Siti Suminarti Fasikhah dan Siti Fatimah, "Self-Regulated Learning (SLR) Dalam Meningkatkan Prestasi Akademik Pada Mahasiswa," *Jurnal Ilmiah Psikologi Terapan* 1, no. 1 (2013): 145–55, https://doi.org/10.22219/jipt.v1i1.1364.

[12] Novia Khoerunnisa, Euis Eti Rohaeti, and Devy Sekar ayu Ningrum, "Gambaran Self Regulated Learning Siswa Terhadap Pembelajaran Daring Pada Masa Pandemi Covid 19," *FOKUS (Kajian Bimbingan & Konseling Dalam Pendidikan)* 4, no. 4 (July 30, 2021): 298–308, https://doi.org/10.22460/fokus.v4i4.7433.

[13] Octheria Friskilia and Hendri Winata, "Regulasi Diri (pengaturan Diri) sebagai Determinan Hasil Belajar Siswa Sekolah Menengah Kejuruan," *Jurnal Pendidikan Manajemen Perkantoran* 3, no. 1 (2018): 36–43, https://doi.org/10.17509/jpm.v3i1.9454.

[14] Nani Sutarni et al., "Self-Regulated Learning and Digital Learning Environment: Its' Effect on Academic Achievement During the Pandemic," *Jurnal Cakrawala Pendidikan* 40, no. 2 (June 19, 2021): 374–88, https://doi.org/10.21831/cp.v40i2.40718.

[15] Reinhard Pekrun et al., "Academic Emotions in Students' Self-Regulated Learning and Achievement: A Program of Qualitative and Quantitative Research," *Educational Psychologist* 37, no. 2 (January 1, 2002): 91–105, https://doi.org/10.1207/S15326985EP3702_4.

[16] S. E. Atmojo, T. Muhtarom, and B. D. Lukitoaji, "The Level of Self-Regulated Learning and Self-Awareness in Science Learning in the COVID-19 Pandemic Era," *Jurnal Pendidikan IPA Indonesia* 9, no. 4 (December 31, 2020): 512–20, https://doi.org/10.15294/jpii.v9i4.25544.

[17] Barbara L. McCombs, "Self-Regulated Learning and Academic Achievement: A Phenomenological View," in *Self-Regulated Learning and Academic Achievement: Theory, Research, and Practice*, ed. Barry J. Zimmerman and Dale H. Schunk, Springer Series in Cognitive Development (New York, NY: Springer, 1989), 51–82, https://doi.org/10.1007/978-1-4612-3618-4_3.

[18] E. Villalobos et al., "Measuring and Supporting Self-Regulated Learning in Blended Learning Contexts," vol. 3292, 2022, 39–45.

[19] Ernesto Panadero, "A Review of Self-Regulated Learning: Six Models and Four Directions for Research," *Frontiers in Psychology* 8 (2017), https://www.frontiersin.org/articles/10.3389/fpsyg.2017.00422.

assignments[20]. According to Chilifah[21] PjBL syntax includes 1) analyzing and solving problems; 2) create a problem solving plan; 3) prepare a project completion schedule; 4) project monitoring; 5) and submission of the final results of the project tasks. In this research, the PjBL model involves 1) finding problems; 2) create a problem solving plan; 3) prepare a project completion schedule; 4) project monitoring; 5) and submission of the final results of the project tasks.

PjBL facilitates students to active in groups, while teacher students act as assistants and facilitators[22]. With the application of this model students get used to working to solve and evaluate a problem[23]. PjBL also requires students to plan and check the completeness of their assignments[24]. The application of PjBL in learning can increase self-confidence, learning motivation, and independent learning attitudes[25]. Furthermore, Sungur also explained that PjBL is able to teach how to learn. Thus PjBL is able to significantly improve students' SRL skills [26]; [27]; [28].

