

The Effect of Flipped Classroom and Project-Based Learning on Engagement and Learning Outcome in Higher Education

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Abstract

This study aims to determine the impact of the integration of the flipped classroom learning model and project-based learning on student involvement and learning outcomes in multimedia learning. This research is important to fill the gap in empirical data regarding the effectiveness of these learning strategies. The method used is a quasi-experiment design, comparing the experimental group that applies the flipped classroom model and project-based learning with the control group that uses conventional methods and project-based learning. Data collection was carried out through pretest and posttest, as well as student engagement surveys, with one-way ANOVA analysis. The results showed that the experimental class had an average student involvement score of 85.36, an efficacy score of 83.70, and a self-regulated learning score of 79.90. Meanwhile, the control class had an average student engagement of 80.42, an efficacy score of 82.71, and a self-regulated learning score of 77.24. The posttest t-test showed a significance value of 0.035, which was smaller than 0.05 (sig. 0.035 < 0.05), so the null hypothesis (H0) was rejected and the alternative hypothesis (H1) was accepted. This means that there is a significant difference in multimedia learning outcomes between students who use the flipped classroom approach and project-based learning compared to those who follow the conventional model. These results prove that the flipped classroom and project-based learning methods are more effective in improving learning outcomes and student involvement in multimedia learning. These findings provide valuable insights for future learning development.

Keywords: *Flipped Classroom, Multimedia Education, Learning Outcomes, Student Engagement, Project-Based Learning.*

INTRODUCTION

The current educational paradigm specifically emphasizes the importance of developing 21st-century skills, which include creativity, critical thinking, collaboration, and communication [1][2]. These abilities are deemed crucial in equipping pupils to confront challenges and opportunities in an increasingly connected and competitive world. Through the use of the Flipped Classroom method, student involvement in the learning process can be optimized by learning the material at home and utilizing class time for in-depth and interactive activities by students [3][4]. This approach not only improves creativity, critical thinking, collaboration, and communication skills but also actively engages students in their knowledge construction [5]. A focus on creativity encourages students to think innovatively and develop unique solutions to a problem. Critical thinking allows them to analyze information effectively and make informed decisions. Collaboration emphasizes the importance of working together in a team, leveraging each member's strengths and expertise to achieve a common goal. Meanwhile, good communication skills ensure that ideas and information can be conveyed clearly and effectively, which is especially important in professional and personal environments. Through this 21st-century skills-oriented education, the modern educational paradigm aims to equip students with the necessary tools to succeed in their future careers and everyday life, with a special emphasis on student's active involvement in learning [6][7].

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In the context of the Industrial Revolution 4.0, education 4.0 has emerged as a key element in development. This technology-based education is transformational, significantly affecting the dynamics of learning and teaching. The use of technology in education not only changes the way lecturers and students interact but also increases the value of the education system as a whole [8][9]. This technology improves the efficiency and effectiveness of the teaching and learning process while providing important new skills for lecturers and students. The integration of technology such as a Learning Management System (LMS) in the learning process also enriches the learning experience, allowing for more personalized and adaptive learning according to individual needs[10]. Thus, education 4.0 plays a vital role in preparing future generations to face challenges and opportunities in the digital era.

The Flipped Classroom and Project-Based Learning (PjBL) models have revolutionized teaching in higher education by combining innovative traditional teaching and the use of modern technology. Through Flipped Classroom, direct instruction is moved outside the classroom and replaced with homework that is converted into a classroom activity, allowing students to learn theoretical material at home and apply it in in-depth discussions and collaborative projects in the classroom [11][12]. It enhances student-lecturer interaction and facilitates adaptive learning, supporting the development of students' critical and creative skills. On the other hand, PjBL engages students in completing complex projects that are often interdisciplinary, encouraging the practical application of knowledge, collaboration, and innovative thinking [13][14]. The integration of Trello, a project management platform, improves organization and collaboration in both models, allowing for efficient task management and tracking of task and project progress. This combination of methods not only enriches the interaction between students and learning materials but also hones important skills such as problem-solving, time management, and communication, which are crucial for future professional success.

