Project-Based Flipped Learning and Student`s Universites Learning Motivation

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Abstract. This study was inspired by the need to ascertain whether the recently developed project-based flipped learning model influences college students' motivation to learn. This study aimed to determine how the project-based flipped learning approach affected college students' motivation to learn. This study is a quasi-experimental one with 100 pupils. Questionnaires were distributed to collect data—the SPPS 26 data analysis technique. The tests included descriptive analysis, homogeneity testing, normality testing, and hypothesis testing. The post-test average results show a difference between the experimental and control groups' averages and that students who learn to use project-based flipped learning outperform those who study using the conventional approach on post-tests. In conclusion, project-based learning affects college students' motivation to learn. The findings of this study have ramifications for initiatives aimed at enhancing higher education students' enthusiasm to learn.

Keywords: flipped learning, projects, students, learning motivation.

1 Introduction

One of the areas impacted by technological growth in the reform era is the educational system. This growth affects how well students learn in class as well. The educational process is crucial in helping students realize their full potential [1], [2]. Students will be helped in finding information about the learning materials during the learning process [3]. The learning objectives will be easy for students to accomplish if they are engaged in the learning process. According to Hendri et al. (2021), education through learning can provide superior, intelligent, and competitive resources to raise an individual's standard of living [4].

Education is crucial for producing the best students in all academic subjects [5], [6]. Additionally, education is crucial in developing students who understand science. But it also depends on how well the teacher has prepared the lecture. The lecturer has an impact on whether learning is successful or unsuccessful. To produce a meaningful learning process, teachers must design qualified instruction to create a favorable learning environment [7], [8]. Students can meet the defined learning objectives if there is a meaningful learning process.

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The accomplishment of these learning goals will influence the results of learning [9], [10]. One of the key aspects in measuring the degree of achievement of learning objectives is learning outcomes. The last aspect used to assess whether students have successfully applied the learning process is learning outcomes. However, additional factors can also have an impact on learning results [11]. Both internal and external factors may influence students. Students' internal and external factors, as well as other factors. There are psychological (readiness, maturity, attention, interest, motivation, talent, and intelligence) and physical (physical disability and health) factors as well as fatigue variables (physical fatigue and spiritual fatigue) that make up internal factors. While there are many factors that are external, including family factors [12], [13]. For the balance of the learning process, the family is crucial. Students who get parental assistance have better learning outcomes than students who do not. In terms of the factors that influence family support, we can mention the family environment, family finances, parental education process, and affection within the family. The school factor is another key. Schools have a significant influence in motivating students to meet their academic objectives. Facilities and infrastructure, time allocation, learning materials, learning media, learning methods, and learning models are some of the factors that schools must be aware of in the teaching and learning process. The teacher must be aware of this so the students can meet the targeted learning objectives. Teachers must actively participate in creating learning models that are tailored to the needs of their students, including university students. The ability to create learning models that follow the characteristics of students in higher education is a requirement for lecturers as educational subjects. Additionally, lecturers must be capable of considering the 4.0 era in perspective.

The researchers conducted observations at one of the universities in the province of Aceh, Indonesia, to learn more about the issues in the field. According to the observations, the teaching technique used by the lecturers was still quite teacher-centered. The learning process is dominated by lecturers. According to the data, students tend to be passive. Students do not seem to be motivated to learn. The researchers then ran a questionnaire on students' learning motivation. The following table shows the questionnaire's findings:

Table 1. Learning motivation of university students.

No	Statement	Yes		No	
		∑	%	∑	%
1	Procrastinating doing assignments	34	34	66	66
2	Taking notes on the lecturer's explanations of the material.	43	43	57	57
3	Completing assignment independently	23	23	77	77
4	Receiving additional scores if finish assignments early	36	36	64	64
5	Feeling pleased if the lecturer holds a quiz	49	49	51	51
6	Focusing on learning	44	44	56	56

Table 1 shows that up to 34% of students are still procrastinating doing assignments, up to 43% of students are only taking notes on the lecturer's material, up to 23% of students are completing assignments independently, up to 36% of students are

finishing assignments early to receive additional scores, up to 49% of students are pleased if the lecturer provides a quiz and up to 44% of students are focusing on learning. This survey indicates that undergraduates still have low learning motivation.

