

Enhancing Motivation and Learning Outcomes in Multimedia Education: Integrating the Flipped Classroom Model with Trello's Learning Management System

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Manuscript received May 12, 2024; revised June 19, 2024; accepted August 5, 2024; published November 15, 2024

Abstract—This study explores the impact of integrating the flipped classroom learning model with Trello's Learning Management System (LMS) on student learning outcomes and motivation in multimedia learning. This research is important because it fills empirical data gaps regarding the effectiveness of learning strategies using the flipped classroom model integrated into the Trello LMS. This study used a quasi-experimental design method. It compared one experimental group that applied the flipped classroom model integrated into the Trello LMS with a control group using conventional techniques through pretest and posttest with one-way Analysis of Variance (ANOVA) and motivation surveys. In Trello LMS experimental classes, lecturers provide materials before class, students can use class time for in-depth discussions and collaborative activities, and lecturers guide and monitor student project work after class sessions. The results showed that classes using the flipped classroom model integrated with Trello LMS produced an average learning outcome score of 82.33 and a high learning motivation score of 88.13. In contrast, conventional classes had an average learning outcome score of 76.54 and a high learning motivation score of 86. Statistical analysis revealed that the flipped classroom model integrated with the Trello LMS significantly improved student learning outcomes and motivation, with a significance value of 0.035. Integrating the flipped classroom approach with the Trello LMS significantly enhances project- and case-based multimedia learning outcomes and student motivation, offering valuable insights for future learning development.

Keywords—flipped classroom, Learning Management System (LMS) trello, multimedia education, learning outcomes, student motivation

I. INTRODUCTION

The implementation of the approach of flipped classrooms in the context of multimedia learning has been proven to effectively increase student participation by shifting the theoretical learning process to independent activities outside the classroom [1–3]. This allows the allocation of time in class to be optimally used in more in-depth multimedia practice, where students can apply and experiment with concepts learned with direct guidance from lecturers. Furthermore, using Trello's Learning Management System (LMS) as a project management tool supports collaborative interaction between students and tracks the progress of multimedia projects in a more structured and efficient manner, resulting in a significant increase in productivity and the quality of student learning outcomes. The integration of these two strategies, flipped classroom and Trello, in multimedia

learning creates a student-centered learning environment, encouraging their success in mastering the material [4, 5]. This comprehensive approach reflects a deep understanding of the need to adapt current teaching methods. This method not only maximizes the use of technology in learning but also triggers optimal learning motivation and learning outcomes for students. Through this method, students become more independent in their learning and more skilled in time management, collaboration, and communication, which are important competencies needed in the world of work in this modern age.

The flipped classroom model has been shown to have a significant positive impact on student engagement compared to conventional teaching models [6, 7]. The results of a meta-analysis involving 198 studies with 33,678 students revealed that flipped classroom had a moderately positive effect ($g = 0.50$) on student engagement. These influences vary from weak (e.g., for information technology, $g = 0.30$; $k = 14$) to strong (e.g., for the humanities, $g = 0.98$; $k = 34$) [8]. Additionally, the study shows that a flipped classroom improves overall student performance by providing opportunities for active learning and structured problem-solving, which is very different from traditional teaching approaches that tend to be more passive and didactic. This study underscores the importance of pre-class preparation, active involvement in the classroom, and small group activities as key factors in the effectiveness of the flipped classroom model. Thus, applying this model across different disciplines and levels of education can significantly improve student engagement and performance.

The effectiveness of the flipped classroom model in multimedia learning, particularly how it affects student motivation and learning outcomes, still requires a broader study. Multimedia learning, which relies heavily on creativity and innovation, presents unique challenges in implementing flipped classrooms and using project management tools such as Trello [9, 10]. We must conduct further research to investigate how the Trello LMS can enhance collaboration and project management efficiency in a flipped classroom setting. We must also pinpoint the most effective ways to incorporate both techniques into multimedia course learning, maximizing student engagement.

In addition, there is a lack of in-depth empirical data on how using the Trello LMS in conjunction with flipped classroom techniques contributes to improved student

learning outcomes and motivation. This gap highlights the importance of more in-depth research to optimize multimedia learning and ensure students are not only engaged but also experience significant improvements in skills relevant to the modern world of work [11, 12].

Improving the quality of education requires addressing gaps in understanding how to apply the flipped classroom model and Trello in multimedia learning. This involves utilizing interactive technology and teaching strategies that support cooperation, creating opportunities for students to engage more in their learning process. To achieve this, we need a learning theory that supports the flipped classroom model, specifically:

1) Constructivism theory

According to Piaget [13], constructivism is centered on the idea that learners are active in building their knowledge rather than just passively receiving information. This means that knowledge is not only transferred from lecturers to students but also to students, who develop their understanding through interaction with their environment.

2) Social and Collaborative Learning Theory

It is an effective learning approach that integrates social and collaborative learning principles, such as case-based and project-based learning, as formulated by several educational theorists. Albert Bandura, with his theory of social learning, states that individuals learn through observation, imitation, and modeling [14].