Gaps in education are evident in the development of critical skills such as critical thinking, problem-solving, creativity, and effective collaboration. Many students still struggle to apply theoretical knowledge in real-world situations, which indicates an urgent need for a more meaningful and competency-oriented learning model. This gap is mainly due to the lack of effective integration between technology and learning activities. Although technology has been introduced in many aspects of education, its use is still not optimal for improving effective learning outcomes and creating immersive learning experiences for students[15][16]. The traditional emphasis on passive learning inhibits students' ability to actively engage and think independently[17][18]. There is an urgent need for an educational approach that not only imparts knowledge but also enhances students' ability to use it creatively and collaboratively. This approach will allow students to be better prepared for real-world challenges with relevant and competent skills.

Filling this gap requires the adoption of learning models that are integrated with technology, such as project-based learning with a flipped classroom approach (flipped-project-based learning). This model creates an environment where students can be more actively engaged through online discussions and exploration of material before and after class sessions [19][20]. PjBL encourages students to tackle complex problems by thinking critically and working collaboratively, preparing them for real-life challenges [13][14]. Similarly, the Flipped Classroom model optimizes class time for more in-depth discussions and practical application, making learning more dynamic and student-centered[11]. Implementing these models not only aligns educational practices with the demands of the 21st century, but also significantly improves student engagement and learning outcomes. This approach enriches students' learning experience and strengthens their ability to think critically and creatively, work together in teams, and apply knowledge in a variety of contexts, which is vital in today's and tomorrow's workforce.

Research Question

What is the difference in student involvement in multimedia learning between students taught using the Flipped Classroom model and project-based learning, and those taught using conventional and project-based learning methods?

How do students who receive instruction using the Flipped Classroom model and project-based learning compare to those who receive instruction using conventional and project-based learning methods in terms of multimedia learning outcomes?

MATERIALS AND METHODS

Research Design

In this study, the quasi-experimental methodology is used to compare the effectiveness of conventional learning models and project-based learning with the Flipped Classroom approach, which also integrates project-based learning. This research involves the use of two different classes, where one is used as an experimental class and the other is used as a control class. The design is a non-equivalent control group design. In practice, the experimental class applies a combination of Flipped Classroom and project-based learning, while the control class adopts conventional methods along with project-based learning in multimedia learning. This conventional approach is specifically applied to the control class to compare the two methods. The effectiveness of the two learning models was evaluated through a pre-test conducted at the beginning of multimedia learning and a post-test held after the 15th learning session, which is a standard practice in educational research, as explained by Francesc Garcia I Grau et al. [21]. Figure 1 further explains the research process.

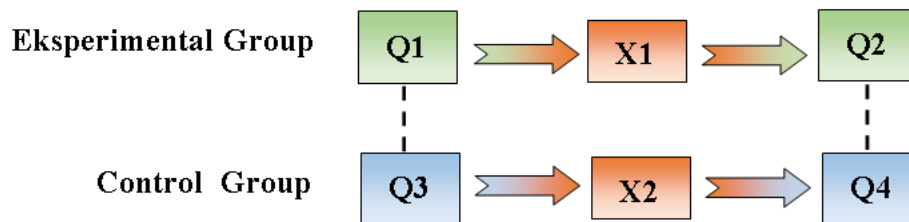


Fig. 1 Quasi-Experimental Research Design using "Non-equivalent Control Group Design"[22], [23]

In this design, Q1 is a pretest experimental group, which consists of a test or questionnaire that must be answered by participants before the treatment is carried out. The teaching of the Flipped Classroom model, which is integrated with project-based learning, is carried out in as many as twelve learning meetings and is marked X1. For the experimental group, Q2 is a posttest. For the control group, Q3 is a pretest, Q4 is a posttest, and X2 is a conventional model of teaching that is also integrated with project-based learning. Trello's LMS platform is used to complement teaching by providing online access to lecture materials and assignments, as well as allowing students to download and review materials outside of class hours. Furthermore, LMS can help students interact and work together even though learning is done using conventional models.