Research on PjBL on increasing SRL has been carried out by Luthfi et al.[29] The results showed that PjBL was effective in increasing SRL in a good category. Similar

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[20] Yustinus Calvin Gai Mali, "Project-Based Learning in Indonesian EFL Classrooms: From Theory to Practice," *IJEE (Indonesian Journal of English Education)* 3, no. 1 (June 28, 2016): 89–105.
[21] Puri Selfi Cholifah et al., "Online Project-Based Learning for Improving the Innovative Initiation during Diffusion and Innovation Course," in *2019 5th International Conference on Education and Technology (ICET)*, 2019, 55–60, https://doi.org/10.1109/ICET48172.2019.8987221.
[22] Vincent Troy Greenier, "The 10Cs of Project-Based Learning TESOL Curriculum," *Innovation in Language Learning and Teaching* 14, no. 1 (January 1, 2020): 27–36, https://doi.org/10.1080/17501229.2018.1473405.
[23] Dina Tsybulsky and Yulia Muchnik-Rozanov, "The Development of Student-Teachers' Professional Identity While Team-Teaching Science Classes Using a Project-Based Learning Approach: A Multi-Level Analysis," *Teaching and Teacher Education* 79 (March 1, 2019): 48–59, https://doi.org/10.1016/j.tate.2018.12.006.
[24] Judy Robertson, "The Educational Affordances of Blogs for Self-Directed Learning," *Computers & Education* 57, no. 2 (September 1, 2011): 1628–44, https://doi.org/10.1016/j.compedu.2011.03.003.
[25] Semra Sungur and Ceren Tekkaya, "Effects of Problem-Based Learning and Traditional Instruction on Self-Regulated Learning," *The Journal of Educational Research* 99, no. 5 (May 1, 2006): 307–20, https://doi.org/10.3200/JOER.99.5.307-320.
[26] Mohamed Yassine Zarouk et al., "The Impact of Flipped Project-Based Learning on Self-Regulation in Higher Education," *International Journal of Emerging Technologies in Learning (IJET)* 15, no. 17 (September 11, 2020): 127–47, https://doi.org/10.3991/ijet.v15i17.14135.
[27] Nijolė Burkšaitienė, "Project-Based Learning for the Enhancement of Self-Regulated Learning and Creativity in a Course of ESP," *Radoša Personība / Creative Personality* 11 (January 1, 2014): 164–72.
[28] S. Ribeiro et al., "Competence Development Strategies after COVID-19: Using PBL in Translation Courses," *Education Sciences* 13, no. 3 (2023), https://doi.org/10.3390/educsci13030283.
[29] Rika Rezki M. Luthfi, Ismail Ismail, and Muhammad Wiharto, "Implementasi Model Pembelajaran Project Based Learning Untuk Meningkatkan Kemampuan Self Regulated Learning, Kemampuan Berpikir Kreatif Dan Hasil Belajar Siswa Kelas XI MIPA SMA Negeri 2 Sidenreng Rappang" (masters, Universitas Negeri Makassar, 2019), http://eprints.unm.ac.id/12350/.

research has also been conducted by Muslihudin and Andini[30], which states that PjBL is able to develop student learning independence. This research is different from previous research because it focuses on learning issues after the COVID-19 pandemic. Where in post-pandemic learning requires re-adaptation of students. Students are still carried away by a more flexible online learning atmosphere. This resulted in low student SRL. The post-pandemic SRL improvements will also have effect on students' cognitive improvement [31]. Based on this background, it is urgent to conduct research related to the effectiveness of the performance of the PjBL model in learning sciences for SRL students.

RESEARCH METHODS

This research used the "Pretest-Posttest Control Group Design" to conduct a quasi-experiment [32]. During the "academic year 2021–2022," this study was carried out at a Islamic Elementary School in Yogyakarta. The population of this study was made up of fourth-grade kids from the four classes A, B, C, and D. The samples of this study were students of class IV A, totaling 23 students as the control class and IV C, totaling 21 students as the experimental class. The Selection of control and experimental classes using cluster random sampling technique. In class IV C as the experimental class the PjBL learning model was applied, while in IV A as the control class the Discovery learning (DL) model was applied. Assuming that the PjBL model and learning with the DL model are carried out in groups.

The PjBL model learning implementation data and the SRL data were collected for this research. The observation sheet instrument is used to collect data on how the PjBL model of learning is being implemented. This observation's purpose is to determine whether or not the PjBL model is good implemented. Table 1 displays the grid of the PjBL model's implementation observation sheets.