3) Reflective practical theories

According to Schön, reflective practice involves a process in which individuals actively rethink and evaluate their experiences to gain a deeper understanding [15].

4) Theory of Learning Behavior

According to Skinner, behavior is learned through rewards and punishments, also known as reinforcements. Skinner argues that reinforcing behaviors tend to be repeated, while behaviors that are not reinforced or punished will disappear [16]. Behaviorism theory has a wide range of applications in education. It can be applied in a classroom by providing reinforcement or rewards for desired behavior and avoidance or punishment for unwanted behavior.

5) The Learning Theory of Connectivity

Connectivity also represents the challenges faced in managing activities. The necessary knowledge must be connected to the right people in the right context to be classified as learning. Social network analysis is an additional element in understanding learning models in the Kleiner digital era [17].

Evaluation of the effectiveness of these two strategies allows researchers to find best practices that deepen learning and improve student motivation and learning outcomes according to the needs of educational adaptation to the digital age. By proposing the hypothesis that the combination of the flipped classroom and Trello will enrich the learning environment to be more dynamic and flexible, it is expected that students can participate more actively and develop their multimedia skills more effectively so that there is an increase in learning outcomes and student motivation [18–20]. The main objective of this study is to reveal new insights into multimedia teaching, with the ultimate goal of improving the quality of interaction between students with students and

students with teachers, thus encouraging the production of works that are not only creative but also reflect a high level of professionalism. Research questions are as follows:

- 1) Are the multimedia skills of students using the model of learning in flipped classrooms in conjunction with Trello LMS significantly different from those of students using the conventional learning model?
- 2) How is the learning motivation of students who apply the flipped classroom learning model integrated with Trello LMS and the student learning motivation of those who use the conventional learning model?

II. LITERATURE REVIEW

In the “flipped classroom” learning model, there is an innovation in the method of teaching that changes the conventional paradigm by reversing the student learning process. In this model, student group activities, which are generally carried out in the classroom, are moved outside the classroom [5, 8]. Instead, individual assignments that used to be done at home are now part of classroom learning activities. Students are expected to prepare themselves before class by studying the material provided by the lecturer, which may be in the form of videos, e-modules, e-job sheets, or other learning materials uploaded to the Learning Management System (LMS) or other digital platforms. Furthermore, time that used to be spent listening to lectures in class is now used to carry out practical activities such as practical experiments, applying concepts learned, and problem-solving. This activity aims to increase understanding and deeper interaction between students and the material, lecturers, and classmates through discussion, analysis, and the exchange of opinions. Fig. 1 illustrates the differences between the conventional model classroom approach and the flipped classroom model class.

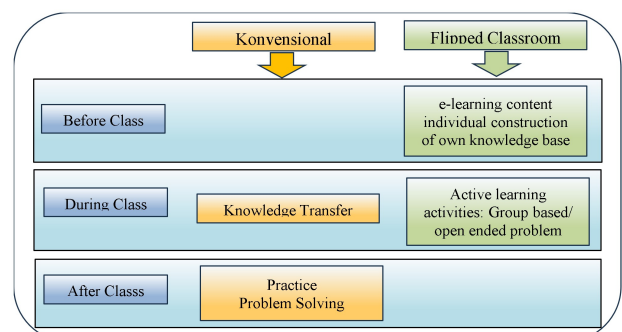


Fig. 1. Conventional classroom vs. flipped classroom [21, 22].

Fig. 1 defines “flipped classroom” as a pedagogical approach that encourages active learning and consists of two main components: (a) self-paced learning that focuses on the use of technology and is conducted outside the classroom using digital materials such as videos and e-modules; (b) collaborative work in the classroom involving challenging and interactive problem-based activities. Various literature shows that the flipped classroom method has been effectively applied in many disciplines, including engineering, information systems, and statistics, as evidenced by numerous studies [23–25]. In this research, we developed a flipped classroom model that prioritizes efficiency in achieving learning objectives and focuses on increasing student

engagement and creating positive and memorable learning experiences. This model ultimately supports the development of student competencies and students' overall analytical and critical abilities.

Learning motivation is a stimulus that influences, directs, and maintains a person's behavior during the learning process, either through internal impulses such as personal interests or due to external factors such as rewards [26, 27]. This motivation is essential for active and continuous learning.

The motivation for learning here is how Trello LMS supports the formation of student learning independence by providing access to learning materials that can be accessed and studied independently outside of class hours [28]. Trello facilitates the provision of rich and structured learning resources, allowing students to manage their own study time, repeat as much material as they need, and better prepare for collaborative and interactive learning sessions in the classroom, thereby improving their motivation and learning outcomes [29, 30].

Collaboration and effective communication in the classroom often create positive and memorable learning experiences [31]. When students actively interact, share ideas, and work together to solve problems, they deepen their understanding of the subject matter and develop social skills. This collaborative process supports a dynamic learning environment where each student feels engaged and valued, which in turn increases learning motivation and provides a more fulfilling experience academically and personally [32]. Comparison of Trello LMS with other LMS.