The link between the flipped classroom the project-based learning approach, and taxonomy blooms in Figure 2 below:

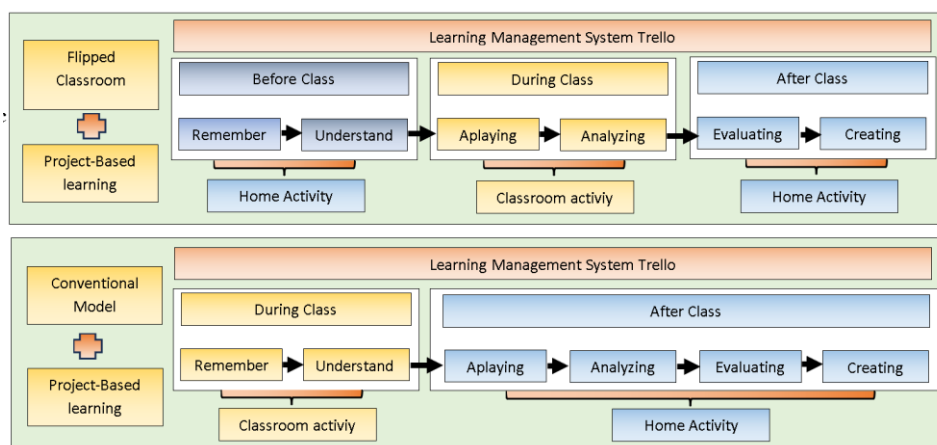


Fig.2 The integrated Flipped Classroom and project-based learning on taxonomy bloom [24]

In the "Flipped Classroom" method and project-based learning, the lecturer's "before class" phase ensures that all teaching materials are available and accessible to students through Trello's LMS. At this stage, the lecturer also provides detailed directions regarding the tasks that students must do before class, aiming to improve their understanding of the material, thus facilitating the achievement of a level of recall and comprehension in Bloom's taxonomy. During the "during class" phase, lecturers support interaction between students through constructive talks and discussions to ensure understanding of the material and provide evaluation tasks from the practicum to measure their understanding and analytical skills. This learning activity uses a synchronous and asynchronous approach with the Zoom application, allowing the achievement of the Apply and Analyze stages. This phase also includes team organization and project planning, which are crucial in project-based multimedia learning, thus encouraging collaboration and developing cooperation and problem-solving skills. The "after-class" phase requires students to continue and complete the project that has started, with the support of lecturers as supervisors and facilitators. The stages of evaluation and creation in Bloom's taxonomy are achieved in this phase. Students are also required to compile a report on the solution they find and present it. In the evaluation phase, an authentic assessment approach is applied to assess their skills and performance holistically, including the process they go through, which contributes to the achievement of maximum learning outcomes.

Participants

This research was conducted in the fourth semester of the 2022–2023 academic year, involving as many as 32 students from the informatics study program at the Payakumbuh College of Technology. The students are enrolled in multimedia learning, which specifically explores the concepts of graphic design and 3D animation. We formed two groups in the framework of this study to compare different learning methodologies. The experimental class, consisting of 16 students, uses the Flipped Classroom method and project-based learning. Learning in this class is carried out asynchronously using Zoom and Trello platforms and synchronously held in the multimedia laboratory. On the other hand, the control class, which also consists of 16 students, follows the learning process with conventional and project-based learning methods and is also supported by Trello LMS. These two classes are analyzed to evaluate the effectiveness of using flipped and project-based teaching with conventional and project-based teaching that focuses on graphic design and 3D animation materials, then compare the learning outcomes and student involvement in learning between the two methods.

Data Collection

In measuring learning outcomes, this study applies a data collection method that involves evaluation through pretest and posttest scores in both classes, namely the experimental class and the control class. This evaluation relies on a test consisting of 38 multiple-choice questions, all of which are closely related to the material presented in multimedia learning. Furthermore, to measure the level of student involvement in multimedia learning, a student involvement questionnaire was used.

The student engagement questionnaire selected for this study is a modified version of the student engagement questionnaire developed by Rizkia Amalia Rahmawati [25]. This questionnaire focuses on student engagement in learning, reviewing self-efficacy, self-regulated learning, and student engagement.