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[30] Muslihudin Muslihudin and Wulan Andini, "Pengelolaan Model Project Based Learning Untuk Meningkatkan Kemandirian Mahasiswa," *AL-TARBIYAH: Jurnal Pendidikan (The Educational Journal)* 30, no. 1 (June 20, 2020): 59–69, https://doi.org/10.24235/ath.v30i1.6480.

[31] Friskilia and Winata, "Regulasi Diri (pengaturan Diri) sebagai Determinan Hasil Belajar Siswa Sekolah Menengah Kejuruan."

[32] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif Dan R&D* (Bandung: Alfabeta, 2016).

Table 1.
Instrument of the PjBL Model Implementation Observation

No.	Syntax of PjBL	Item Number
1	Find problems develop	1-3
2	Develop a problem solving plan	4-6
3	Develop a project completion schedule	7-9
4	Project Monitoring	10-15
5	Delivery of the final results of the project task	16-20

SRL data obtained with a questionnaire instrument. The questionnaire instrument is in the form of 40 statement items consisting of 23 positive and 17 negative statements. In the experimental class, this questionnaire instrument was given before implementing the PjBL model (pretest) and after implementing the PjBL model (posttest). In the control class, the pretest is given before the implementation of the DL model and the posttest is given after the implementation of the DL model. The SLR questionnaire are shown in Table 2.

Table 2.
SLR Questionnaire Instrument

Assesment Aspects	Indicator	No. Item		Amount
		+	-	
Metacognition	Students are able to adjust learning strategies with self-regulation in learning	1,2,3	4	4
	Students are able to analyze tasks given carefully	5,6	7,8	4
	Students are able to organize themselves in preparation for learning well	9,10,11	12	4
Motivation	Students are able to apply cognitive and metacognitive strategies well	13,14,15	16,17,18	6
	Students are able to control emotions and motivate yourself to study carefully	19,20	21,22	4
	Students are able to carry out activities learn responsibly	23	24, 25, 26, 27	5
Active Behaviour	Students are able to choose strategies to overcome failures in learning carefully	28	-	1
	Students are able to monitor again good work yourself.	29	30	2
AMOUNT		16	14	30

The observation sheet of PjBL model implementation and the SRL Questionnaire were validated before being used for field tests. The validation carried out includes content validation and empirical validation. Content validation was carried out by experts, as many as two lecturers with qualifications who had taught Learning Evaluation and Learning Strategies courses. While empirical validation is done by field test. Field test were conducted on students of class IV B who were not used for research. From the results of this field test, an analysis was then carried out on each item of the questionnaire statement. The results of this analysis that statements are declared valid and invalid.

A main field test is conducted after the instrument has been deemed valid. Both the experimental and the control class took the pre-test for SRL. After the pretest, treatment was given to the experimental class using the PjBL model, while the control class used the DL model. The posttest was then given after the treatment to find out the student's SRL data with the giving of the treatment.

To ascertain the effectiveness of the PjBL model for enhancing student SRL, data analysis was done using an independent sample t-test followed by an n-gain test. Through the SPSS application for Windows, the results performed under the constraint that H_0 is acceptable if sig. 2-tailed > 0.05, if sig. 2-tailed <0.05, then H_0 is rejected or H_a is accepted. To find out how PjBL is effective against SRL by using the N-Gain test. The following is the formula for calculating N-gain.

$$\text{N-gain} = \frac{Posttest\ Score - pretest\ score}{Max\ score - pretest\ score} [33]$$

RESULT AND DISCUSSION

This research aims to find out whether the PjBL learning model is effective in improving students' SRL in post-pandemic science learning. Post-pandemic learning requires readjustment from both teachers and students[34]. One thing that needs to be fixed is the SRL. Pupils who have good SRL in learning, they will try to motivate themselves to continue learning and manage their own learning style. So that students will try to

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[33] R. R. Hake, *Analyzing Change/Gain Scores* (AREA-D American education research association's devision. Measurement and Reasearch Methodology., 1999).

