IJORER : International Journal of Recent Educational Research
Homepage : https://journal.ia-education.com/index.php/ijorer
Email : ijorer@ia-education.com

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 5, No. 2, March 2024
Page 345-358

Improving Individual Innovative Behavior and Post-COVID-19 Student' Learning Outcomes Through Project-Based Blended Learning

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DOI: https://doi.org/10.46245/ijorer.v5i2.568

Sections Info

Article history:
Submitted: January 23, 2024
Final Revised: February 19, 2024
Accepted: February 20, 2024
Published: March 7, 2024

Keywords:
Innovative behavior;
Learning outcomes;
online asynchronous;
Post COVID 19 Era;
Project Based Blended Learning;
Synchronous online.

ABSTRACT

Objective: This study aims to improve individual innovative behavior and learning outcomes and determine differences in individual innovative behavior and student learning outcomes after being taught with Project_Based Blended Learning synchronous and asynchronous online models followed by face-to-face offline models in the post-COVID-19 era. **Method:** The research used a quasi-experiment; the control class samples were 33, and the experimental class was 33 students. Data were collected using questionnaires, test instruments, and observation sheets, and the collected data were analyzed using descriptive statistics, gain tests, and t-tests. **Result**: The increase in individual innovative behavior and learning outcomes before and after teaching in the control class in the moderately effective category is lower and significantly different compared to the experimental class in the practical category. The final score of individual innovative behavior and learning outcomes of the control class is lower and significantly different than that of the experimental class. **Novelty:** Blended Learning in this research is integrated with Project-Based Learning with synchronous and asynchronous online models to produce project products assigned to be used in practical courses.

INTRODUCTION

The post-COVID-19 era has significantly impacted technological change and human life. Changes in technology and human life have consequences for technological advances in education (Azman et al., 2020; Laoli et al., 2022; Mallisza et al., 2021). Lecturers must modernize the learning system by integrating and utilizing the latest technology to create innovative, exciting teaching materials and make it easier for students to learn (Indarta et al., 2021; Timor et al., 2021). Lecturers must be able to create and utilize teaching material products that attract attention and make learning more accessible (Ziliwu et al., 2022). The emergence of new technologies must also be followed by efforts to develop individual innovative behavior and innovative application of technology. Innovation is a process that involves generating and implementing ideas. Individual behavioral innovation is a multi-stage process, starting from identifying problems, coming up with ideas and solutions, combining mutually supportive ideas, forming a support network, realizing ideas, developing new products, and improving work processes. The inappropriate use of learning models and methods can cause a low quality of education.

Blended Learning is a student-centered, self-paced, flexible, and resource-rich learning approach to complement face-to-face learning offline (Stein & Graham, 2020); a series of content blocks sequenced to create a learning experience (Utami & Vioreza, 2021); combination of physical and online learning (Han & Ellis, 2019); elements are a combination of face-to-face and e-learning, applications, tutorials, collaboration, and evaluation (Zahari, 2019); lecturers and students undergo self-directed online learning to gather initial information, be active in classroom learning, and participate in online learning in their neighborhood (Stein & Graham, 2020); students are involved in solving problems by investigating, designing, deciding, and creating products, the role of lecturers is to monitor and guide student activities. The determinants of the success of Blended Learning implementation in vocational education are critical to note. The determining factor for the success of its application in vocational education is determined by the teacher's ability to design a learning model pedagogically. In order to optimize the results, the stages in designing and implementing are determining the type and material of teaching, the design used, the format of online learning, conducting trials, implementing the design properly, and preparing evaluation criteria. Blended Learning is also a response to technological developments (Kiranawati, 2019); it can improve learning outcomes, students are satisfied and agree to be applied because it is efficient and effective (Destiana et al., 2019); and have a high impact on improving knowledge and skills, behavior and motivation (Handayani et al., 2020).