The self-efficacy scale consisted of 24 statements with five answer choices. The self-regulated learning scale consisted of 22 statements with five answer choices. Meanwhile, the scale of student involvement in learning consists of 24 statements with five answer choices. This analysis aims to understand how various aspects of student involvement are affected by the use of innovative learning methods in multimedia learning.

Data Analysis

In evaluating the data obtained from this study, we utilize statistical techniques in the form of descriptive tests and one-way ANOVA tests. The purpose of this test is to examine the impact of the use of the Flipped Classroom learning model and project-based learning on the effectiveness of learning outcomes and the level of student involvement in Multimedia learning, which includes experimental and control classes. To analyze the results of the study, we used SPSS version 22 software, with a significance value of 0.05 for all tests. To determine the distribution of data normality, we applied the Kolmogorov-Smirnov test. Furthermore, the data

homogeneity test was carried out using Levene's Test, and the comparison of learning outcomes between the experimental class and the control class was carried out through the t-test.

RESULT AND DISCUSSION

The Flipped Classroom and Project-Based Learning Model

This research has successfully implemented the flipped classroom and project-based learning models in multimedia courses by applying the existing steps in project-based learning at each stage of the flipped classroom model. For more clarity, you can see in Figure 3.

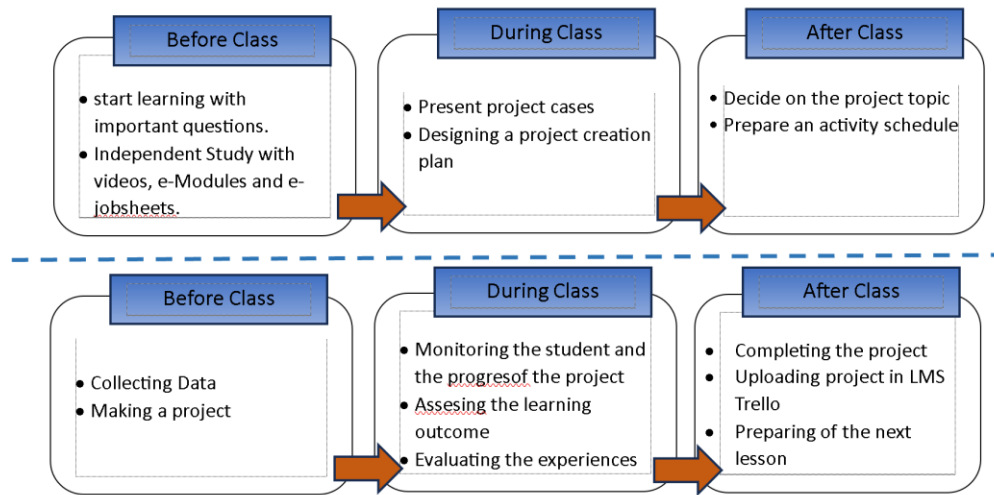


Fig.3 The Flipped Classroom and Project-Based Learning Model

The flipped classroom and project-based learning (PBL) learning models are applied to enrich the learning process by integrating activities before, during, and after class. In this model, a flipped classroom prepares students before class by providing learning materials such as videos, e-modules, and e-job sheets, as well as assignments through the Trello LMS platform. This allows students to access and understand the basic material at the time and place of their choice so that they come to class more prepared.

Project-based learning, on the other hand, engages students in a more in-depth learning process during class. Students engage in discussion, planning, problem-solving, and decision-making, which makes learning not only engaging but also meaningful. According to Mioduser and Anazifa [26] [27], This model increases student engagement and 21st-century students' knowledge and skills, such as their critical thinking skills, creativity, collaboration, and communication.

The combination of these two models not only makes students better prepared to face learning challenges but also allows lecturers to apply more effective strategies for achieving higher levels in Bloom's taxonomy. Andriani et al [24] It also supports the idea that the integration of a flipped classroom can increase student engagement in learning, knowledge, and the effectiveness of the learning process. In case of difficulties, students can easily communicate with lecturers through Trello's LMS and ensure that help is available as students need it. Table 1 illustrates the integration of the flipped classroom and project-based learning.