- 1) As an LMS, Trello offers high flexibility in project management with an easy-to-customize board view. Its advantages are its user-friendly interface and extensive integration capabilities with other tools, but it lacks education-specific features such as automated learning progress tracking [28].
- 2) Google Classroom is designed specifically for educational needs, making it easy to distribute assignments, communicate between lecturers and students, and integrate with other Google tools. The downside is the lack of flexibility in feature customization compared to platforms like Trello [33].
- 3) U-Learn is often used in academic settings for structured learning with full support for online courses, including quizzes and exams. It provides in-depth analysis tools but may feel less intuitive for users who are not familiar with more complex learning management systems [34].

Trello stands out among its competitors in project-based multimedia learning with its visual consistency and good project management capabilities, especially through its intuitive and customizable board and card system, which is perfect for learning. The platform also collaborates and communicates by providing comprehensive tools, including real-time commenting, team member assignments, checklists, and extensive cross-platform integrations, ensuring effective team coordination. Additionally, Trello excels at time and task management with clear task scheduling features, automated reminders, calendar visualizations, checklist systems, and labeling that make it easy to manage and monitor tasks [35]. In contrast, platforms like Google Classroom and U-Learn focus more on task management and instructional

content with less powerful tools for complex projects [36]. Google Classroom provides basic tools that are more suitable for assignment and class management. In contrast, U-Learn offers similar scheduling and management tools but lacks features that facilitate structured and efficient management for larger and more complex tasks.

Based on LMS comparisons, Trello is the best choice for multimedia learning needs. In multimedia learning, the expected learning outcome is the ability of students to produce animation and graphic design projects based on given cases. Trello supports this well because of its powerful project management platform, which efficiently tracks student project progress.

III. MATERIALS AND METHODS

A. Research Design

The methodology used in this research is the design of a quasi-experimental study to compare the effectiveness of conventional learning models with the flipped classroom model integrated with the Trello LMS. The study used one experimental class and one control class, which used the design of nonequivalent control groups. The experimental class was treated using a flipped classroom model integrated with the Trello LMS strategy. In contrast, the control class followed the conventional learning model using the Trello LMS only to complement face-to-face teaching. The effectiveness of both models is measured through a pre-test given at the beginning of the multimedia lesson and a post-assessment given following the lecture at the 15th meeting, which is a common method in educational research, as revealed by Buck and Wage [37]. This is illustrated in Fig. 2 as follows:

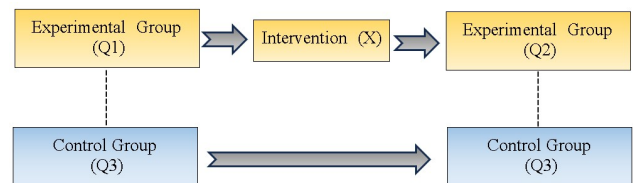


Fig. 2. Quasi-experimental research design using “non-equivalent control group design” [38, 39].

In this design, Q1 represents the experimental group pretest, which consists of a questionnaire or test that must be filled out by participants before the implementation of the treatment. The treatment implemented, marked with X, is the teaching of the flipped classroom model integrated into the Trello LMS, carried out in as many as 12 learning meetings. Q2 represents the posttest for the experimental group [40]. For the control group, Q3 was the pretest, and Q4 was the posttest. Although special treatment was provided solely for the experimental group, the control group also used the Trello LMS. The platform complements face-to-face teaching by providing online access to lecture and assignment materials and enabling students to download and review the material outside of class hours. Despite conventional learning, LMS can also improve student interaction and collaboration. Then, both control and experimental groups carried out the pre-and post-tests.

The flipped classroom model and Trello's strategy are

illustrated in Fig. 3.

In the “flipped classroom” learning model integrated with a strategy of using Trello, the lecturer’s “pre-class” stage ensures the availability and accessibility of learning materials for students through LMS Trello. In addition, lecturers provide special instructions regarding pre-class assignments to deepen the understanding of learning material before face-to-face sessions so that the remembering and understanding stages of Bloom’s taxonomy can be achieved at this stage. In the “in-class plan” at this stage, lecturers encourage interaction between students through dialogue and constructive discussion to ensure understanding of the material and provide practicum evaluation questions to measure students’ comprehension and analytical skills. The Zoom application facilitates both synchronous and asynchronous learning, enabling the achievement of the apply and analyze stages. The “organize team and plan project completion” stage is important in project-based multimedia learning, thus encouraging collaboration and developing students’ cooperation and problem-solving skills. After that, at the “after class” stage, students are responsible for continuing and completing the project cases given earlier, with the help of lecturers as a source of information and advice. At this stage, the creation stage of the bloom taxonomy is reached. In the “project reporting and presentation” stage, students report the solutions found and present them. In contrast, in the evaluation stage, an authentic assessment approach is used to holistically evaluate students’ skills and performance, including their process. Thus producing learning outcomes at the Higher-Order Thinking (HOTS) level.