[34] Mitro Mitro, "Pembelajaran Tatap Muka Terbatas Pasca Pandemi COVID-19 di SMKN 1 Muara Teweh Kabupaten Barito Utara," *Bawi Ayah: Jurnal Pendidikan Agama dan Budaya Hindu* 13, no. 2 (October 31, 2022): 70–85, https://doi.org/10.33363/ba.v13i2.890.

compile and determine plans in learning, choose learning strategies, plan and monitor when studying, and students will manage the learning process independently despite facing difficult assignments and increase learning motivation in order to achieve learning goals, namely in order to obtain good performance[35]. However, the facts found that students SRL in science learning post-pandemic are low, so it is necessary to apply the PjBL model in learning to improve student SRL[36].

This study consisted of three stages, namely pretest, giving treatment using the PjBL model, and posttest. The pretest and posttest were took in the experimental and the control class to find out the SRL score before and after the treatment was given. Meanwhile, the treatment in the form of implementing the PjBL model was given to the experimental class, while the control class used the DL model. The treatment is given in five meetings.

Before being used in main field testing, all the instruments to be used have been validated constructively or empirically. The results of experts judgment can be seen in Table 3 while the empirical validity test can be seen in Table 4.

Table 3.
The Results Expert Jugments of Self-Regulation Questionnaire

No	Aspect	Expert 1	Expert 2
1.	Clarity	12	12
2.	Language	7	7
3.	Content accuracy	18	19
4.	Relevance	8	7
5.	Validity	4	4
6.	No biases	4	4
	Average Value	95	95

After the SRL questionnaire instrument was declared valid by the expert, the next step was to test the empirical validity of the instrument. Empirical tests were conducted on 23 students class IVB who were not involved in the field test. The analysis results found that from 40 statement items, there were 30 valid statement items and 10

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[35] Khoerunnisa, Rohaeti, and Ningrum, "Gambaran Self Regulated Learning Siswa Terhadap Pembelajaran Daring Pada Masa Pandemi Covid 19."

[36] Nora Susilowaty, "Pengaruh model pembelajaran Project based Learning terhadap peningkatan kemampuan self-regulated learning Mahasiswa Universitas Advent Indonesia: Penelitian Pre-experimental," *Jurnal Padegogik* 3, no. 1 (February 26, 2020): 71–80, https://doi.org/10.35974/jpd.v3i1.2235.

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other items were declared invalid. As for the invalid statement items, they will be discarded (not used in research). In detail the results of the analysis each items were shown in Table 5. The results of the reliability test showed that the Cronbach Alpha value obtained was 0.945> 0.7, so the instrument was declared reliable.

Table 4.
Empirical Validity Test Results

Item Number	Correlation Value (*Person Correlation*)	Correlation Probability (sig.2 *tailed*)	Information
1	0.528	0.010	Valid
2	0.109	0.621	Invalid
3	0.569	0.005	Valid
4	0.552	0.006	Valid
5	0.528	0.010	Valid
6	0.094	0.670	Invalid
7	0.471	0.023	Valid
8	-0.140	0.523	Invalid
9	0.518	0.011	Valid
10	0.502	0.015	Valid
11	0.594	0.003	Valid
12	-0.113	0.608	Invalid
13	0.541	0.008	Valid
14	0.870	0.000	Valid
15	0.793	0.000	Valid
16	0.571	0.004	Valid
17	0.657	0.001	Valid
18	0.787	0.000	Valid
19	0.771	0.000	Valid
20	0.539	0.008	Valid
21	0.563	0.005	Valid
22	0.621	0.002	Valid
23	0.697	0.000	Valid
24	0.659	0.001	Valid
25	0.249	0.253	Invalid
26	0.501	0.015	Valid
27	0.684	0.000	Valid
28	0.697	0.000	Valid
29	0.024	0.914	Invalid
30	0.571	0.004	Valid
31	0.624	0.001	Valid

Item Number	Correlation Value (*Person Correlation*)	Correlation Probability (sig.2 *tailed*)	Information
32	0.656	0.001	Valid
33	0.684	0.000	Valid
34	0.209	0.339	Invalid
35	0.911	0.000	Valid
36	0.259	0.233	Invalid
37	0.520	0.011	Valid
38	0.307	0.154	Invalid
39	0.011	0.959	Invalid
40	0.552	0.006	Valid

These 30 SRL questionnaire statements which were stated to be constructively and empirically valid were used to obtain SRL data. After all the instruments are declared valid and reliable, the next step is to conduct the main field test in the control and the experimental class. The main field test is divided into three activities, namely pretest, treatment and posttest.