Although many studies have revealed the positive potential of blended learning, there is still debate about its implementation, especially in vocational and professional training, because it is primarily hands-on, and online learning is not feasible. There needs to be a balance of online and face-to-face theoretical lectures so that online learning media can present actual situations in the classroom (Maimaiti et al., 2023; Singh et al., 2021). There are still differences in the development of Blended Learning, especially in vocational education, regarding the impact of its implementation. PjBL is one type of creative learning; students face challenging tasks and complex issues, conduct in-depth investigations, focus on acting on problems, multidisciplinary work tasks, and finally directed to a product (Oskah et al., 2020). The steps start planning, creating, and processing (Oskah et al., 2020). The use of PjBL is more effective by applying Blended Learning in developing professional and information competencies; there is a significant positive effect between the PjBL model variables and learning outcomes (Distyasa et al., 2021); there is an interaction effect of the PjBL model and creative thinking skills on the learning outcomes of engineering students (Mursid et al., 2022).

PjBL is an integration of PjBL with Blended Learning. PjBL has pedagogical advantages. It has been adopted at the secondary to higher education level because, at this level, it is the stage of formal thinking (Priatna et al., 2022). Piaget's theory states that students are considered adults at the formal operation stage, so it is easier to apply when they receive a learning model update. Its application allows students to develop strong character and acquire skills through project activities. The information for practice is authentic and accurate, indirectly giving students a technical experience based on constructivist philosophy (Ziliwu et al., 2022). Constructivism is a learning philosophy centered on ideas generated by their experiences to generate more effective ideas (Laoli et al., 2022). Recent technological advances also allow for synchronous and asynchronous online PjBL. Effective online learning requires lecturers' awareness of using technological tools and online learning approaches (Cong et al., 2020). In asynchronous online learning, lecturers provide indirect interaction spaces, engage them in group activities, respond to problems, and ensure they feel supported doing their asynchronous work (González-Lloret, 2020).

PjBL can be used as an alternative solution in Vocational Education by technological advances. Its application has a positive impact, so it attracts the attention of implementers in developing learning models and methods. The author is also interested in researching "Improving Individual Innovative Behavior and Post-COVID-19 Student Learning Outcomes with PjBL. The course in this study is the Practice of Regulating and Using

Electric Motors on the sub-topic of making project products for Direct On Line (DOL) starting current controllers, star/delta starting current controllers, right-left rotating electric motor controllers, 2 alternating rotating motor controllers, and two sequential rotating motor controllers. It is suspected that the implementation is more suitable for improving individual innovative behavior and learning outcomes if using PjBL Synchronous Online Model (MOLS) followed by Face to Face Offline Model (PjBLMOLSDMFFOF) or PjBL Asynchronous Online Model (MOLS) followed by Face to Face Offline Model (PjBLMOLADMFFOF). This study aims to determine the improvement and differences in individual innovative behavior and student learning outcomes before and after being taught using PjBLMOLSDMFFOF and PjBLMOLADMFFOF. Hence, the research objective is to determine the improvements and differences in individual innovative behavior and student learning outcomes before and after being taught using PjBLMOLSDMFFOF and PjBLMOLADMFFOF and whether there are differences in the final learning outcomes of individual innovative behavior and final learning outcomes of students taught PjBLMOLSDMFFOF compared to PjBLMOLADMFFOF.

RESEARCH METHOD

This research is motivated by post-COVID-19 conditions, with face-to-face learning in the classroom limited in frequency and time. The solution is to utilize technology and apply the suitable PjBL model to improve individual innovative behavior and student learning outcomes. The type of research is quasi-experimental because researchers have difficulty controlling variables outside the study that might affect the results of the study (Aslami et al., 2021; Gopalan et al., 2020; Kamaruddin et al., 2023; Tang & Hew, 2022; Tarhan et al., 2020). Determination of the sample with the purposive sampling technique is setting specific criteria according to research objectives to reduce bias (Sugiono, 2020). The total sample was 66 students; the control and experimental classes were 33 students each. Data on individual innovative behavior were obtained through a questionnaire. Initial and final learning outcomes in the cognitive domain were obtained through tests using test instruments. Data on affective learning outcomes were obtained through observations using observation sheets. Psychomotor learning outcomes data were obtained through observations and portfolios using student performance assessment sheets, product performance assessment sheets, and portfolio assessment sheets. Before the research instrument was used, it was validated by media, evaluation, and learning experts using a validation sheet. The validation data were analyzed, and the results were valid.