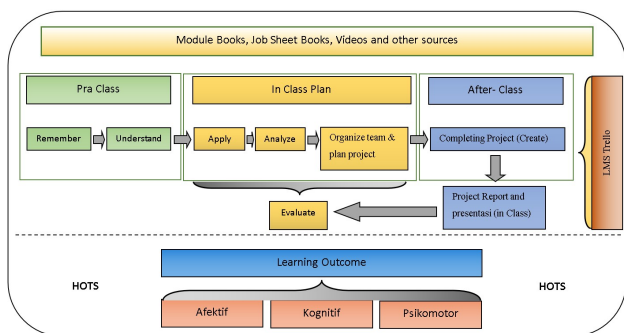


Fig. 3. The integrated flipped classroom model on the Trello LMS.

B. Participants

This research involved 32 students in the fourth semester of the 2022–2023 academic year from the informatics study program at the Payakumbuh College of Technology who were enrolled in the multimedia course, whose learning was about graphic design and 3D animation films. Two classes participate in the multimedia class, which is divided into two groups. An experimental class of 16 students was taught using a flipped classroom integrated with the Trello LMS, where the learning consists of three steps that are carried out for 12 sessions, namely pre-class, In class plan and after class, in the pre-class stage students learn the material through e-modules and videos provided by lecturers through LMS Trello, at the stage in class plan, Learning is carried out asynchronously via Zoom and LMS Trello and synchronously carried out in the

Multimedia laboratory, where learning is in the form of discussion and confirmation of the material that has been learned before, at the After Class stage, students work on graphic design projects and 3D animated films based on cases in groups and report every progress of the work process through the Trello LMS for two weeks for graphic design projects and 5 weeks for 3D animation film production so that each group can discuss, monitor the progress of project work through the Trello LMS and lecturers can guide and direct students through the Trello LMS. Meanwhile, 16 students in the control class followed the conventional learning method, which consisted of two stages. The first is during class, during which the lecturer conducts learning, the student receives the teaching, and the student can access the material provided on the LMS Trello control class to learn and understand. In the after-class stage, students are assigned to work on projects that are done in groups at the same time as the experimental class and report the progress of each class meeting, and the lecturer can direct and guide the student’s projects in class.

In this study, the determination of the experimental class and control class was carried out through a draw using the whellofname application. The two classes listed, one as an experimental class and one as a control class, were drawn three times. The class that often emerges from this draw is determined by its role. After three draws, class A was produced as an experimental class and class B as a control class.

In carrying out this research, the author is always based on the basic principles of research ethics, namely: before starting participation in the research, each subject receives a thorough explanation of the purpose of the study, the procedures followed, the benefits obtained, the potential risks, and their right to withdraw at any time without consequences. Participants were also allowed to ask questions and get further explanations before they became participants.

In terms of confidentiality and privacy, all data collected from participants is stored with an identification code to protect their identity. Regarding protecting participants’ rights, they were given complete information about their rights, including the right to obtain information about the research results.

C. Data Collection

Data was collected using experimental and control class pretest and posttest scores to compare learning outcomes. This test consists of 38 multiple-choice questions related to learning in multimedia courses. Then, student motivation questionnaires will be used to assess how much the learning model motivates students to follow learning in multimedia classes. This study adapts the motivation questionnaire from Makarim [41]. This questionnaire includes four items related to intrinsic motivation: responsibility for tasks, desire to delve deeper into the material, pleasure in solving learning problems, and expectations for achievement. Data Analysis

To assess the data in this study, we used a descriptive statistical test and a one-way ANOVA test. This test aims to evaluate the effect of the flipped classroom learning model combined with LMS Trello on learning outcomes and student motivation for learning in multimedia courses, both in experimental and control classes. The findings were analyzed

using SPSS software version 22, with a significance level 0.05 for both test scores. In addition, the Kolmogorov-Smirnov test is used to check data normality. Levene's test is used to test data homogeneity, and the t-test is applied to compare student learning outcomes between experimental and control classes.

D. Validity and Reliability Test Results

This quantitative research uses validity and reliability tests to ensure the measurement instruments provide accurate and relevant data. Before being used in the study, this instrument was validated by six experts: one expert in the field of evaluation, two experts in the field of multimedia, one expert in the field of flipped classrooms, one expert in the field of learning models, and one expert in the field of language. Validation is carried out through focus group discussion to ensure the question items can measure multimedia learning outcomes. The validation results from the experts are presented in Table 1.