Table 1. Combination of the Flipped Classroom Model and Project-Based Learning

Cycle	The Syntax of Flipped Classroom	The Syntax of PjBL
1 Cycle	Before Class	<ul style="list-style-type: none"> start learning with important questions. Lecturers stimulate students to learn independently through Trello LMS Independent Study with videos, e-Modules, and e-job sheets. Students learn independently through videos, e-modules, and e-job sheets provided on Trello LMS and do their assignments

	During Class	<ul style="list-style-type: none"> Present project cases The lecturer gives cases to groups of students to be discussed as a project that has been solved Designing a project creation plan Then, each group designs their project plan. They will make a 3D animated film
	After Class	<ul style="list-style-type: none"> Students decide on a project topic and create a schedule for 4 weeks. During the project spelling process, every progress that has been achieved, students report through the Trello LMS.
4 Cycle	Before Class	Students create projects and collect data for their experiments such as preparing an animated movie storyboard, selecting characters along with scene environments and dialogues, conducting experiments, and analyzing the results.
	During Class	Lecturers control students and their progress and assess their learning outcomes. Students report on the progress of their animated film project. In the last stage, lecturers evaluate and provide suggestions on student projects and presentations.
	After Class	After completing the project, Students upload the project to Trello's LMS and then students prepare for the next lesson.

The Effect of Flipped Classroom and Project-Based Learning Model on Learning Outcome

The pre-test and post-test results of the experimental and control classes show how well students can utilize multimedia learning when working on their projects. Both methods flipped classroom and project-based learning, have been tested to see their impact on student learning outcomes in the context of multimedia learning. The purpose of this analysis is to assess how effective both methods are in improving students' understanding. We compare the test results of the two classes to find out their effectiveness. The provided test comprised 38 multiple-choice questions about multimedia learning materials. Table 2 shows the results of both classes.

Table 2. Pre-test and post-test results in experimental and control classes based on processed SPSS 22 data

Test	N	Min	Max	Mean	Std. Deviation
Pre-Test Eks	16	23,68	52,53	40,41	8,80
Post-Test Eks	16	71,05	94,74	82,33	8,47
Pre-Test Kontrol	16	28,95	52,63	40,59	9,42
Post-Test Kontrol	16	73,68	81,58	76,54	3,06

The pre-test results from Table 2 show that the experimental class got an average score of 40.41, slightly lower than the control class, which had an average score of 40.59. However, after implementing the learning method, the average score of the experimental class in the post-test increased significantly to 82.33, while the control class reached an average score of 76.54 in the post-test. Figure 4 shows a comparison between the lowest and highest scores achieved by each group, providing a visual representation of how much improvement occurred in both groups.