Data on innovative behavior and learning outcomes that have been obtained are tabulated and analyzed with descriptive statistics. The t-test analysis used Paired and Independent Samples Test analysis techniques, with a 5.00% error rate. The t-test was preceded by a prerequisite test of analysis, namely regular and homogeneous data, random samples, and interval and ratio scale data (Sugiono, 2020). Calculate the increase in individual innovative behavior and learning outcomes before and after being taught using the N-Gain formula and its categorization in Table 1.

Table 3.1. N-Gain Categorization

N-Gain	Scores of experimental class learning outcomes
$0.70 \leq g \leq 1.00$	High
$0.30 \leq g \leq 0.70$	Medium

0.00 < g < 0.30	Low
0.00 = g	No increase
-1.00≤ g < 0.00	There was a decrease

RESULTS AND DISCUSSION

Results

PjBL syntax in the learning course of the Practice of Regulating and Using Electric Motors with the sub-topic of making Direct Online (DOL) starting current controller projects, star/delta starting motor current controllers, left-right rotary motor controllers, controllers of 2 alternating rotating motors, and controllers of 2 sequential rotating motors as in Table 2.

Table 2. Syntax PjBL.

Syntax PjBL	Model PjBL		Time (Minutes)
	Control Class	Experiment Class	
Basic question	Model Online Sinkron (MOLS)	Model Online Asinkron (MOLA)	2x170
Arrange project plan	MOLS	MOLA	2x170
Arrange schedule	MOLS	MOLA	2x170
Monitor student's progress of the project	Model Face-to-Face Offline (MFFOF) in the Electrical Workshop	Model Face-to-Face Offline (MFFOF) in the Electrical Workshop	10x170
Result evaluation	MFFOF in the Electrical Workshop	MFFOF in the Electrical Workshop	2x170
Experience evaluation	MOLS	MOLA	2x170

Figure 1 shows a histogram of indicators and initial and final scores of individual innovative behavior. Indicators of individual innovative behavior include identifying problems, generating ideas, combining related ideas, managing and combining concepts for solutions, realizing ideas, developing new products, and improving work processes. Histograms of indicators and initial and final scores of learning outcomes are shown in Figure 2. Indicators of learning outcomes include creating a project topic, designing the project, organizing the schedule, working on the project, testing the project results, and making written and oral reports (Joko et al., 2022).