1. Pretest

The pretest was in the form of giving SRL instruments to students in the experimental and the control class. The SRL instrument consists of 30 valid and reliable questionnaire statements. The pretest results from the experimental and control classes were shown Table 5.

Table 5.
Pretest SRL Scores

Description	Experimental Class	Control Class
Average	75.67	74.10
Standard Deviation	9.774	7.402
The Highest Score	100	93
The Lowest Score	50	61

Based on these results it can be conclude that the average SRL score in the experimental class and control class is relatively the same. To clarify the comparison of the SRL scores of the experimental with the control class, were shown in Figure 1.
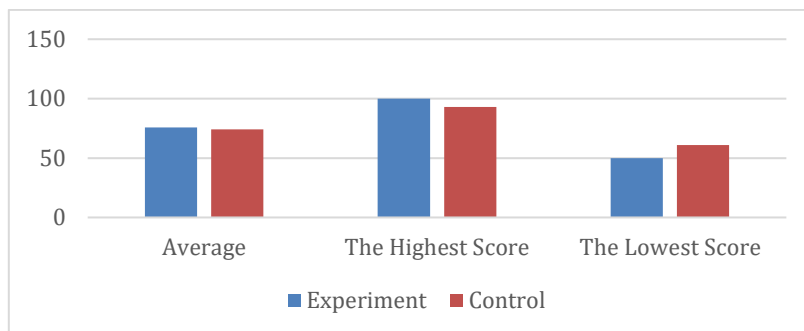
Figure 1.
Pretest Score SRL

2. Treatment

Treatment is the activity of implementing the PjBL model into science learning on the theme "Water as an Alternative Energy Source" in the experimental class. Meanwhile, the control class was given energy material learning with the DL Model. Treatment was given in five meetings with different activities. Activities at each meeting were shown Table 6.

Table 6.
Learning Activities on the theme "Water as an Alternative Energy Source"

Meeting to-	Activity
1	Energy in everyday life: Observation
2	Forms of energy and changes of energy forms: Finding potential alternative energy sources in the surrounding environment
3	Making a Simple Waterwheel Project
4	Project Monitoring: Project Progress Presentation
5	Submission of the final results of project assignments

To ensure that all PjBL model syntax is actually implemented, an observation is made on the implementation of the PjBL model. This observation needs to be done to find out how far the implementation of the learning model [37]. Observers are pupils who have done the Learning Strategy course. Table 7. Shows the percentage of implementation of the PjBL model.

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[37] Fatria Dewi, Afrida Afrida, and Mayang Sari, "Analisis Keterlaksanaan Model Pembelajaran Problem Posing Tipe Post Solution Posing Dan Pengaruhnya Terhadap Kreativitas Siswapada Materi Termokimia Kelas XI IPA SMAN 2 Kota Jambi," *Journal of The Indonesian Society of Integrated Chemistry* 8, no. 2 (December 22, 2016): 39–46, https://doi.org/10.22437/jisic.v8i2.5070.

Table 7.
The Percentage of PjBL Model Implementation

Meeting to :	Performance Percentage(%)	
	Yes	No
1	100.00	0.00
2	100.00	0.00
3	100.00	0.00
4	100.00	0.00
5	100.00	0.00

Based on the outcomes of observations of the PjBL model's implementation, it is known that the implementation is 100%. Thus it can be concluded that the PjBL model is really implemented very well in learning.

PjBL is applied in science learning in groups. During the learning process students are very enthusiastic in following it. Each member has their own role in completing the project that has been given. Each of these members is responsible for the success of their respective group projects. This is in accordance with what was stated by Rifai et. al.[38] which states that PjBL is able to increase children's scientific responsibility. This is because each of them is given their own roles and duties, so they must be responsible for completing these roles and tasks.

Each of students played a role from planning a simple waterwheel project to coming up with the project and testing their product. Harry stated that PjBL-based learning was able to increase student activity in participating in learning [39]. Children will be enthusiastic in learning because they are directly involved in the project.