Table 1. Results of validation of research instruments by experts

No	Evaluation System	Aiken's V Average	Category
1	Test questions can measure students' multimedia skills	0.83	Valid
2	The indicators of competence to be achieved are clear and can be measured	0.83	Valid
3	The aspects assessed are very clear and measurable	0.83	Valid
4	Test instructions are easy to understand and implementable	0.88	Valid
5	The purpose of the test is well-communicated and very clear	0.79	Valid

Based on the data of Table 1, the results of the validation test by experts are valid with Aiken's values ranging from 0 to 1, and the larger the validation result is closer to the number 1; it can be interpreted to have a reasonably high coefficient that is declared valid, which means that the question items on the research instrument can measure the results of multimedia learning. Following the advice of experts, the research instrument is ready to be tested.

Furthermore, the questionnaire was tested on 30 participants who participated in multimedia lectures in classes other than the experimental and control classes. The following describes the validity and reliability of the test results.

- a) Based on the results of the validity test, the consecutive values from item 1 to item 48 are as follows: **0.066**
-0.308 0.564 0.488 **0.296** 0.653 0.582 0.544
0.296 0.616 0.597 0.568 0.755 0.484 0.445
-0.055 0.477 **-0.213** 0.762 0.547 0.580 0.675
0.480 0.552 0.562 0.513 **-0.112** **-0.013** 0.496
0.468 0.605 0.467 **-0.175** 0.378 0.528 0.399
0.546 0.455 0.445 **-0.108** 0.491 0.530 0.529
0.538 0.550 0.480 0.568 0.529

Based on the data above, there are ten invalid items because the calculation value is less than r 0.3610 (r minimum table). So, there are 38 questions left.

- b) Based on test results, reliability using the Cronbach Alpha SPSS program known as the 0.913 can be seen in Table 2 below.

Table 2. Reliability statistics

Cronbach's Alpha	N of Items
0.913	38

From the output table above, it is known that N items have 38 question items with a Cronbach's Alpha value of 0.913. Because Cronbach's Alpha value is $0.913 > 0.6$, in the reliability test above, it can be concluded that all 38 question items are reliable

Cronbach's alpha value of 0.913 indicates a high level of reliability. In the context of this study, these figures suggest that the test items used are trusted to produce consistent and accurate data on student learning outcomes. Therefore, the results of this test can be used with confidence in further analysis [42].

c) Implications of reliability value

With a Cronbach alpha value of 0.913, we can be confident that this test is reliable for measuring the intended learning outcomes. This high reliability means that the test results can be trusted, and the results obtained from the test can be used to make accurate decisions regarding the student's abilities or knowledge [42]. Cronbach's high alpha score indicates that the test has good internal consistency. The items in the test tend to give similar results in the measured population, which means they measure the same concepts or constructs reliably. This value also indicates a slight measurement error in the test. The higher the Cronbach alpha value, the lower the rate of random errors that can affect the test results, which means that variations in test results are more likely to be caused by differences in measured abilities than by other factors [43].

IV. RESULT AND DISCUSSION

A. Integrate Flipped Classroom to LMS Trello

In this study, we have successfully integrated the learning model of flipped classrooms in the Trello LMS, as Fig. 4 illustrates.

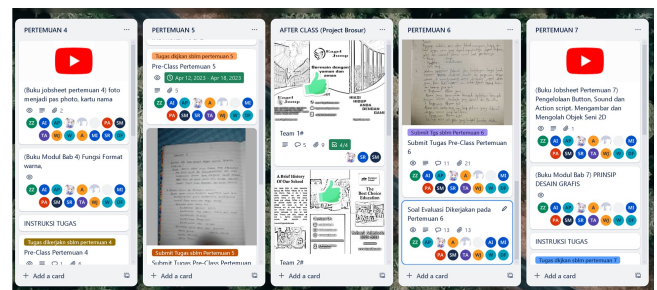


Fig. 4. Flipped classroom integration on Trello LMS.

Fig. 4 shows how the flipped classroom stage was added to the Trello LMS: the pre-class stage, which at this stage contains instructions to students about the material and exercises that must be learned before lectures start in class. According to Listiqowati [44], as quoted in its publication in 2022, the implementation of the pre-class stage has excellent potential to increase learning motivation, independence, and student preparation for synchronous or face-to-face online class sessions. This is in line with other findings that show the advantages of the “flipped learning” approach in modern education [45, 46], Then the stage in the class plan. When entering this stage, lectures begin with an opening to stimulate

student enthusiasm for the material to be discussed [44, 45, 47–49]. Furthermore, the lecturer ascertains whether the students understood the material learned at the “pre-class” stage. In this confirmation process, if students have doubts or questions about the material, other students can give their answers or opinions. This encourages a lot of interaction between students, creating constructive dialogue and discussion to find solutions to the questions asked [44, 46, 48, 50, 51]. After the discussion process, the lecturer gave practicum evaluation questions. The aim is to see how far students have understood the material and how well they can apply it in practical situations [47, 48, 51–53]. Next is the Class stage; in this stage is the implementation phase and the accuracy of the project case completion analysis [44, 50, 51]. At this stage, students are responsible for continuing and completing the project case that has been given previously. They must work together within the specified time to formulate a solution based on initial analysis and report on each step of project completion progress through the Trello LMS so that each team member can monitor and collaborate on completing the project.