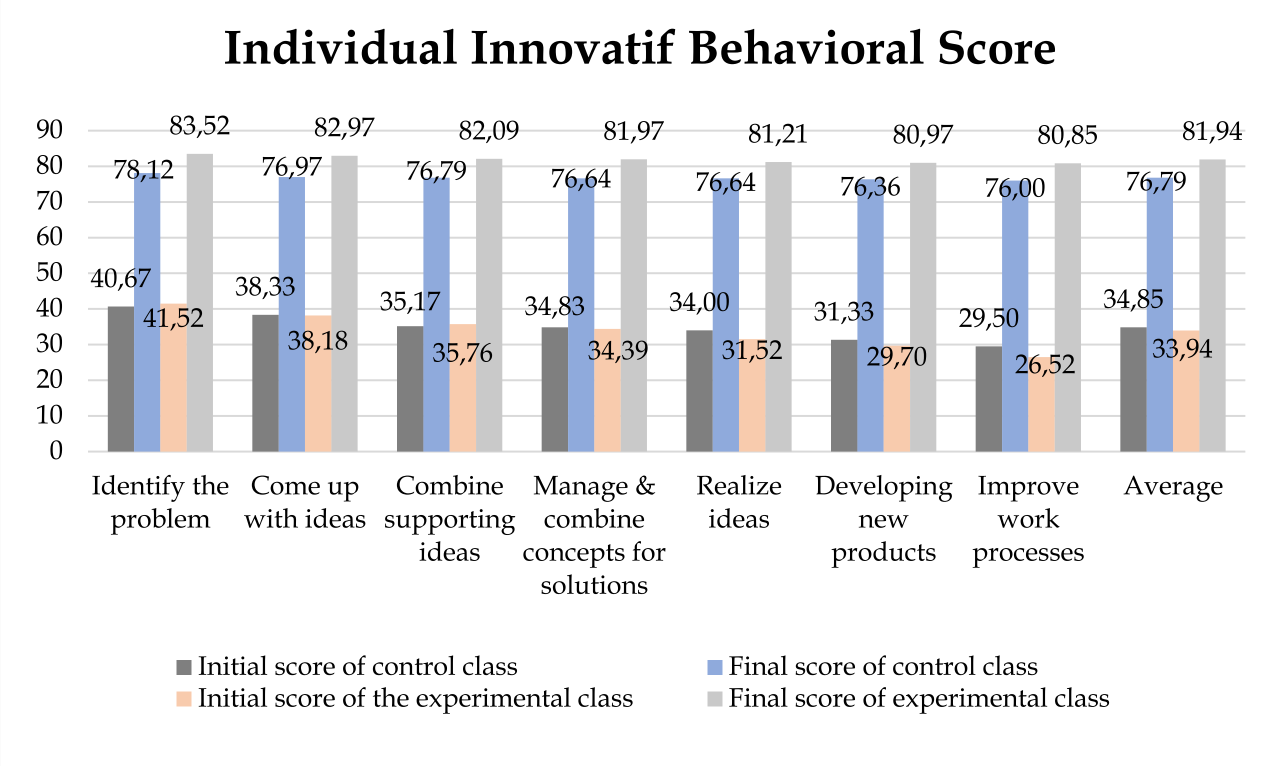

Figure 1. Histogram of indicators and scores of individual innovative behavior.