In the process of completing the water wheel project it also shows that student learning motivation increases. This can be seen from the enthusiasm of students when participating in learning, their readiness to take part in learning

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[38] Siti Rifai, Din Uswatun, and Iis Nurasiah, "Model Project Based Learning (PjBL) Untuk Meningkatkan Sikap Tanggung Jawab Ilmiah Peserta Didik Di Kelas Tinggi," *JIPVA (Jurnal Pendidikan IPA Veteran)* 3 (October 31, 2019): 127, https://doi.org/10.31331/jipva.v3i2.874.
[39] Harry.

and preparing their progress, as well as their activeness during learning. This is similar to what was stated by (Akbar & Bahri, 2017) that PjBL has the potential to increase student learning motivation [40].

3. Posttest

The posttest was used to determine whether the SRL of the students had increased as a result of their PjBL model treatment. Both the experimental and the control class took this posttest. The SRL questionnaire, which has 30 statement items, serves as both the pretest and posttest instruments. Table 8 displays the findings of the posttest.

Table 8.
The SRL Posttest Scores

Description	Experimental Class	Control Class
Average	77,38	71,81
Standard Deviation	7,256	7,789
The Highest Score	97	80
The Lowest Score	65	50

Table 8. demonstrates that the experimental class's SRL score is higher than the control class's. Figure 2 shows the posttest SRL scores. Thus figure demonstrates that the experimental class's average SRL score is higher than that of the control class.
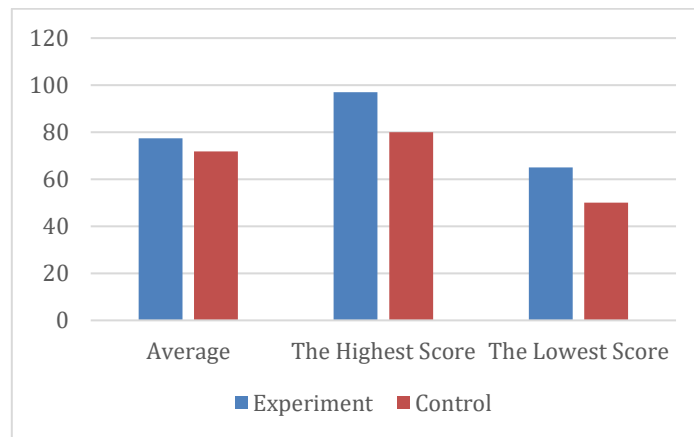

Figure 2.
Posttest SRL Scores

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[40] Fauzan Akbar and Arsad Bahri, "Potensi Model PjBL (Project-Based Learning) dalam Meningkatkan Motivasi Belajar Peserta Didik dengan Gaya Belajar Berbeda," *Sainsmat : Jurnal Ilmiah Ilmu Pengetahuan Alam* 6, no. 1 (March 30, 2017): 95–106, https://doi.org/10.35580/sainsmat6198902017.

PjBL is able to increase the activity of teachers and students[41] which is indirectly able to increase the independence of student learning. In the PjBL model, the teacher guide students to plan project activities[42], while students must actively complete their projects. This will train students to be more independent in learning and completing their projects.

A hypothesis test utilizing the independent sample t-test is performed to see whether there is a significant difference in the SRL score between the control and the experimental class. The following is the study's hypothesis.

H_0: there is no difference in SRL scores in the experimental and the control class

H_a: there are differences in SRL scores in the experimental and the control class

Before testing the hypothesis, a prerequisite hypothesis test is carried out, namely the normality and homogeneity test. Based on the normality test, it is known that the sig.2-tailed value > 0.05 indicates that the SRL data in both the control class and the experimental class are normally distributed. The homogeneity test shows that the sig.2-tailed value is 0.544> 0.05, it can be said that the SRL data for the experimental class and the control class are homogeneous. Because it has met the prerequisite assumptions of the hypothesis, then the hypothesis test is carried out.

Based on the hypothesis test using the independent sample t-test, it is known that the sig.2-tailed value is 0.021 <0.05. This shows that H_0 is rejected and H_a is accepted. It can be concluded that there is a significant difference in SRL scores in the experimental and the control class.