B. Learning Outcome

After collecting data through pretest and posttest and measuring student motivation with questionnaires, analysis was conducted to evaluate the performance of the experimental and control groups. This analysis aims to determine the effectiveness of the flipped classroom learning model integrated into the Trello LMS in the context of multimedia learning. This effectiveness is assessed based on comparing test results from the experimental and control classes. The test is administered as a set of multiple-choice questions, with 38 related to multimedia learning resources. Table 3 below presents the results of the experimental and control class tests:

Table 3. 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

Table 1 of the experimental class’s pre-test results shows that the average score was 40.41, compared to 40.59 for the control class. Then, in the experimental class’s post-test results, the average score was 82.33. Conversely, the control class’s post-test score was 76.54. In Fig. 5, we can see how each group’s lowest and highest numbers compare to each other.

Based on the experimental class’s pre-test test results (Fig. 5), the control class’s pre-test score, with the lowest figure being 28.95 and the maximum value being 52.63; in contrast, the lowest score was 23.68 and the highest value was 52.53. The experimental class’s post-test results showed that the lowest score was 71.05, and the best score was 94.74. In the control class, the post-test score ranged from 73.68 to 81.58.

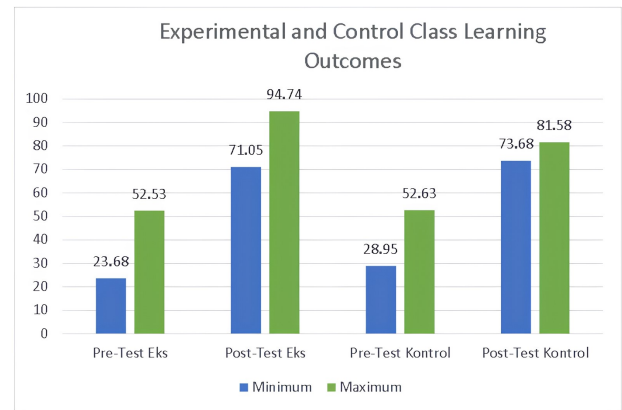


Fig. 5. Experimental and control class learning outcomes.

C. Learning Motivation

In the learning process, experimental and control classes assess student learning motivation based on assessment questionnaire indicators consisting of responsibility for tasks, desire to explore the material, ability to solve learning problems, and expectations of achievement. Table 4 illustrates the significance of student motivation to learn.

Table 4. Student learning motivation assessment result

Class	N	Min	Max	Average
Experiment Class High Motivation	10	80	95	88.13
Experiment Class Low Motivation	6	30	75	65
Control Class High Motivation	7	80	95	86
Control Class Low Motivation	9	60	70	65.7

Based on Table 4, an assessment of student motivation in multimedia learning, ten students are highly motivated in experimental classes, and six students are lowly motivated. In the control class, seven students are highly motivated for multimedia learning, and nine are lowly motivated. In Fig. 6, we can see how each group’s lowest and highest numbers compare.

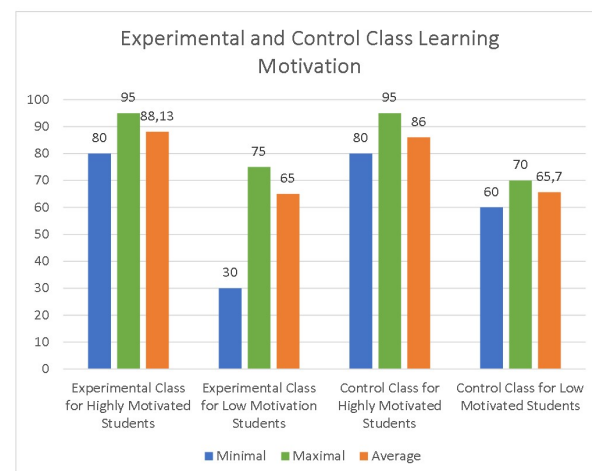


Fig. 6. Results of student motivation in experimental and control classes.

Fig. 6 compares multimedia learning outcomes based on student motivation levels. In the experimental class, highly motivated students recorded a low score of 80, a high score of 95, and an average of 88.13. Low-motivation students in the same class recorded a low score of 30, a high score of 75, and an average score of 65. In the control class, highly motivated college students had the same lowest and highest grades as the

experimental class, but their average was slightly lower, at 86. Meanwhile, low-motivation students in the control class recorded a low score of 60, a high score of 70, and an average of 65.7.

D. Normality Test Result

A normality test was used in this investigation to ascertain the data's distribution. This test uses Kolmogorov-Smirnov,

where the data are considered normal when the significance level ($p > 0.05$) exceeds 0.05 and abnormal if less than 0.05 ($p < 0.05$). Based on the Kolmogorov-Smirnov test, the experimental class's significant values were 0.124, while the control class's values were 0.053, proving the normal distribution of the data. Further details on these results can be seen in Tables 5.