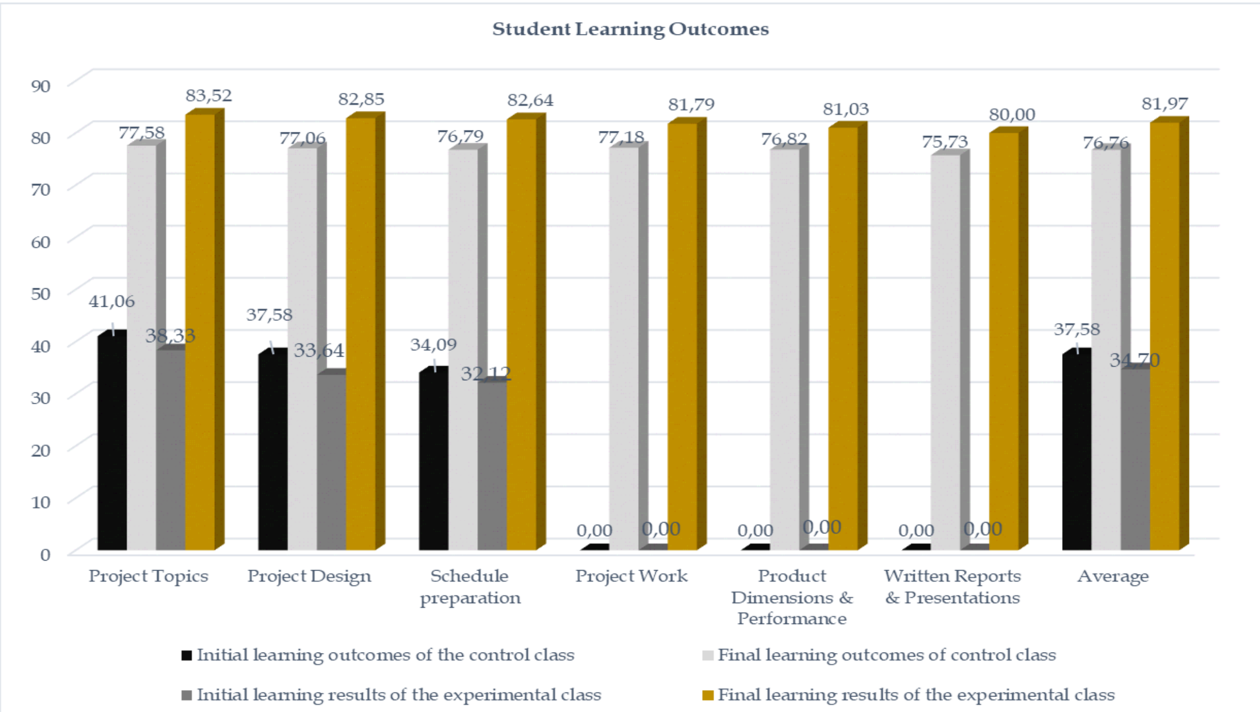

Figure 2. Histogram indicator and student learning outcome.

Descriptive statistics of the initial and final scores of individual innovative behavior and learning outcomes of control and experimental classes are in Table 3. The control class's mean initial score of individual innovative behavior was 34.85; the final score was 76.79; the mean initial learning outcomes were 37.88, and the final score was 76.76. The mean initial score of individual innovative behavior was 33.94; the final was 81.94; the mean initial score of learning outcomes was 34.70, and the final was 81. 97.

Table 3. Descriptive statistics of individual innovative behavior scores and learning outcomes.

	Statistic		Std. Error
Initial score of individual innovative behavior of control class	Mean	34.85	1.44
	Std. Deviation	8.24	
Final score of individual innovative behavior of control class	Mean	76.79	1.18
	Std. Deviation	6.80	
The initial score of individual innovative behavior of an experimental class	Mean	33.94	1.456
	Std. Deviation	8.363	
The final score of experimental class individual innovative behavior	Mean	81.94	1.239
	Std. Deviation	7.119	
Initial score of control class learning outcomes	Mean	37.88	1.189
	Std. Deviation	6.377	
Final score of control class learning outcomes	Mean	76.76	1.110
	Std. Deviation	6.833	
Initial score of experimental class learning outcomes	Mean	34.70	1.583
	Std. Deviation	9.095	
Final score of experimental class learning outcomes	Mean	81.97	1.182
	Std. Deviation	6.789	

The summary of the N-Gain of individual innovative behavior and learning outcomes of the control and experimental classes is in Table 4.

Table 4. Summary of N-Gain of individual innovative behavior and learning outcomes.

	N-Gain		Categories
Control class individual innovative behavior score	0.64	64.85%	Medium/ moderately effective
Experimental class individual innovative behavior score	0.72	72.21%	High/effective
Control class learning outcome score	0.62	62.75%	Medium/ moderately effective
Scores of experimental class learning outcomes	0.71	71.80%	High/effective

Difference between Initial and Final Scores of Individual Innovative Behavior and Learning Outcomes of Control and Experimental Classes

The data is the normal distribution and homogeneous variance in the paired Samples Test prerequisite test. The summary of the normality test results is in Table 5.

Table 5. Summary of tests of normality results.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Initial score of individual innovative behavior of control class	0.15	33	0.05	0.93	33	0.06
Control class individual innovative behavior final score	0.12	33	0.20*	0.94	33	0.09
Initial score of control class learning outcomes	0.15	33	0.03	0.94	33	0.08
Final score of control class learning outcome	0.12	33	0.19	0.94	33	0.06

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
The initial score of individual innovative behavior of an experimental class	0.13	33	0.12	0.95	33	0.19
The final score of individual innovative behavior of an experimental class	0.11	33	0.20*	0.94	33	0.09
Initial score of experimental class learning outcomes	0.15	33	0.05	0.95	33	0.22
Final score of experimental class learning outcomes	0.11	33	0.20*	0.94	33	0.12