To find out the effectiveness of the PjBL model in increasing SRL, then N-gain analysis was carried out. Based on the results of the N-gain analysis for the experimental class is 0.070 and the control class is -0.088, it indicated that the N-gain of the experimental class was greater than that of the control class. This shows that the PjBL model is effective in increasing SRL.

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[41] Halimatus Sadiyah and Lutfiyah Hidayati, "Pengaruh Model Pembelajaran Project Based Learning terhadap Self Regulated Learning Siswa dalam Mata Pelajaran Produk Kreatif dan Kewirausahaan pada Kelas XI Tata Busana WU Di SMK Negeri 1 Buduran," *Jurnal Online Tata Busana* 8, no. 2 (May 9, 2019), https://doi.org/10.26740/jotb.v8n2.p%p.

[42] Ardian Retno Anggraeni, Andri Anugrahana, and Patrisia Betris Yan Ariyanti, "Penerapan Model Pembelajaran Project Based Learning Terhadap Kreativitas Siswa Dengan Menggunakan Bahan Alam Pada Kelas 1 SD Negeri Plaosan 1," *Jurnal Pendidikan Tambusai* 7, no. 1 (March 28, 2023): 3683–90, https://doi.org/10.31004/jptam.v7i1.5790.

PjBL is a concept that implements learning through projects and student-centered learning, student independence, as well as group/team learning and through assignments[43]. PjBL is able to develop an attitude of student responsibility[44]. Students are given the responsibility to carry out in-depth investigations of how to complete all of their assignments independently. PjBL which is set in groups is able to foster an active learning atmosphere. Each member of the group has their respective roles and duties, so that they are able to grow SRL[45].

PjBL implementation in learning is able to foster internal motivation which is part of the SRL[46]. Teachers provide support and guidance during project work which is indirectly able to foster students motivation.

PjBL also requires students to plan and check the completeness of their assignments[47]. The application of PjBL in learning can increase self-confidence, learning motivation, and independent learning attitudes[48]. Furthermore, Sungur also explained that PjBL is able to teach how to learn. Thus PjBL is able to significantly improve students' SRL skills [49]; [50]; [51].

CONCLUSION

The results of the study demonstrate that implemented the PjBL model into the science learning "Water as an Alternative Energy Source" can increase students' enthusiasm, responsibility, and independence when working on their projects. According to the findings of the PJBL analysis, it is successful at raising students' SRL. This is demonstrated by the independent sample t-test results, which show a significant

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[43] Mali, "Project-Based Learning in Indonesian EFL Classrooms."

[44] Dahlia Novarianing Asri, "Self-Regulated Learning Sebagai Moderator Dalam Implementasi Strategi Pembelajaran Berbasis Proyek Untuk Menurunkan Prokrastinasi Akademik," *Prosiding Seminar Nasional Hasil Penelitian LPPM Universitas PGRI Madiun*, no. 0 (November 1, 2017): 106–13.

[45] Ke Zhao and Yongyan Zheng, "Chinese Business English Students' Epistemological Beliefs, Self-Regulated Strategies, and Collaboration in Project-Based Learning," *The Asia-Pacific Education Researcher* 23, no. 2 (June 1, 2014): 273–86, https://doi.org/10.1007/s40299-013-0103-z.

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[47] Robertson, "The Educational Affordances of Blogs for Self-Directed Learning."

[48] Sungur and Tekkaya, "Effects of Problem-Based Learning and Traditional Instruction on Self-Regulated Learning."

[49] Zarouk et al., "The Impact of Flipped Project-Based Learning on Self-Regulation in Higher Education."

[50] Burkšaitienė, "Project-Based Learning for the Enhancement of Self-Regulated Learning and Creativity in a Course of ESP."

[51] Ribeiro et al., "Competence Development Strategies after COVID-19."

difference in the SRL score between the experimental and the control class with a sig.(2-tailed) value of 0.021<0.05. The findings of the N-gain study, which showed that the experimental class's results were 0.070 while the control class's results were -0.088, also demonstrated the effectiveness PjBL increasing SLR.

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DECLARATION OF CONFLICTING INTERESTS

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