Table 5. Normality test results in experimental and conventional classes: Model flipped and Trello strategy and model conventional

N	Normal Parameters ^{a,b}		Most Extreme Differences			Test Statistic	Asymp. Sig. (2-tailed)	Class
	Mean	Std. Deviation	Absolute	Positive	Negative			
16	82.3307	8.47725	0.203	0.189	-0.203	0.203	0.124 ^c	Experimental
	76.5350	3.06687	0.241	0.241	-0.176	0.241	0.053 ^c	Conventional

Note: a: normality assumption; b: data analysis method; c: level of significance

Based on Table 5 above, the data is said to have a normal distribution because it has a significant value of 0.124 where $0.124 > 0.05$. and a significant value of 0.053 where $0.053 > 0.05$.

E. Homogeneity Test Result

In this study, the homogeneity test on the data aims to confirm whether the data from the experimental and control classes are from populations with the same variance. When the level of significance is greater than 0.05 ($p > 0.05$), the data are regarded as homogenous and inhomogeneous if less than 0.05 ($p < 0.05$). Based on the results of Levene's test, the significant value obtained is 0.460, indicating that the data has a homogeneous variance.

Table 6 presents the data as homogeneous because it has a significant value of 0.460, where $0.460 > 0.05$.

Table 6. Test for homogeneity

F Statistic Value	df1 (Numerator)	df2 (Denominator)	Sig. (Significance)
0.893	3	22	0.460

F. Hypothesis Testing Research

The hypothesis of this test is:

H0: There were no significant disparities in multimedia

learning results between students who used the flipped classroom learning model with Trello LMS and those who used the conventional learning model.

H1: There are significant disparities in multimedia learning results between students who use the flipped classroom learning model with Trello LMS and those who use the conventional learning model.

So that:

$$H0: \mu_1 = \mu_2$$

$$H1: \mu_1 \neq \mu_2$$

An independent Analysis of the T-test sample was carried out using the SPSS 22 application program, which functions to compare the state of the research object before and after being given the treatment of the Trello LMS-integrated flipped classroom with conventional models; the decision criterion is that if the P -value ≤ 0.05 , there is a significant difference between student learning outcomes between the experimental class and the control class so that the learning model of flipped classrooms integrated with Trello LMS is effectively used. If the P -value is ≥ 0.05 , then there is no significant difference, so the learning model of flipped classrooms integrated with Trello LMS is ineffective. Table 7 displays the outcomes of the t-test on independent samples.

Table 7. T-test results for independent sample

Table 7.1: t-test results for independent samples										
Levene's Test for Equality of Variances		t-test for Equality of Means								
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Student Learning Outcomes	Equal variances assumed	22.844	0.000	2.241	24	0.035	5.79571	2.58679	0.45685	11.13458
	Equal variances not assumed			2.383	16.810	0.029	5.79571	2.43247	0.65922	10.93221

Based on Table 7, the results of the posttest t test given in the experimental class and the control class obtained a significance result of 0.035, which means a small from 0.05 (sig. $0.035 < 0.05$), and it can be concluded that H_0 was rejected and H_1 was accepted, which means there is a significant difference in the outcomes of multimedia learning among students instructed using the flipped classroom instructional approach that integrates with LMS Trello and students taught using the learning model conventional. As a result, the Trello LMS-integrated flipped classroom has proven to be more effective at improving learning outcomes and student motivation in multimedia learning. This research

aligns with studies conducted by Gitadewi *et al.* [54], Zhao *et al.* [55], and Durak [56].

Combining the flipped classroom model with Trello LMS increases student participation and strengthens their understanding of the material. The availability of online learning materials and videos makes it easier for students to learn at their own pace, increasing the efficiency of their time use and preparation.

In using Trello LMS, the interaction between lecturers and students and between students themselves is very helpful in completing group projects, especially in after-class sessions. This makes it easier to complete group projects where,

initially, students plan tasks and divide the tasks according to the multimedia skills of each member. They set deadlines for each task that must be completed. Then, students create a periodic schedule; they arrange periodic meetings to check the progress and ensure all members stay on the right track. Each group member and lecturer monitors this through the Trello LMS to complete the progress of their project. Lecturers can guide and direct students through the Trello LMS if there are obstacles in completing their projects. Then, in the Review and Evaluation Session, Students held several sessions to review their completed work before the deadline. This method allows for responsive and dynamic teaching, where lecturers can provide quick and precise responses through Trello's LMS and also with the help of the multimedia class WhatsApp Group application. This effective interaction deepens students' understanding of the material and strengthens cooperation, leading to more productive group learning and satisfying learning experiences.