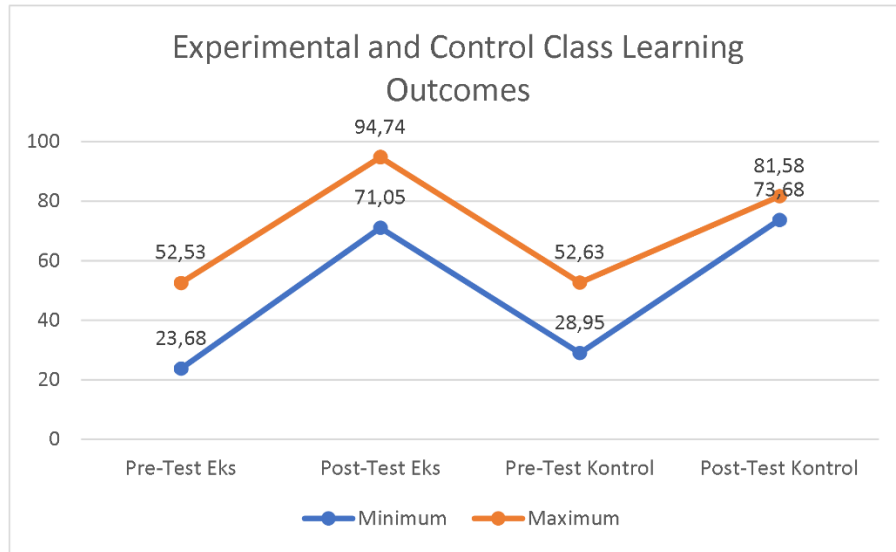


Fig. 4 Experimental and control class Learning Outcomes

Based on the pre-test data shown in Figure 4, the control class had the lowest score of 28.95 and the highest score of 52.63. Meanwhile, the experimental class scored the lowest at 23.68 and the highest at 52.53. In the post-test, the lowest score of the experimental class was 71.05, and the highest score reached 94.74. For the control class, the post-test score was in the range of 73.68 as the lowest and 81.58 as the highest.

The Effect of Flipped Learning Models and Project-Based Learning on Student Engagement

In the learning process carried out, both the experimental class and the control class systematically measured student involvement in learning, reviewing efficacy, self-regulated learning, and student involvement. The questionnaire was designed with several important indicators that aim to assess various aspects of student involvement in learning. This aspect includes the engagement aspect, consisting of cognitive engagement, emotional engagement, and behavior engagement; the self-regulated learning aspect, consisting of cognitive, motivational, and behavioral aspects; and the self-efficacy aspect, consisting of aspects of cognitive level, stress, and generality. The effectiveness of students in meeting these indicators was then processed, and the results are shown in detail in Table 3. This analysis can help understand how effective the learning methods applied are in increasing student learning engagement.

Table 3. Student Learning Involvement Assessment Result

Class	N	Min	Max	Average
Experiment Class for Engagement	16	74,17	94,17	85,36
Experiment Class for efficacy	16	75	93,33	83,70
Experiment Class for Self-Regulated Learning	16	71,67	85,83	79,90
Control Class for Engagement	16	73,33	90,83	80,42
Control Class for efficacy	16	71,67	91,67	82,71
Control Class for Self-Regulated Learning	16	69,17	87,50	77,24

From the data listed in Table 3, which focuses on assessing student engagement related to multimedia learning, we can observe significant differences between the experimental class and the control class. In the experimental class, it was recorded that 16 students had an average score of 85.36 for student involvement in

learning.

The efficacy value was 83.70, and the self-regulated learning value was 79.90. In the control class, 16 students had an average score of 80.42 for student involvement in learning, 82.71 for efficacy, and 77.24 for self-regulated learning. Figure 5 provides a clear illustration of how the value of student engagement in learning from each of these groups compares to each other and is a detailed picture of the distribution of student engagement in learning in the two learning environments.

