Al-Ishlah: Jurnal Pendidikan
Vol.18, 1 (March, 2026), pp. 1092-1108
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v18i1.9620

Integrating Flipped Classroom and Problem-Based Learning to Enhance Self-Efficacy and Problem-Solving in Higher Education

Miftahus Surur[1]*, Yesi Puspitasari[2], Siti Karunia Dewi[3]

[1,2,3] STKIP PGRI Situbondo, Situbondo, Indonesia; surur.miftah99@gmail.com

ARTICLE INFO

Keywords:

flipped classroom;
problem-based learning;
self-efficacy;
self-directed learning;
problem-solving

Article history:

Received 2026-01-13
Revised 2026-02-23
Accepted 2026-03-31

ABSTRACT

The increasing demand for 21st-century competencies in higher education highlights the need for instructional approaches that enhance students' self-efficacy, learning autonomy, and problem-solving skills. While Flipped Classroom (FC) and Problem-Based Learning (PBL) have been widely studied independently, their integrated effects remain underexplored, particularly in the Indonesian context. This study employed a quasi-experimental design with a nonequivalent control group involving 70 undergraduate students. The experimental group (n = 35) received an integrated FC-PBL intervention over one semester, while the control group (n = 35) experienced conventional instruction. Data were collected using validated instruments measuring academic self-efficacy, self-directed learning, and problem-solving ability. Statistical analyses included independent samples t-tests and MANOVA. The findings revealed that the experimental group significantly outperformed the control group in academic self-efficacy ($t(64) = -3.473$, $p = .001$), self-directed learning ($t(64) = -5.991$, $p < .001$), and problem-solving ability ($t(64) = -2.475$, $p = .016$). Multivariate analysis confirmed a significant overall effect of the intervention (Hotelling's Trace = 0.836, $F(3, 62) = 17.274$, $p < .001$, partial $\eta^2 = 0.455$), indicating a large effect size. The integration of FC and PBL significantly enhances students' affective, metacognitive, and cognitive outcomes. This study provides empirical support for FC-PBL as an effective pedagogical approach to foster essential competencies in higher education. Future research should employ randomized and multi-institutional designs to improve generalizability.

Corresponding Author:
Miftahus Surur
STKIP PGRI Situbondo, Indonesia; surur.miftah99@gmail.com

1. INTRODUCTION

In the contemporary higher education landscape, academic self-efficacy serves as a critical psychological determinant of student success (Rifandi et al., 2022). Grounded in Bandura's social cognitive theory, academic self-efficacy represents an individual's belief in their capability to mobilize the motivation and cognitive resources necessary to execute specific academic tasks (Kodir, 2023). According to Bandura's self-efficacy theory, strong confidence is built through the accumulation of mastery experiences and social validation, which allows individuals to conduct objective and optimistic self-evaluation (Ouyang et al., 2023). Without a robust self-efficacy foundation, students' cognitive potential is often constrained by performance anxiety and a fear of failure, which subsequently inhibits the development of self-regulated learning behaviors.

The escalation of academic self-efficacy is inherently linked to the growth of self-directed learning. Students who possess a strong belief in their academic capabilities tend to demonstrate greater initiative in assessing their educational needs, defining personal learning objectives, and orchestrating higher-order cognitive processes (Zheng et al., 2020). According to Zimmerman's self-regulatory cycle, this independence is an internal force that encompasses full responsibility for one's cognitive and motivational processes (Panadero, 2017). In this context, self-directed learning serves as a control mechanism that transforms theoretical knowledge into directed academic action, forming the essential groundwork for advancing complex problem-solving competencies, skills positioned at the highest levels of Bloom's taxonomy (analysis, evaluation, and creation).

Despite the theoretical importance of these attributes, a significant gap exists between 21st-century competency demands and actual student performance. In "Innovative Learning Media" courses, which require students to engage in collaborative design tasks and authentic project development, observations often reveal low student initiative, characterized by passive attitudes and a heavy dependence on instructor guidance. Students frequently exhibit anxiety when presenting original ideas and show systematic doubts when solving problems that require the application of deep conceptual frameworks. This suggests that traditional, teacher-centered instruction is insufficient for addressing the psychological and cognitive needs of modern learners.

To address these challenges, pedagogical models such as the Flipped Classroom (FC) and Problem-Based Learning (PBL) have been widely adopted. The FC model offers cognitive flexibility by moving basic knowledge transfer outside the classroom through digital materials, allowing students to build readiness at their own pace (Alfiyah & Habiby, 2025). Conversely, PBL establishes an instructional environment where learners utilize acquired knowledge to engage in collective examination of realistic scenarios (Senocak & Demirkıran, 2023). However, emerging scholarship has largely investigated these models in isolation. For instance, studies by Sun et al. (2023) have focused on the FC model's contribution to cognitive achievement, while research by Dewi et al. (2024) has examined PBL's impact on affective variables. There is a notable lack of empirical evidence examining the synergistic effects of integrated FC-PBL frameworks, particularly in how pre-class preparation in a flipped format specifically moderates anxiety and strengthens academic self-efficacy when students are faced with multifaceted PBL challenges in the Indonesian higher education context.