**. This is a lower bound of the true significance.*
a. Lilliefors Significance Correction

In the control class, the initial score of individual innovative behavior sig. 0.06 > 0.05 and the final score of 0.09 > 0.05, the initial score of learning outcomes sig. 0.08 > 0.05, and the final score is sig. 0.06 > 0.05. In the experimental class, the initial score of individual innovative behavior sig. 0.19 > 0.05 and the final score of 0.09 > 0.05, the initial score of learning outcomes sig. 0.22 > 0.05, and the final score is sig. 0.12 > 0.05. These results indicate that all data on the initial and final scores of individual innovative behavior and learning outcomes of the control and experimental classes are typically distributed. The results of the Test of Homogeneity of individual behavior scores and learning outcomes of control and experimental classes are shown in Table 6.

Table 6. Summary of test of homogeneity of variances results.

Levene Statistic		df1	df2	Sig.
Start-end score of individual innovative behavior of control class	0.89	1	64	0.34
An initial-end score of control class learning outcomes	0.93			0.33
An initial-end score of experimental class learning outcomes	1.91			0.17
Skor awal-akhir perilaku inovatif individu kelas eksperimen	0.31			0.57
Experimental class individual innovative behavior start-end score	0.29			0.58
Final score of individual innovative behavior of control and experimental classes	0.00			0.96
Final score of control and experimental class learning outcomes	3.55			0.06
Final score of control and experimental class learning outcomes	0.07			0.78

In the control class, the initial-end score of individual innovative behavior sig. 0.34 > 0.05, the initial-end learning outcome score sig 0.33 > 0.05. In the experimental class, the initial-end score of individual innovative behavior sig. 0.57 > 0.05, early-late learning outcomes 0.17 > 0.05. The initial score of individual innovative behavior of the control and experimental classes sig. 0.58 > 0.05, and the final score is sig. 0.96 > 0.05. The initial score of learning outcomes of control and experimental classes sig value. 0.06 > 0.05, and the final score is sig. 0.78 > 0.05. The results of the Test of Variances all sig. > 0.05, meaning that all data tested have homogeneous variances. All data were normally distributed, and the variance was homogeneous, followed by a t-test. A summary of the Paired Samples Test is shown in Table 7.

Table 7. Summary of paired samples test results.

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper	t	df	Sig. (2-tailed)
Pair 1	End-start score of individual innovative behavior of control class	41.93	4.80	0.83	40.23	43.64	50.17	32	0.000
	An end-start score of individual innovative behavior of an experimental class	-48.00	10.29	1.79	-51.65	-44.34	-26.77	32	
	End-of-study results of the control class	-38.87	6.54	1.13	-41.19	-36.55	-34.14	32	
	End-of-study results of the experimental class	-47.27	11.14	1.94	-51.22	-43.32	-24.37	32	

Difference in Individual Innovative Behavior Final Score and Learning Outcome Final Score

A summary of the Independent sample test results for individual innovative behavior scores and learning outcomes is shown in Table 8.

Table 8. Summary of independent samples test results.

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Initial scores of individual innovative behavior of control and experimental classes	Equal variances assumed	0.29	0.58	0.35	64.00	0.72
	Equal variances are not assumed.			0.35	63.55	0.72
Final score of individual innovative behavior of control and experimental classes	Equal variances assumed	0.00	0.96	-3.00	64.00	0.00
	Equal variances are not assumed.			-3.00	63.86	0.00
The initial score of control and experimental class learning outcomes	Equal variances assumed	3.55	0.06	1.64	64.00	0.10
	Equal variances are not assumed.			1.64	57.34	0.10
	Equal variances assumed	0.07	0.78	-3.10	64.00	0.00

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Final learning outcomes of control and experimental classes	Equal variances are not assumed.			-3.10	63.99	0.00