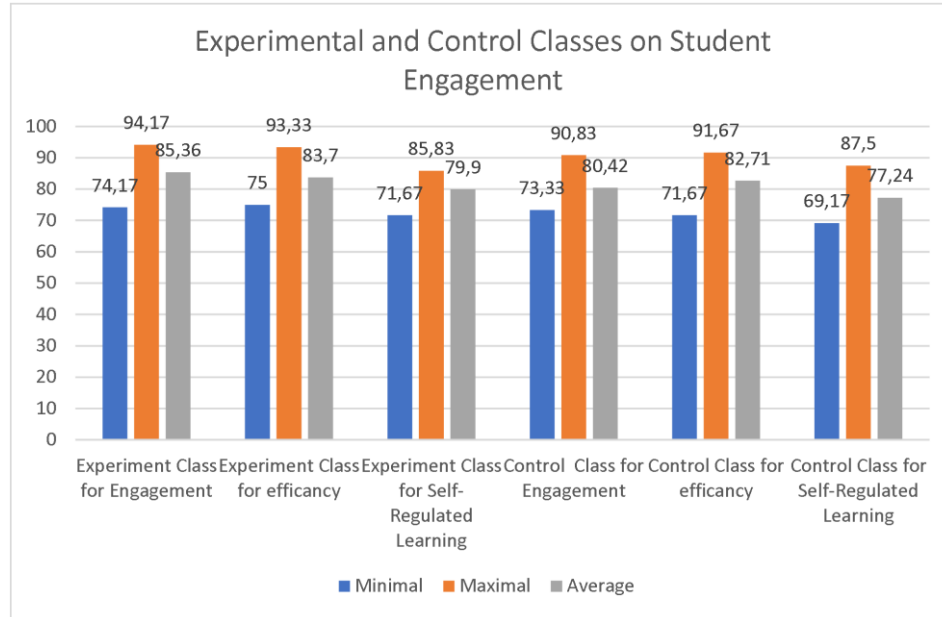


Fig. 5 Results of student Involvement in experimental and control classes

Figure 5 presents data that compares multimedia learning outcomes based on student engagement levels in two different groups. In the experimental class, student involvement in learning reached a minimum score of 74.17, a maximum of 94.17, and an average score of 85.36. The efficacy value was 75 at the minimum, 93.33 at the maximum, and 83.70 at the average. The value of self-regulated learning reached a minimum score of 71.67, a maximum of 85.83, and an average score of 79.90. In the control class, student involvement in learning reached a minimum score of 73.33, a maximum of 90.83, and an average score of 80.42. The minimum efficacy value was 71, the maximum was 90.83, and the average value was 82.71. The value of self-regulated learning reached a minimum score of 69.17, a maximum of 87.50, and an average score of 77.24. This data demonstrates student engagement in the context of multimedia learning, with clear variability between different groups.

Normality Test Result

This study conducted a normality test to confirm the distribution of the obtained data. The method used is the Kolmogorov-Smirnov test, which assesses whether the data is normally distributed or not. Following the test criteria, the data were considered to have a normal distribution if the significance level (p-value) was more than 0.05 ($p > 0.05$) and was considered abnormal if it was less than 0.05 ($p < 0.05$). The Kolmogorov-Smirnov test results reveal a significance value of 0.124 for the experimental class and 0.53 for the control class, indicating a normal distribution of the data in both classes. Table 4 presents details regarding these results, offering a more detailed overview of the data distribution in both classes.

Table 4. Normality test results in experimental and control classes

Group	Null hypothesis	Test	Significance	Decision
Group Model Flipped and Project-based (Experimental)	The distribution of the score experimental is normal with a mean of 82,33 and standard deviation of 8,48	One sample Kolmogorov-Smirnov test	0,124	Retain the null hypothesis
Group conventional and project-based (control)	The distribution of the score experimental is normal with a mean of 76,53 and standard deviation of 3,07	One sample Kolmogorov-Smirnov test	0,53	Retain the null hypothesis

In this study, the analysis of data distribution was carried out using the Kolmogorov-Smirnov test. Based on Table 4, the data from the group that used the flipped classroom and project-based learning models showed a significance value of 0.124, which was greater than 0.05. This indicates that the distribution of data in this group is normal, meeting the statistical criteria for normality. Meanwhile, data from the group that combined conventional and project-based learning methods also showed a normal distribution with a significance value of 0.053, which was slightly above the threshold of 0.05. These two results confirm that the data from both groups is normally distributed, thus allowing further analysis that relies on the assumption of a normal distribution of data.

Homogeneity Test Result

The homogeneity test is an important part of this study, aiming to determine whether the data from the experimental and control classes have uniform or homogeneous variants. The test measures whether the two data groups are from the same population with similar variants. The criteria for determining homogeneity in this study is a significance value of more than 0.05 ($p > 0.05$). If the significance value is less than 0.05 ($p < 0.05$), then the data is considered non-homogeneous. The results of the Levene Test in this study show a significance value of 0.460, which far exceeds the threshold of 0.05 (table 5). This indicates that the data from both classes have homogeneous variations, fulfilling one of the key assumptions for the statistical analysis of these data.

Table 5. Test for Homogeneity

Levene's Test of Equality of Error Variances ^a			
Dependent Variable: Multimedia Learning Outcomes			
F	df1	df2	Sig.
.893	3	22	.460
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.			
a. Design: Intercept + A + B + A * B			

Based on the analysis shown in Table 5, the data is classified as homogeneous, as evidenced by a significant value of 0.460 greater than the threshold of 0.05. This significant value indicates that the variance across the dataset is consistent, which confirms that the data meet the homogeneity criteria required for further statistical evaluation.