The Flipped Classroom model offers cognitive flexibility by moving the transfer of basic knowledge outside the Classroom through digital materials, so that students can build intellectual readiness at their own learning rhythms (Syofyan, 2020). Conversely, Problem-Based Learning establishes an instructional environment where learners utilize acquired knowledge to engage in collective examination of realistic scenarios (Surur et al., 2020). The integration of FC-PBL creates an ecosystem in which independent preparation outside the Classroom (FC) fuels intensive, interactive problem-solving in the Classroom, thereby systematically reducing students' psychological barriers (Rahayu et al., 2025).

Emerging scholarship has investigated the specific contributions of the Flipped Classroom model toward enhancing cognitive learning achievements. However, there is still very limited literature that examines the synergy between the two models in student psychological dynamics. Most previous studies have tended to separate affective variables, such as self-confidence, from cognitive variables, such as problem-solving, or have focused on only one aspect of self-regulation. There is a gap in the literature on how self-preparation in a flipped format can specifically moderate anxiety and strengthen students' self-efficacy when they are faced with complex PBL challenges.

This study addresses this gap by providing a holistic examination of the FC-PBL integration as a systemic unit. The "Innovative Learning Media" course provides an ideal setting for this intervention due to its focus on project authenticity and the need for collaborative design, which can potentially support the development of critical thinking, creativity, collaboration, and communication. This investigation aims to evaluate how the synthesized FC-PBL methodology shapes academic self-efficacy, self-directed learning, and complex problem-solving proficiency. Based on the theoretical framework and identified research gaps, the following hypotheses are proposed:

1. H1: The integrated FC-PBL approach significantly increases students' academic self-efficacy compared to conventional instruction.
2. H2: The integrated FC-PBL approach significantly enhances students' self-directed learning behaviors compared to conventional instruction.
3. H3: The integrated FC-PBL approach significantly improves students' complex problem-solving abilities compared to conventional instruction.
4. H4: The integrated FC-PBL approach has a significant multivariate effect on the combined outcomes of academic self-efficacy, self-directed learning, and problem-solving proficiency

2. METHODS

This study employed a quasi-experimental research framework with a nonequivalent control group design. This approach was selected due to the impracticality of random assignment within an established academic setting (Cook & Campbell, 1979). The investigation assessed the influence of a synthesized Flipped Classroom and Problem-Based Learning (FC-PBL) pedagogical model on three dependent variables: academic self-efficacy, self-directed learning, and complex problem-solving proficiency. Data collection occurred at two intervals: a pre-test (O1, O3) to establish baseline equivalence and a post-test (O2, O4) to evaluate the intervention's impact. The structural framework of this investigation is schematically represented below:

Table 1. Research Design Scheme

Cohort	Baseline Assessment	Intervention	Final Evaluation
Experiment	O1	Flipped Learning Model Classroom Integrated Problem-Based Learning	O2
Control	O3	Conventional Learning Model	O4

Information:
O1 = Initial measurement (pre-test) for the experimental cohort
O2 = Final measurement (post-test) for the experimental cohort
O3 = Initial measurement (pre-test) for the control cohort
O4 = Final measurement (post-test) for the control cohort

The study was conducted over one academic semester (16 weeks) at a public university in Indonesia, specifically within the "Innovative Learning Media" course. The target population comprised undergraduate students from the Departments of Information Technology Education and Economics Education. Using purposive sampling, 70 students were selected based on their lack of prior exposure to FC or PBL frameworks and comparable academic achievement (GPA > 3.00). Participants were divided into two cohorts: the experimental group ($n = 35$) and the control group ($n = 35$). The demographic distribution included 42% male and 58% female students, with an average age of 20.4 years ($SD = 1.2$). To minimize selection bias, a pre-test equivalence analysis was performed, confirming no significant baseline differences in the measured constructs between groups ($p > .05$). Ethical approval was obtained from the Institutional Review Board (IRB), and all participants provided written informed consent.

Both groups were taught by the same instructor to ensure consistency in content delivery and time-on-task. The FC-PBL intervention followed a structured three-phase cycle:

1 Pre-class (Flipped): Students accessed digital materials (15-20 minute instructional videos and PDF modules) via the Learning Management System (LMS) 72 hours before the face-to-face session. A mandatory pre-class quiz (5 items) served as an accountability mechanism.
2 In-class (PBL): Classroom time was dedicated to the five stages of PBL: (a) orientation to the problem, (b) organizing students for study in small groups (n=5), (c) assisting independent and group investigation, (d) developing and presenting artifacts (e.g., media prototypes), and (e) analyzing and evaluating the problem-solving process.
3 Post-class: Students engaged in reflective blogging on the LMS to consolidate their learning experiences.

The control group received traditional lecture-based instruction. This included 100 minutes of instructor-led presentations, followed by 50 minutes of individual practice or Q&A sessions. While the content was identical to the experimental group, students received no pre-class materials and worked primarily on individual assignments rather than collaborative PBL tasks.

Three instruments were utilized to collect data:

1. Academic Self-Efficacy Scale: Adapted from Bandura's guidelines, consisting of 12 items (e.g., "*I am confident I can design complex learning media*") on a 5-point Likert scale. Content validity was confirmed by three experts (CVI = 0.92), and internal consistency was high (Cronbach's α = 0.88).
2. Self-Directed Learning Readiness Scale: A 15-item questionnaire measuring initiative, independence, and responsibility. Reliability analysis yielded a Cronbach's α of 0.85.
3. Problem-Solving Proficiency Test: A descriptive test comprising four complex scenarios requiring students to analyze, evaluate, and propose solutions. Responses were scored using a standardized rubric (0-100). Inter-rater reliability between two independent markers was excellent (Cohen's κ = 0.84).