The results of the Independent Samples Test test of the initial score of individual innovative behavior of the control and experimental classes sig value (2-tailed) 0.72 > 0.05, meaning that there is no significant difference in the initial score or initial ability of individual innovative behavior of the control class mean 34.85 compared to the experimental class mean 33.94, then continue the differential test on the final results. The t-test results on the final score of individual innovative behavior sig value. 0.00 <0.05, meaning that the learning outcomes of innovative behavior of the control class 76.79 are significantly lower than the mean of the experimental class 81.94. The difference test results between the initial score of the learning outcomes of the control and experimental classes sig. 0.10 > 0.05, indicating no significant difference in the initial learning outcomes of the control class mean of 37.88 compared to the experimental class mean of 34.7, continued the t-test of the final score. The t-test results of the final score of learning outcomes sig value. 0.00 <0.05, showing the final score of the control class learning outcomes mean 76.76, significantly lower than the experimental class mean of 81.97.

Discussion

Test the difference between the initial and final scores of individual innovative behavior and learning outcomes using the Paired Samples Test after the pre-test is met, that the data is usually distributed, and the variance is homogeneous. Independent Samples Test is conducted if the data is homogeneous, normally distributed, random sample, ratio and interval scale data, and initial ability is not significantly different. The increase in individual innovative behavior of the control class before and after being taught with PjBLMOLSDMFFOF was 64.85% in the moderately effective category, and the increase in learning outcomes score was 62.75%. The increase in individual innovative behavior scores of experimental classes before and after being taught with PjBLMOLADMFFOF was 72.21%, and the learning outcomes score was 71.80% in the practical category.

The results of this study are reinforced by research by Destiana et al. (2019) that the application of Blended Learning can improve learning outcomes, be effective, efficient, and satisfying, improve skills, knowledge, motivation, and behavior (Handayani et al., 2020); the PjBL model variable has a significant positive effect on learning outcomes (Distyasa et al., 2021); there is an interaction effect of the PjBL model and creative thinking skills on the learning outcomes of engineering students (Mursid et al., 2022). The results of the study can also be an alternative to answer the problem that the low quality of education can be caused by the use of inappropriate learning models and methods (Utami & Vioreza, 2021) and solve the problem that there is still debate in the implementation of Blended Learning, especially in Vocational and Professional Training because most of them are hands-on and less possible if applied online.

Individual innovative behavior score of the control class sig value. (2 tailed) 0.00 <0.05, indicating the initial score of individual innovative behavior of the control class before being taught mean 34.85 is lower and significantly different than after being taught using

PjBLMOLSDMFFOF mean 76.79. The individual innovative behavior score of the experimental class sig value (2-tailed) 0.00 <0.05, which means that the initial score of the individual innovative behavior of the experimental class before being taught the mean 33.94 is lower and significantly different than after being taught with PjBLMOLADMFFOF mean 81.94. The control class learning outcome score sig value (2-tailed) 0.000 <0.05, indicating the initial score of the control class learning outcome before being taught the mean 37.88 is lower and significantly different than after being taught with PjBLMOLSDMFFOF mean 76.76. The experimental class learning outcome score sig value (2-tailed) 0.000 <0.05 shows the mean score of the experimental class learning outcome before being taught mean 34.70 is lower and significantly different than after being taught PjBLMOLADMFFOF mean 81.97.

Independent Samples Test results of the initial score of individual innovative behavior sig value. (2 tailed) 0.726> 0.05, meaning there is no significant difference in the initial score of individual innovative behavior of the control class mean of 34.85 and the experimental class 33.94. Because the initial score is not significantly different, the Independent Samples Test of the final score of individual innovative behavior of the control class is compared with the experimental class. The result, sig value (2-tailed) 0.00 <0.05, means that the final learning outcome of innovative behavior of the control class taught with PjBLMOLSDMFFOF mean 76.79 is more petite and significantly different than the experimental class taught with PjBLMOLADMFFOF mean 81.94.