Lecturers have a huge responsibility here. The teaching process depends heavily on the lecturers [14]. It's significant for lecturers can select methods, frameworks, and teaching strategies that work for them [15]. From the questionnaire's results, students' low levels of learning motivation are because teacher-centered learning is still the main focus of learning. To boost learning motivation and meet the needs of students, a proper learning model is therefore required.

The flipped learning model works well in the 4.0 era. The flipped learning model is a method of learning that involves doing activities completed in the classroom online or at home, while the learning process in class is concentrated on improving problem-solving skills [16]. According to numerous research [17]–[20], flipped learning can enhance student learning. However, researchers have created a project-based flipped learning model in earlier studies. The feasibility and usefulness of this project-based flipped learning model have been determined. The purpose of this study was to determine the impact of the project-based flipped learning model on student learning motivation to assess the effectiveness of this model.

This research is supported by previous research. Research conducted by Yamamoto examined the increase in student learning motivation in tertiary institutions using smartphone-assisted interactive learning [21]. The results of the study state that using smartphone-assisted interactive learning can increase student learning motivation in tertiary institutions. Research conducted by Burenkova et al. studies the use of role-playing models can increase student learning motivation in tertiary institutions [22]. The study results stated that students who studied using the role-playing model could increase student learning motivation. Research conducted by Khan et al. examines the effect of using augmented reality on student learning motivation in tertiary institutions [23]. The study's results stated that students who used augmented reality had higher motivation. Tall. Research conducted by Raza et al. examines the effect of using case-based learning to increase student learning motivation [24]. The results of this study state that students who study using case-based learning have high motivation. From this research, research related to increasing student learning motivation has begun to be carried out. However, the research that researchers are doing is different from before. This study examines the effect of the project-based flipped learning model, which was developed by considering the conditions of students and the environment on learning motivation.

Research on the effect of the project-based flipped learning model on student learning motivation has significant importance. This learning model combines a project approach with a flipped learning approach, enabling students to be actively involved in relevant project activities and increase their involvement in learning. Learning motivation is crucial in achieving optimal learning outcomes, and the project-based flipped learning model can increase student learning motivation through relevant project activities. In addition, this model is also responsive to the needs and characteristics of current students familiar with technology and project-based learning. This research provides practical guidance for educators in designing effective learning

strategies and also contributes to academic knowledge about effective learning methods in increasing student learning motivation. Therefore this research needs to be developed.

2 Method

This study uses a quantitative approach. The quantitative approach was chosen because this study aims to provide a more objective and general understanding of the effect of the Project-Based Flipped Learning Model on student learning motivation. The numerical data collected and analyzed provide statistical power supporting or refuting the research hypothesis. Thus, the quantitative approach helps to measure the extent to which the influence of the learning model has on student learning motivation objectively and can be measured numerically.

This study is quasi-experimental [1]. This study used a quasi-experimental method because it was impossible to carry out randomization or random randomization for the division of the experimental and control groups. In this method, the researcher selects the experimental and control groups based on specific characteristics without going through a randomization process. In the context of the effect of the Project-Based Flipped Learning Model on student learning motivation, the researcher chose an experimental group consisting of students enrolling in courses with this learning model. In contrast, the control group consisted of students enrolling in similar courses but with a conventional learning approach. This quasi-experimental method was used to compare the results between the two groups and understand the learning model's effect on learning motivation.

In this study, sampling was carried out using a purposive sampling technique which involved specific steps. The population studied was geography education students at a university in Aceh province. First, the researchers determined specific inclusion criteria, namely 6th-semester students. After that, the number of samples was determined, namely 100 people, divided into 50 for the experimental class and 50 for the control class. The researcher then matched the inclusion criteria with the existing population of geography education students through university data or direct communication with the course lecturers. Based on this matching, the researcher deliberately chose 50 students who met the criteria for the experimental class and 50 other people for the control class. After the selection is made, the researcher contacts the participants to explain the purpose of the research, solicit their participation, and schedule a time and place for conducting the research. Using a purposive sampling technique, researchers were able to select participants according to the relevant inclusion criteria, enabling this research to be more focused and specific in analyzing the effect of the Project-Based Flipped Learning Model on student learning motivation in geography education.