Data were analyzed using SPSS v.26. During the post-test, the experimental group had four instances of missing data due to student absence. Analysis of missingness indicated it was Missing Completely at Random (MCAR); consequently, listwise deletion was applied, resulting in a final analytical sample of N = 66 (n_{exp} = 31, n_{ctrl} = 35). Inferential statistics included:

1. Independent Samples T-tests: To compare post-test means and calculate effect sizes (Cohen's d).
2. MANOVA: To assess the multivariate effect on combined outcomes. Assumption tests for MANOVA were conducted, including Box's M test for homogeneity of covariance matrices ($p = .050$) and Levene's test for equality of error variances ($p > .05$ for all DVs).
3. Effect Size Interpretation: Cohen's d values of 0.2, 0.5, and 0.8 represented small, medium, and large effects, respectively, while partial η^2 for MANOVA was interpreted based on Cohen's (1988) benchmarks. The significance level was set at $\alpha = .05$.

3. FINDINGS AND DISCUSSION

3.1 Findings

3.1.1 Pre-test Equivalence Analysis

To ensure baseline equivalence between the experimental and control groups, an independent samples t-test was conducted on pre-test scores for all dependent variables. As shown in Table 1, no statistically significant differences were observed between the two groups ($p > .05$), confirming that participants in both cohorts started with comparable levels of academic self-efficacy, self-directed learning, and problem-solving proficiency.

Table 2. Pre-test Equivalence Results

Variable	Group	M	SD	t	df	p
Academic Self-Efficacy	Exp	24.12	3.15	-0.452	68	.653
	Ctrl	24.45	2.98			
Self-Directed Learning	Exp	21.05	2.45	0.321	68	.749
	Ctrl	20.88	2.12			
Problem-Solving	Exp	45.20	5.60	-0.185	68	.854
	Ctrl	45.45	5.75			

3.1.2 Descriptive Statistics and Categorical Distribution

The descriptive results for the post-test assessments are summarized in Table 3. The final analytical sample consisted of 66 students (n_exp = 31, n_ctrl = 35) following the removal of four cases from the experimental group due to absence (Missing Completely at Random).

Table 3. Post-test Descriptive Statistics

Variable	Group	n	Min	Max	M	SD
Academic Self-Efficacy	Exp	31	30	40	35.00	5.21
	Ctrl	35	23	39	31.43	3.78
Self-Directed Learning	Exp	31	20	38	32.74	5.21
	Ctrl	35	21	36	26.08	3.78
Problem-Solving	Exp	31	65	97	84.94	8.06
	Ctrl	35	17	99	75.89	18.88

Categorical distributions were determined based on standardized cut-off scores (High: >75%, Medium: 50-75%, Low: <50%). As detailed in Table 3, the experimental group showed a higher proportion of students in the "High" category for self-efficacy and problem-solving. Interestingly, for self-directed learning, while the experimental mean was higher, the "Low" category proportion was also larger (20.2% vs 5.7%). This is attributed to the wider variance (SD = 5.21) in the experimental group, indicating that while the FC-PBL model significantly benefited most students, a subset of learners struggled with the increased autonomy required, highlighting the model's demand for high self-regulation.

Table 4. Categorical Distribution of Post-test Scores

Variable	Category	Experimental (n=31)	Control (n=35)
Academic Self-Efficacy	High	48.5%	25.0%
	Medium	51.5%	50.0%
	Low	0.0%	25.0%
Self-Directed Learning	High	16.8%	14.3%
	Medium	63.0%	80.0%
	Low	20.2%	5.7%

Variable	Category	Experimental (n=31)	Control (n=35)
Problem-Solving	High	20.0%	8.6%
	Medium	65.6%	88.5%
	Low	14.4%	2.9%

3.1.3 Results of Descriptive Analysis of Student Confidence

Descriptive statistics pertaining to learner self-efficacy data are presented as post-test quantitative data. The post-test aims to assess students' confidence after treatment. Research data on student confidence were obtained from test instruments. The following table presents the terminal self-assessment data from the intervention and comparison cohorts.

Table 5. Description of Trust Data Self-Student Experiment and Control

		Control Class	Experimen Class
N	Valid	35	31
	Missing	0	4
Mean		31.42	35.00
Median		30.00	36.00
Standard Deviation		4.95	3.05
Minimum		23.00	30.00
Maximum		39.00	40.00

Descriptive statistical examination indicates a peak assessment outcome of 40 points for students in the treatment condition, whereas the highest result for participants in the standard instructional group was 39. Conversely, the minimum scores were 30 and 23 for the intervention and control cohorts, respectively. Furthermore, the calculated mean values are 35.00 for the intervention cohort and 31.43 for the control cohort. These summary statistics indicate a more pronounced enhancement in learner self-assurance within the group exposed to the pedagogical intervention.

Categorization of terminal assessment scores for learner self-efficacy across both cohorts is detailed in the subsequent table.