Hypothesis Testing Research

The hypothesis of this test is:

H0: There was no significant difference in multimedia learning outcomes between students who used the flipped classroom and project-based learning models and students who used conventional and project-based learning models.

H1: There was a significant difference in multimedia learning outcomes between students who used the flipped classroom and project-based learning models and students who used conventional and project-based learning models.

So that:

$$H_0 : \mu_1 = \mu_2$$

$$H_1 : \mu_1 \neq \mu_2$$

The analysis using independent T-test samples was carried out through the SPSS version 22 program, which aimed to compare changes in the state of the research subjects before and after the application of the Flipped Classroom and project-based methods, as well as conventional and project-based models. The criteria for making decisions in this analysis are set as follows: If the P-value is ≤ 0.05 , then there is a significant difference between the learning outcomes of students in the experimental class and the control class, which means that the flipped classroom and project-based learning models are effective. On the other hand, if the P-value is ≥ 0.05 , the difference is not significant, which means that the flipped classroom and project-based learning models are considered ineffective. Table 6 presents the results of this t-test.

Table 6. T-Test Results for Independent Sample

Independent Samples Test		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		F	Sig.	t	df	Sig. (2-tailed)
				Lower	Upper					
Student Learning Outcomes	Equal variances assumed	5.79571	2.58679	.45685	11.13458	22.844	.000	2.241	24	.035

Based on the data listed in Table 6, the results of the t-posttest applied to the experimental class and the control class showed a significance value of 0.035, which was smaller than 0.05 (sig. $0.035 < 0.05$). From these results, it can be concluded that the null hypothesis (H0) was rejected and the alternative hypothesis (H1) was accepted, which means that there was a significant difference in multimedia learning outcomes between students who used the Flipped Classroom approach and project-based learning compared to students who followed the conventional learning model and project-based learning. These results prove that the Flipped Classroom method and project-based learning are more effective in improving learning outcomes and student engagement in multimedia learning.

The flipped classroom and project-based learning models have been able to increase student participation and understanding of the material by providing online learning materials and videos. This approach increases efficiency in the use of time and preparation. Interaction between lecturers and students, especially in group projects, is essential for responsive and dynamic teaching. This method has succeeded in deepening students' understanding and cooperation, resulting in a more productive group learning experience. The application of the flipped classroom model and project-based learning has succeeded in significantly increasing student engagement and learning outcomes. The average score of student involvement in the experimental class was 85.36, while the average score of student involvement in the control class was 80.42. Based on this description, the use of flipped classroom and project-based learning models has shown its effectiveness in improving learning outcomes and student involvement in multimedia learning. Although some research suggests that the concept of flipped classes may not have a significant impact on academic achievement [28][29], For example, research conducted by Taspolat et al. (2021) argues that the impact of the flipped class model on student learning is greater, related to engagement with peers and lecturers than measurable academic gains [28][29]. This shows that the flipped classroom model does not have a positive impact on academic achievement.

However, this is proof that the flipped class and project-based learning approaches are student-centered learning approaches that can increase student engagement and student academic achievement by encouraging

students to become active learners and prioritizing independent learning through optimizing lecture time outside the classroom and active and collaborative learning activities in the classroom and outside the classroom [30] [31].

CONCLUSION

This study succeeded in revealing the effectiveness of the implementation of the flipped classroom and project-based learning approach, which is proven to be more effective in its implementation than conventional and project-based learning models so that student learning outcomes increase and student involvement increases in multimedia learning. The average value of student learning outcomes in classes that apply the flipped classroom and project-based learning models is 82.33, and the average value of involvement of students in multimedia learning is 85.36, while the learning outcomes of students taught with conventional models and project-based learning were 76.54. In addition, the average value of student involvement in multimedia learning in conventional model classes was 80.42. The flipped class and project-based learning approach is a student-centered learning approach that can increase student involvement in learning and student academic achievement by encouraging active learning and prioritizing independent learning through optimizing lecture time outside the classroom and conducting collaborative learning activities both inside and outside the classroom.

Conflicts of Interest: The authors declare no conflicts of interest.

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