Trello LMS significantly strengthens multimedia learning through improved time management, effective communication, and dynamic collaboration. In time management, Trello makes planning easy by organizing all learning components, including modules, e-job sheets, videos, and assignments, on board with clear deadlines, allowing students to use task division and checklists independently. At the same time, lecturers can intervene and adjust schedules promptly to ensure a smooth and effective learning process. On the communication side, Trello facilitates organized distribution and access of materials, with each card providing complete information and facilitating direct communication between lecturers and students through comment features, supporting real-time exchange of ideas and enriching interactive discussions. Meanwhile, in collaboration, Trello efficiently does task division in groups, where students can assign sub-tasks and monitor progress on cards open to all team members, improving coordination and fostering a sense of ownership and responsibility, improving collaborative learning. The application of the flipped classroom model integrated with Trello LMS has resulted in a significant increase in student motivation and learning outcomes, where the average value of student learning motivation who has high motivation in the experimental class is 88.13, as many as ten students. The average value of student learning motivation who has low motivation in the experimental class is 65, with as many as six students. In contrast, the average value of students with learning motivation with high scores in the control class was 86, as many as seven students, and the average value of learning motivation of students with low motivation in the control class was 65.7, as many as nine students. Likewise, the multimedia learning outcomes of students were based on posttests in the experimental class, with an average score of 82.33 and the average score of learning outcomes in the control class of 76.56. Therefore, implementing this model has proven effective in improving student learning outcomes and motivation in multimedia learning.

Some research suggests that the flipped classroom model may not significantly affect academic achievement [57, 58]. For example, research conducted by Taspolat *et al.* [58]. argues that the impact of the flipped classroom model on

student learning has more to do with engagement with peers and educators than measurable academic gains [57, 58]. Shows that the flipped classroom model does not have a positive impact on educational achievement [58].

But this is proof that the flipped class approach and Trello LMS are student-centered learning approaches that can increase student motivation and 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.

Integrating the flipped classroom model with Trello's Learning Management System (LMS) has significant practical implications for improving learning outcomes and student motivation in multimedia learning. In addition, it also has implications for: a) Increased Student Engagement: By providing learning materials in pre-class sessions through Trello, students come to class already understanding the subject matter, so class sessions become more productive and interactive. It is particularly effective in learning that requires high engagement with complex multimedia tools and concepts. b) Increased Collaboration: Trello's board and card system allows for seamless collaboration between students. In multimedia projects, students must work together on complex tasks, allowing for better tracking of progress and responsibilities through cards on Trello's LMS. c) improved time management: Trello allows for structured and transparent scheduling of tasks and deadlines. Lecturers can use this to help students manage their learning assignments more effectively.

The class session is divided into three stages to apply this model to other natural and project-based learning: pre-class, in-class, and after-class. At the pre-class stage, students start by exploring essential questions and learning independently through videos, e-modules, and worksheets available in Trello LMS, so students prepare themselves with the necessary materials for class discussions. In the in-class stage, lecturers introduce project cases that must be completed by groups of students, where they design a project creation plan, such as a 3D animated film, and set an implementation schedule that lasts 12 weeks. In the after-class stage, the entire progress of the project, which includes all stages, from the creation of the animated film storyboard to the analysis of the results, is reported periodically through the Trello LMS. Lecturers monitor and evaluate student progress, provide constructive feedback, and at the end of the project, students upload the final results to Trello LMS before preparing for the next lesson.

V. CONCLUSION

This study revealed the effectiveness of implementing the flipped classrooms approach integrated with the Trello LMS, which proved to be more effective in its application in multimedia learning than the conventional model so that student learning outcomes increased. Student learning motivation also increased, and the average value of student learning outcomes in classes that applied the flipped classroom learning model integrated with the Trello LMS was 82.33. The average value of student motivation with high

motivation is 88.13, while the learning outcomes of students taught with conventional models are 76.54. Additionally, the mean value of student learning motivation for those with high motivation in conventional model classes is 86.

Research on the flipped classroom model using Trello LMS shows limitations due to the influence of unexpected external factors. Namely, in the student project presentation session, there was a request for the study program to be assessed by English course lecturers, so students were worried that they would also be evaluated by other lecturers, affecting their performance. In addition, there are obstacles in implementation, such as a lack of literacy and technological competence among students, which requires short training in using Trello LMS.

These findings suggest the need for further research to explore reverse class research in the future. This research can focus on various aspects, including investigating the impact of flipped classrooms on different research areas, integrating them with other learning models, and evaluating the effectiveness of learning media to improve outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

In this research, Zulkifli develops research concepts and designs and is responsible for collecting research data. Ambiyar specializes in data analysis and uses statistical software to process and translate results while guaranteeing the statistical integrity of research findings. Syahril plays an essential role in writing and drafting scripts. Lastly, Dedy Irfan ensures all aspects of this research meet established ethical and scientific standards. All authors had approved the final version.

ACKNOWLEDGMENT

We thank my Promotor, Prof. Dr. Ambiyar, M.Pd, and Prof. Ir. Syahril, M.Sc., PhD., for their guidance and input throughout this research. We also thank the head of STT Payakumbuh for permitting me to research the students of the Informatics study program and all parties who have contributed to the completion of this research.

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