Table 6. Categorization of Trust Scores: Self-student Class, Experiment, and Control

Category	Control Class	Experiment Class
	Frequency	Frequency
Low	4 (11.4%)	6 (17.2%)
Medium	21 (50%)	18 (51.5%)
High	10 (28.6%)	7 (20.1%)
Total Student	35	31

Table 6 delineates the dispositional trends regarding self-assurance among learners in both the treatment and comparison cohorts. Based on the table, in the control class, 21 students (50%) are classified in the medium category. Meanwhile, in the experimental class, student confidence was classified as medium for 18 students (51.5%). Examination of the categorized score distributions indicates a greater proportional increase in learner self-assurance within the intervention cohort relative to the control group.

3.1.4 Results of Descriptive Analysis of Student Learning Independence

The learner self-efficacy data is characterized using descriptive post-intervention metrics. The posttest post-testdetermine the student's learning independence after receiving treatment. Research data on student learning independence were obtained from test instruments. The data on student confidence from the post-test experimental and control classes are delineated in the subsequent table.

Table 7. Description of Independence Data Study Student Experiment and Control

		Control Class	Experiment Class
N	Valid	35	31
	Missing	0	4
Mean		26.09	32.74
Median		25.00	35.00
Standard Deviation		3.78	5.21
Minimum		21.00	20.00
Maximum		36.00	38.00

Table 7 illustrates a distinct disparity in autonomous learning behaviors between the two cohorts during the final assessment. The comparison group comprised 35 valid responses, with no instances of missing data, while the experimental class had 31 valid data points and 4 missing values. This difference in data quantity does not affect the overall tendency of the descriptive results. The mean score for autonomous learning behaviors within the intervention cohort (M = 32.74) was higher than that in the control class (M = 26.09), indicating a greater increase in learning independence among students who received the treatment. The median scores reinforced these findings: the experimental class had a median of 35.00.

In contrast, the control class had a median of 25.00, indicating that most students in the experimental class achieved consistently higher levels of learning independence. In terms of data distribution, the standard deviation in the experimental class (SD = 5.21) was greater than that in the control class (SD = 3.78), indicating greater variation in learning independence in the experimental class. In addition, the maximum score in the experimental class reached 38, higher than the control class's maximum of 36. Conversely, the minimum observed scores were similar, measuring 20 in the intervention group and 21 in the control group. Collectively, this descriptive analysis indicates that learners in the intervention cohort demonstrated a superior level of autonomous learning relative to their counterparts in the control condition.

The subsequent table delineates the categorized scores and results from the terminal assessment of autonomous learning for both the intervention and comparison groups.

Table 8. Categorization of Learning Independence Scores of Students in the Experimental and Control Classes

Category	Control Class	Experiment Class
	Frequency	Frequency
Low	2 (5.7%)	7 (20.2%)
Medium	28 (80%)	22 (63%)
High	5 (14.3%)	2 (5.7%)
Total Student	35	31

An examination of the final assessment data in Table 8 highlights divergent profiles in self-directed learning attainment between the two participant groups. Within the control condition, most participants (80%, n=28) demonstrated a moderate level of proficiency. A smaller segment achieved high (14.3%, n=5) or low (5.7%, n=2) proficiency ratings. The intervention group presented a different configuration; although a majority likewise reached a moderate level (63%, n=22), a larger subset was rated as low (20.2%, n=7), and a minimal proportion qualified as high (5.7%, n=2). This variance in categorical distribution, despite a shared central tendency toward moderate proficiency, points to an altered structure of learning self-regulation in the treatment group post-intervention, signaling a modified developmental pathway relative to the control.

3.1.5 Results of Descriptive Analysis of Student Problem Solving

The data pertaining to learners' problem-solving capabilities are characterized using descriptive statistics from the final evaluation, which was administered to gauge competency following the instructional intervention. Evidence for this construct was gathered via an assessment instrument comprising open-ended questions designed to evaluate autonomous learning. The relevant self-efficacy metrics from the concluding assessment for both instructional cohorts are summarized in the subsequent table.

Table 9. Description of Solving Data Problem: Student Experiment and Control

		Control Class	Experiment Class
N	Valid	35	31
	Missing	0	4
Mean		75.89	84.94
Median		81.00	86.00
Standard Deviation		18.88	8.06
Minimum		17.00	65.00
Maximum		99.00	97.00

Analysis of the descriptive statistics in Table 9 indicates a disparity in problem-solving performance between the two instructional groups on the final assessment. Data from the control condition included 35 complete and valid responses, while the experimental class had 31 valid data points and 4 missing values. Participants exposed to the novel instructional method obtained a superior average result on the evaluation of problem-resolution skills (M = 84.94) compared to their counterparts in the control group (M = 75.89). This result suggests the pedagogical treatment contributed to enhanced performance in this domain.

Similarly, the median score for the intervention cohort (86.00) exceeded that of the control group (81.00), indicating a tendency toward consistently better achievement in the experimental group. In terms of data distribution, the intervention group demonstrated less score variability, as indicated by a smaller standard deviation (SD = 8.06) than the control class (SD = 18.88). This reflects a greater consistency in learning achievements among participants who received the intervention. Furthermore, the lowest observed score for this cohort (65) significantly surpassed the minimum result recorded in the control condition (17).