The results of the Independent Sample Test of initial learning outcomes sig (2-tailed) 0.10> 0.05, meaning there is no significant difference in the initial learning outcomes of the control class mean of 37.88 compared to the experimental class mean of 34.70. Because there is no significant difference, it is continued with the Independent Samples Test t-test. The results of the Independent Samples Test t-test of the final learning outcomes of the control class compared to the experimental class, sig value (2-tailed) 0.00 < 0.05, indicating the final learning outcomes of the control class mean 76.76 lower and significantly different than the final learning outcomes of the experimental class students mean 81.97.

Previous research results support this study. Blended Learning is compatible because it is flexible with various education system models (Al-Maroof et al., 2022; Islam et al., 2021; Krismadinata et al., 2020; Müller & Mildenberger, 2021). The application of blended learning has positively affected learning outcomes during the pandemic. Improve students' ability to understand concepts and learning outcomes and have a positive effect on the learning process; improve students' interaction with teachers, academic achievement, self-learning ability, and learning attitude; develop strong character and acquiring skills through actual project activities, the information collected is authentic and accurate, provides experience and the techniques are based on constructivist philosophy (Fraile-Fernández et al., 2021; Guaman-Quintanilla et al., 2023; Hajirasouli & Banihashemi, 2022; Mohammed & Kinyo, 2020; Pande & Bharathi, 2020).

In the control class applying PjBLMOLSDMFFOF, the increase in individual innovative behavior and learning outcomes before and after learning is quite adequate, although significantly different. In the experimental class using PjBLMOLADMFFOF, the increase in individual behavior scores and learning outcomes before and after learning were practical, although significantly different. These results show that there is still a need to improve the quality of implementation, especially the online learning model, both synchronous and asynchronous online models. For further research or other researchers in the future, there must be an increase in the quantity and quality of online learning so that the improvement of learning outcomes is more optimal.

CONCLUSION

Fundamental Findings: The results showed an increase in the moderately effective category of individual innovative behavior scores and learning outcomes scores before and after students were taught with the PjBL synchronous online model followed by the face-to-face offline model. The initial score of individual innovative behavior and the initial score of learning outcomes are lower and significantly different than the final score of individual innovative behavior and the final score of learning outcomes. There is an increase in the practical category of innovative behavior scores and learning outcomes scores before and after being taught with the PjBL asynchronous online model followed by the face-to-face offline model. The initial score of individual innovative behavior and the initial score of learning outcomes are lower and significantly different than the final score of innovative behavior and the final score of learning outcomes. The final score of innovative behavior and the final score of learning outcomes of students taught with the PjBL synchronous online model followed by the offline face-to-face model are lower and significantly different from the final score of innovative behavior and the final score of learning outcomes of students taught with PjBL synchronous online model followed by offline face to face model. **Implication:** Implementing the PjBL learning asynchronous online model followed by the offline face-to-face model is more effective and significantly different in improving individual innovative behavior and student learning outcomes than students taught with the PjBL synchronous online model followed by the offline face-to-face model. Increased student behavior in completing projects in identifying problems, generating ideas, combining supporting ideas, managing and combining concepts for solutions, realizing ideas, developing new products, and improving work processes. Improved learning outcomes in compiling project topics, designing projects, setting completion schedules, carrying out project work processes, testing project results, and reporting written and oral results. Thus, utilizing the asynchronous online PjBL model combined with the face-to-face model is more effective in improving the quality of learning outcomes and education in the era of very rapid technological development after COVID-19 and the era of society 5.0. **Limitation:** The implementation of PjBL research on synchronous and asynchronous online models has yet to maximally utilize the learning management system (LMS), so improving individual behavior and learning outcomes could be more optimal. **Future research:** Future research or further research still needs to be done by optimizing the utilization of LMS resources owned by Unesa, especially in synchronous and asynchronous learning involving other variables.

ACKNOWLEDGEMENTS

Thanks to the Chairperson of LPPM, Drkan of the Faculty of Engineering, and Coordinator of the S1 Electrical Engineering Education Study Program for providing opportunities and funding research.

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