The data analysis method benefited from the use of SPPS 26. Descriptive analysis, homogeneity testing, normality testing, and hypothesis testing using independent t-test were the tests that were performed.

2. Results and Discussion

Following each class's actions, measurements were made. The first step in the process is to recapitulate the data, and the outcomes are as follows.

Table 2. Descriptive variables of learning motivation

No	Learning Motivation	Mean	TCR	
			%	Criteria
1	Experimental Class	4,02	81,53	Good
2	Control Class	3,54	74.6	Sufficient
Average of both classes		3,78	78,065	Sufficient

Table 2 shows that the experimental class's learning motivation is in a good category, whereas the control class's motivation is in the sufficient category. The average of the two classes' results falls into the category of being sufficiently good. The table below summarizes the results of the pre-and post-tests for the two classes.

Table 3. Descriptive variables of learning motivation

	N	Minimum	Maximum	Mean	St. Deviation
Pre-test of Experimental class	50	30	62	49.87	7.672
Post-test of Experimental class	50	70	95	87.65	6.362
Pre-test of control class	50	31	52	54.73	6.183
Post-test of control class	50	35	55	78.36	5.342
Valid N (listwise)	50				

Table 3 shows that the experimental class's learning motivation is in a good category, whereas the control class's motivation is in the sufficient category. The average of the two classes' results falls into the category of being sufficiently good. The table below summarizes the results of the pre-and post-tests for the two classes:

Table 4. Descriptive statistics of control class and experimental class

	N	Minimum	Maximum	Mean	St. Deviation
Pre-test of Experimental class	50	30	62	49.87	7.672
Post-test of Experimental class	50	70	95	87.65	6.362
Pre-test of control class	50	31	52	54.73	6.183
Post-test of control class	50	35	55	78.36	5.342
Valid N (listwise)	50				

Table 4 results reveal that there is just a small difference between the experimental class's pre-test and the control class's pre-test. In contrast, it was discovered in the post-test results that the experimental class scores were greater than those of the control class. The normality test, which comes next, seeks to ascertain if the data is regularly distributed. The data's findings are as follows:

Table 5. Summary of normality test results

No	Research variable	Sig	Description
1	Learning motivation of experimental class	0,562	Normal
2	Learning motivation of control class	0,429	Normal

Table 5 shows that every class received a sig value greater than 0.05. This demonstrates that the data are regularly distributed. Additionally, a homogeneity test was run. The homogeneity test's findings are as follows:

Table 6. Results of homogeneity test

	Levene Statistic	Df1	Df2	Sig.
Learning Motivation	3,282	1	100	0,876

Table 6 shows that the obtained sig value is 0.876, which is greater than 0.05. This value suggests that the data is homogeneous. The independent t-test was then performed. The test aims to ascertain whether the averages of the experimental and control classes differ from one another. The outcomes are displayed in the following table:

Table 7. Independent t-test

		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
TPACK	Equal variances assumed	.183	.538	12.832	98	.000	23.850	1.452	14.038	23.635
	Equal variances not assumed			13.938	60.382	.000	23.850	1.452	13.943	23.635

Table 7 shows that the value of sig receives a score of 0.00, which is less than 0.05. This score demonstrates that the averages score of the experimental class and the control class are different. The following step is to examine Table 3 post-test results. The project-based flipped learning model influences the learning motivation of university students, which shows that the experimental class post-test is greater than the control class post-test.

Research from earlier studies is used to support this research. Flipped learning could enhance the knowledge and expertise of prospective teachers, according to research by Sever, ncül, and Ersoy (2019) on this topic. Compared to prospective teachers who do not employ flipped learning, those who learn to conduct research using this method have strong research skills [9]. According to research by Rodriguez-Paz et al. (2020), implementing the flipped learning model can boost students' engagement in their studies. When compared to learners who do not use flipped learning, flipped learning students are more engaged in their studies [3]. According to Santhanasamy & Yunus (2022), flipped learning can help students' speaking abilities. Compared to students who learn using traditional models, students who study using flipped learning have higher speaking skills [25]. According to Susana & Braham (2021), students who learn to use flipped learning have higher levels of writing skills than those who learn to use traditional learning methods [26]. This study demonstrates how flipped learning affects students' writing skills. According to research by Handayani, Sutarno, and Wihadi (2018), flipped learning can enhance students' conceptual knowledge. According to the study's findings, flipped learning can enhance students' writing, speaking, and research skills as well as their learning outcomes [27], [28]. The results, however, differ from previous studies since this study discovered that project-based flipped learning can boost students' learning motivation in higher education.