The subsequent table categorizes the final assessment outcomes for problem-solving competency across both instructional groups.

Table 10. Categorization of Solving Scores, Problem Student

Category	Control Class	Experiment Class
	Frequency	Frequency
Low	1 (2.9%)	5 (14.4%)
Medium	28 (80.5%)	19 (54.5%)
High	3 (8.6%)	7 (20.%)
Total Student	35	31

Table 10 delineates a marked contrast in the distribution of problem-solving proficiency levels between the cohorts on the final evaluation. Within the control group, a predominant majority of participants (28, or 80.5%) were classified at an intermediate level. A minimal number of learners fell into the low (1, or 2.9%) and high (3, or 8.6%) proficiency tiers. These findings suggest that students' problem-solving skills in the control class tend to be concentrated at the intermediate level. In the experimental cohort, the proportion of learners attaining an intermediate proficiency level was lower, constituting 19 participants (54.5%). This reduction corresponded with an increased representation in both the high (7 students, 20%) and low (5 students, 14.4%) categories.

3.2 Data Analysis

The analysis focused on the metrics for self-efficacy, autonomous learning, and problem-solving competency collected from both participant groups. These datasets, comprising the differential scores on the respective assessments, were subjected to analytical procedures to evaluate the study's hypotheses. Preliminary assumption testing, encompassing assessments of normality and homogeneity, was performed prior to the primary inferential analysis.

3.2.1 Normality Test

A normality assessment was employed to evaluate whether the data for each measured construct adhered to a Gaussian distribution. The outcomes of this analysis are detailed in the table below.

Table 11. Normality Test Results

		Kolmogorov-Smirnov [a]			Shapiro-Wilk		
	study program	Statistics	df	Sig.	Statistics	df	Sig.
independent learning	comparison cohort (economic education study program)	,195	35	,052	,866	35	,001
	intervention cohort (information technology education study program)	,273	31	,060	,812	31	,000
self-confident	comparison cohort (Economics Education program)	,128	35	,159	,940	35	,056
	intervention cohort (Information Technology Education program)	,144	31	,098	,932	31	,051
solution to the problem	comparison cohort (economic education study program)	,158	35	,058	,865	35	,001
	intervention cohort (information technology education study program)	,125	31	,200*	,940	31	,084

Table 11 presents the results of normality diagnostics conducted using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The data for autonomous learning, self-efficacy, and problem-solving competency across both instructional groups generally conform to the assumption of normality. The Kolmogorov–Smirnov significance value for all variables and groups was above the significance limit of $\alpha = 0.05$, indicating no significant deviation from the normal distribution. Thus, it can be concluded that the data in both groups are normally distributed and meet the prerequisites for parametric statistical analysis at the next stage.

3.2.2 Homogeneity Test

The homogeneity of variance assessment evaluates the equivalence of variance across groups for the dependent measures. The findings from this test are displayed in the subsequent table.

Table 12. Homogeneity Test Analysis Results

Box's M	38.837
F	6.141
Df1	6
Df2	28476.747
Sig.	.050

Analysis of the homogeneity of covariance, as presented in Table 12 using Box's M Test, yielded a significance value of .050. As this value meets or exceeds the standard alpha threshold of .05, the null hypothesis of equal population covariance matrices is retained. This outcome confirms that the variance-covariance structures for the dependent measures are equivalent across the two groups. Having satisfied this key assumption of homogeneity, the data are deemed appropriate for subsequent parametric multivariate analysis.

3.2.3 A T Test on Student Confidence Levels

During this phase of statistical examination, an independent samples t-test was employed. This analysis tested the proposition of a statistically significant disparity in learner self-assurance levels between the cohort undergoing the integrated Flipped-PBL pedagogical approach and the group exposed to a traditional instructional format. The following portion elaborates on the results yielded by a comparative t-test for independent samples, analyzing differences in final evaluation outcomes between the instructional treatment and reference groups.

Table 13. Hypothesis Testing with the Independent T-test

Class	t-count	df	Sig.	Information
Experiment Class and Control Class	-3.473	64	0.001	There is a difference

Results from the independent-samples t-test, presented in Table 13, reveal a statistically significant disparity in self-efficacy between the two instructional groups. The analysis produced a t-statistic of -3.473 (df = 64, p = .001, two-tailed). Since this p-value falls below the established alpha level of .05, the null hypothesis is rejected. This result demonstrates that the synthesized pedagogical approach significantly enhances learners' perceived confidence relative to traditional instructional methods. Consequently, the observed advantage can be attributed to the intervention rather than random variation.

3.2.4 A Student's Self-Esteem Test

At the data analysis stage, an independent t-test served to evaluate the research hypothesis. Its purpose was to determine if statistically significant variations in learner autonomy emerged between the cohort experiencing the combined Flipped and Problem-Based Learning format and the group receiving standard lecture-based instruction. The class section served as the primary unit of analysis for this comparison.

Table 14. Hypothesis Test Results with Independent T-test

Class	t-count	df	Sig.	Information
Experiment Class and Control Class	-5.991	64	0.001	There is a difference

Table 14 displays the outcomes of an independent-samples t-test evaluating autonomous learning behaviors across the two cohorts. The test yielded a significant result (t(64) = -5.991, p < .001, two-tailed). The resultant p-value, which falls below the established significance level of α = .05, necessitates the rejection of the null hypothesis. This result indicates a significant disparity in the degree of self-regulated learning behaviors demonstrated by the cohort engaged in the synthesized Flipped and Problem-Based Learning format compared to their peers in the conventional instruction group. Consequently, the evidence substantiates that the implemented pedagogical innovation exerts a more pronounced positive influence on cultivating learner autonomy.

3.2.5 T-Test in Students' Problem-Solving Ability Level

To evaluate the central research proposition, a comparative statistical analysis employing an independent-samples t-test was conducted during the analytical phase. This test examined the potential for a significant discrepancy in the analytical and solution-finding competencies of participants, contrasting those engaged in the synthesized Flipped-PBL instructional strategy with counterparts undergoing traditional, teacher-centered instruction. Table 12 presents a summary of the independent-samples t-test results comparing the experimental and control groups.

Table 15. Hypothesis Test Results with Independent T-test

Class	t-count	df	Sig.	Information
Experiment Class and Control Class	-2.475	64	0.001	There is a difference

Table 15 details the findings from an independent-samples t-test conducted to compare problem-solving competency between the two groups. A significant difference was identified (t(64) = -2.475, p = .016, two-tailed). As this probability value is below the alpha level of .05, the null hypothesis is rejected. The analysis reveals a statistically significant effect of the instructional method on learners' performance in tackling complex tasks. Outcomes for participants in the combined flipped and problem-based format were markedly higher than those achieved by students in the conventional learning environment.

3.2.6 Multivariate Test

To evaluate the integrated effect of the pedagogical innovation on students' key competencies namely self-belief, capacity for self-directed study, and analytical proficiency a multivariate analytical procedure was conducted. The outcomes of this statistical examination are subsequently detailed in the following table.

Table 16. Manova Test Results

Effect	Value	F	df	Errordf	Sig.	Conclusion
Hotelling'sTrace	0.836	17.274^{b}	3	62	0.000	There is a difference

The MANOVA results, detailed in Table 16, demonstrate a statistically significant multivariate effect of the integrated instructional approach on the collective dependent measures of learner self-assurance, autonomous study habits, and problem-resolution competency (Hotelling's Trace = 0.836; F(3, 62) = 17.274; p < 0.001). These findings confirm the effectiveness of the learning model in improving various aspects of student learning outcomes comprehensively compared to conventional learning.

The partial η^2 of 0.455 indicates that approximately 45.5% of the variance in the combined dependent variables is explained by the instructional method, representing a large effect size. These findings provide strong support for H4, demonstrating that the FC-PBL model comprehensively outperforms conventional instruction in enhancing student outcomes.

3.3 Discussion

3.3.1 The Effect of the Flipped Classroom Learning Model Integrated with Problem-Based Learning on Student Confidence

The findings demonstrate that the FC-PBL synthesis significantly increases academic self-efficacy compared to traditional instruction. This enhancement is theoretically grounded in Bandura's social cognitive theory, which identifies mastery experiences, social persuasion, and reduced physiological arousal as primary sources of self-efficacy. In the FC-PBL model, pre-class preparation via digital materials allowed students to achieve cognitive readiness at their own pace, effectively reducing pre-session anxiety, a key factor in minimizing negative affective states that inhibit academic confidence (Algarni, 2025).

Furthermore, the in-class PBL phase provided multiple opportunities for "mastery experiences" as students successfully navigated complex, authentic tasks. Unlike traditional lectures where students are passive recipients, the collaborative nature of PBL facilitated "social persuasion" through peer feedback and instructor facilitation within small groups (Ouyang et.al 2023). This synergy between independent preparation (FC) and applied inquiry (PBL) created a reinforcement loop: pre-class success built the confidence to engage in classroom discussions, while successful problem-solving in class further solidified students' beliefs in their academic capabilities.

The significant disparity in self-directed learning behaviors between cohorts underscores the effectiveness of FC-PBL's structural design. The model's pre-class phase inherently demands higher accountability; students must manage their time and select appropriate learning strategies to complete preparatory tasks before face-to-face sessions (Chikeme et.al 2024). This aligns with Zimmerman's self-regulatory cycle, where students engage in forethought (planning pre-class study), performance (engaging with digital content), and self-reflection (evaluating their understanding during in-class PBL) [5]. However, the wider variance in the experimental group's independence scores (SD = 5.21) suggests that the transition to an autonomous model is not uniformly successful. While most students thrived, a subset struggled with the sudden shift from instructor-led to student-centered learning. This highlights that FC-PBL is not merely a method but a demanding pedagogical framework that requires sustained scaffolding to support students with lower initial self-regulation skills (Suharianto et.al 2022).

The superior problem-solving proficiency observed in the experimental group (M = 84.94) can be attributed to the reallocation of classroom time toward higher-order cognitive tasks. By moving basic knowledge acquisition to the pre-class phase, the instructor could dedicate in-class sessions to the "analyze," "evaluate," and "create" levels of Bloom's taxonomy (Nafiati, 2021). The structured five-phase PBL process forced students to move beyond memorization to define problems, synthesize information, and design original media prototypes.

While the study observed increased student engagement and collaborative behaviors during these tasks, these were not formally measured as "creativity" or "communication" constructs. Instead, they are interpreted as "observed indicators" of the problem-solving process within the specific context of the "Innovative Learning Media" course. The authenticity of the project tasks, designing real-world pedagogical tools, likely served as a catalyst for deeper cognitive engagement compared to the abstract assignments typical of conventional lectures.

Despite the significant findings, several alternative explanations must be considered. First, a "novelty effect" may have influenced the experimental group's performance, as the FC-PBL model was a departure from their usual academic routine. Second, although the same instructor taught both groups, the increased interaction time in the PBL format might have inadvertently introduced a "facilitator effect" that was absent in the control group. Third, the "time-on-task" imbalance, where experimental students potentially spent more time engaging with materials pre-class, could account for some of the performance gains. Methodological limitations include the non-random assignment of participants (quasi-experimental), the single-institution context, and the relatively short duration (16 weeks) of the intervention. Furthermore, the reliance on self-report questionnaires for self-efficacy and independence introduces potential social desirability bias. The missing data in the experimental group (n=4), although confirmed as random, also represents a minor threat to the study's internal validity.

Future research should employ a Randomized Controlled Trial (RCT) design across multiple institutions to enhance generalizability. Longitudinal studies are needed to determine if these gains in self-efficacy and independence persist beyond a single semester. Additionally, mediation analysis (e.g., testing whether academic self-efficacy mediates the relationship between FC-PBL and problem-solving success) would provide deeper insights into the underlying psychological pathways of this pedagogical model.

3.3.2 The Influence of the Integrated Flipped Classroom Learning Model of Problem-Based Learning on Student Learning Independence

The findings indicate a statistically significant divergence in self-directed learning behaviors between the cohort exposed to the integrated FC-PBL approach (M = 32.74) and the group receiving conventional instruction (M = 26.08) ($t(64) = -5.991$, $p < .001$, $d = 1.48$). This substantial effect size ($d = 1.48$) underscores the effectiveness of the FC-PBL framework in fostering an autonomous learning attitude, characterized by proactive initiative, disciplined time management, and accountability in task completion.

The observed enhancement in autonomous learning within the intervention group is inherently tied to the operational mechanics of the Flipped Classroom framework. This pedagogical design necessitates that learners independently engage with preparatory materials, such as instructional videos and digital modules, prior to in-class sessions (Chikeme et.al 2024). Unlike traditional models where the instructor dictates the pace, the flipped format empowers students to direct their own educational progress, select appropriate strategies for content mastery, and regulate the tempo of their engagement based on individual competency (Suharianto et.al 2022).

This process aligns precisely with Zimmerman's self-regulated learning theory, which conceptualizes independence through a three-phase cyclical process: forethought, performance, and self-reflection (3). The FC-PBL model facilitates all three phases:

1 Forethought: During the pre-class phase, students must set comprehension goals and plan their study schedule to meet the deadline of the pre-class readiness quiz.
2 Performance: Students independently access and internalize the material, exercising self-control and self-observation as they navigate digital content without direct instructor supervision.
3 Self-Reflection: In-class PBL activities provide an immediate feedback loop. As students apply their pre-class knowledge to solve authentic problems, they are forced to evaluate the adequacy of their preparation, leading to a critical self-assessment of their learning strategies (Alkandri & Alabdulhadi, 2023).

Furthermore, the integration of Problem-Based Learning (PBL) strengthens this autonomy by transitioning students from individual self-regulation to "socially shared regulation." In the PBL phase, students are not only responsible for their own learning but also for their contributions to the team's problem-solving efforts. This dual accountability, individual in the FC phase and collective in the PBL phase, creates a more robust form of learning independence than either model could achieve in isolation (Panadero, 2017).

These findings are consistent with recent scholarship. Kim (2022) observed that PBL enhances self-directed learning through inquiry activities that require independent information seeking, while Strelan et al. (2020) confirmed that the flipped format increases student responsibility for pre-class preparation. However, the current study provides a unique contribution by demonstrating that the synergy of FC and PBL produces a significantly stronger effect on self-regulation skills than conventional methods. While the wider variance in the experimental group (SD = 5.21) indicates that some students found the sudden shift to high-autonomy learning challenging, the overall results substantiate that FC-PBL is a powerful mechanism for transforming passive students into resilient, self-directed learners.

3.3.3 The Effect of the Integrated Flipped Classroom Learning Model of Problem-Based Learning on Students' Problem-Solving Abilities

This investigation reveals a statistically significant disparity in problem-resolution competency between the cohort experiencing the FC-PBL instructional treatment and the group adhering to conventional pedagogy. Participants in the intervention condition consistently achieved superior mean scores on the final assessment relative to the control group, indicating the enhanced efficacy of the integrated approach in fostering advanced cognitive skills. This observed elevation transcends mere academic performance metrics; it signifies a demonstrable improvement in learners' analytical reasoning, capacity to formulate viable solutions, and critical evaluation of implemented strategies. These findings strengthen the argument that FC-PBL integration can accommodate students' needs to develop problem-solving skills more deeply than traditional learning patterns, which tend to be oriented toward delivering material and regular exercises.

One of the key mechanisms that explains the advantages of experimental classrooms is the Flipped Classroom structure, which designs pre-class learning through videos, modules, or reading materials, so that face-to-face time in the Classroom can be devoted to interactive activities and problem-solving (Suhartini & Marianti, 2023). In the control class, most class time is spent on the teacher delivering material, so the space for students to practice critical, analytical, and creative thinking is limited. On the other hand, students in the experimental class arrive with a preliminary understanding, so that face-to-face activities can focus on case analysis, group discussions, and solution exploration. This pedagogical approach resonates with the constructivist principle of active learning, which posits that knowledge is constructed by learners through direct engagement and experience, rather than being passively transmitted by an instructor (Rai, 2025). Thus, the Flipped Classroom serves as a foundation that enables students to use classroom time to internalize, test, and apply concepts in real-world contexts (Goodarzi, 2021).

The integration of Problem-Based Learning enhances the effectiveness of such mechanisms, as PBL encourages students to engage in complex, context-specific problem-solving (Wafiroh & Arianto, 2025). Through PBL, students are challenged to define problems, identify relevant information, formulate alternative solutions, and conduct critical reflection on their choices. This process directly stimulates high-level thinking skills as categorized in the revised Bloom taxonomy at the C4 (analyzing), C5 (evaluating), and C6 (creating) levels. In the analysis stage, students learn to break down the problem into its key components; at the evaluation stage, they weigh the advantages and disadvantages of the existing solution; while at the creation stage, they design original, innovative solutions. Thus, the contribution of PBL in FC-PBL is not only in providing problems as a stimulus but also in encouraging students to move beyond basic memorization or understanding towards complex cognitive skills indispensable to 21st-century problem-solving (Ramadhani et al., 2019).

The connection between these findings and constructivist theory is evident in the constructive learning interactions that are developed. The theory of constructivism holds that knowledge is constructed from experience, with the teacher acting as a facilitator. The FC-PBL framework establishes a constructivist learning environment by creating opportunities for autonomous learner engagement with content prior to scheduled instructional sessions, then construct a deeper understanding through the exploration of authentic problems in the Classroom (Mariani et al., 2025). Thus, learning is no longer a passive process, but a dialogical and reflective activity that encourages students to become the main actors in finding solutions. The Impact of a Synthesized FC-PBL Approach on Learner Self-Efficacy, Autonomy, and Problem-Resolution Competency.

The findings demonstrated that the integrated FC-PBL pedagogical framework exerted a statistically significant and positive effect on enhancing learners' self-assurance, learning independence, and problem-solving ability compared to conventional learning. Quantitative data showed that the experimental class consistently obtained higher posttest post-testcross all three variables than the control class, while qualitative analysis of observations and field records revealed increased active participation, greater courage to express opinions, and improved skills in cooperation and problem-solving. These results indicate that FC-PBL not only contributes to the cognitive domain but also has a wide impact on students' affective and metacognitive aspects, enabling more holistic learning.

The relationship between variables in this study showed that increased confidence was closely associated with greater learning independence and problem-solving ability (Hendriana et al., 2018). Higher self-confidence makes students more willing to take the initiative to study the material before class and to be active in group discussions, ultimately strengthening their learning independence. On the other hand, learning independence through the habit of strategizing, time management, and the use of learning resources fosters confidence, as students feel better prepared for academic tasks. These two variables support each other in forming a strong foundation for the development of problem-solving skills. When students are confident and independent, they are better able to deal with complex problems, analyze critically, and design creative solutions. Thus, FC-PBL integration can be understood as an approach that systematically builds a chain of psychological and cognitive reinforcement that culminates in improved problem-solving skills.

In conclusion, the FC-PBL model functions as a systemic intervention that not only improves cognitive outcomes but also reconstructs the learning environment into a dialogical and reflective space. This transformation is essential for producing graduates who are not only knowledgeable but also capable of applying that knowledge to resolve the multifaceted challenges of the modern era.

4. CONCLUSION

This study demonstrates that the integration of Flipped Classroom and Problem-Based Learning (FC-PBL) significantly enhances students' academic self-efficacy, self-directed learning, and problem-solving proficiency compared to conventional instruction. Statistical evidence confirms large effect sizes for self-directed learning ($d = 1.48$) and self-efficacy ($d = 0.86$), alongside a significant multivariate impact (partial $\eta^2 = 0.455$). These findings suggest that a pedagogical design combining pre-class preparation with authentic, in-class collaborative inquiry creates a robust learning ecosystem that may support the development of resilient and analytical learners. Theoretically, this research contributes to the constructivist paradigm by demonstrating how FC-PBL functions as a systemic mechanism connecting affective, metacognitive, and cognitive domains. Practically, it is recommended that higher education institutions implement FC-PBL by incorporating pre-class readiness checks, structured PBL worksheets, and specialized facilitation training for instructors to manage the transition from teacher-centered to student-centered learning.

A limitation of this investigation is its quasi-experimental design and single-institution focus, which restricts the generalizability of the findings. Future research should employ longitudinal designs and multi-site replications to test the consistency of these outcomes across diverse disciplines and explore the role of self-efficacy as a potential mediator for problem-solving success. Ultimately, this study contributes critical evidence from the Indonesian higher education context that the FC-PBL model is a viable strategy for improving both affective and cognitive outcomes in 21st-century education.

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