The project became the primary learning foundation for developing the project-based flipped learning model [29], [30]. Due to several factors, this project-based flipped learning strategy can enhance students' motivation to learn. Utilizing technology is how this flipped learning concept is implemented. The use of technology is something that students like. Technology use is identical to the 4.0 era, which is the period of development for the millennial generation [31], [32]. Additionally, this flipped learning approach allows students the flexibility to access their education at any time and anywhere [28], [33]. As a result, students are free to follow whichever learning process they choose. Students can choose how they want to learn. Additionally, students are exposed to issues that arise in real life through this project-based flipped learning approach [34]. Through project activities, these issues can be resolved. Project-based learning involves engaging students in the learning process through project activities to inspire them to find solutions to problems encountered in the real world [35]. This factor serves as the foundation for improving student learning motivation.

3 Conclusion

The study's findings indicate that the sample t-test result was 0.00, which is less than 0.05. This score demonstrates that the average scores of the experimental class and the control class are different. Additionally, according to the average post-test result, students who learn using project-based flipped learning to perform better than those who follow the traditional learning model. In conclusion, in higher education, the project-based learning model influences students' learning motivation. This study's results recommend that lecturers develop and use this Project-Based Flipped Learning

model in the lecture process to increase student learning motivation in tertiary institutions.

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References

1. R. Eliyasni, A. K. Kenedi, and I. M. Sayer, "Blended Learning and Project Based Learning: The Method to Improve Students' Higher Order Thinking Skill (HOTS)," *Jurnal Iqra': Kajian Ilmu Pendidikan*, vol. 4, no. 2, pp. 231–248, Dec. 2019, doi: 10.25217/ji.v4i2.549.
2. H. Hamimah, Z. Zuryanty, A. K. Kenedi, and N. Nelliarti, "The Development of the 2013 Student Curriculum Book Based on Thinking Actively in Social Context for Elementary School Students," *Al Ibtida: Jurnal Pendidikan Guru MI*, vol. 6, no. 2, p. 159, Oct. 2019, doi: 10.24235/al.ibtida.snj.v6i2.4931.
3. M. X. Rodriguez-Paz, J. A. Gonzalez-Mendivil, J. A. Zarate-Garcia, I. Zamora-Hernandez, and J. A. Nolazco-Flores, "A hybrid flipped-learning model and a new learning-space to improve the performance of students in Structural Mechanics courses," in *IEEE Global Engineering Education Conference, EDUCON*, IEEE Computer Society, Apr. 2020, pp. 698–703. doi: 10.1109/EDUCON45650.2020.9125385.
4. S. Hendri, R. Handika, A. K. Kenedi, and D. Ramadhani, "Pengembangan Modul Digital Pembelajaran Matematika Berbasis Science, Technology, Enginiring, Mathematic untuk Calon Guru Sekolah Dasar," *Jurnal Basicedu*, vol. 5, no. 4, pp. 2395–2403, Jul. 2021, doi: 10.31004/basicedu.v5i4.1172.
5. Y. F. Fitria and A. Kenedi, "The Need of Blended Learning in Ecoliteration in the Era of Revolution of Industry 4.0 for College," European Alliance for Innovation n.o., Mar. 2021. doi: 10.4108/eai.4-11-2020.2304597.
6. Y. K. Nengsih, C. Handrianto, P. S. Pernantah, A. K. Kenedi, and A. Tannoubi, "The Implementation Of Interactive Learning Strategy To Formulating Learning Objectives In Package C Program," *SPEKTRUM: Jurnal Pendidikan Luar Sekolah (PLS)*, vol. 10, no. 2, p. 311, May 2022, doi: 10.24036/spektrumpls.v10i2.117215.
7. C. Handrianto, A. S. Uçar, E. Saputra, Y. K. Nengsih, A. K. Kenedi, and M. A. Rahman, "Competences of Adult Learning Facilitators in Community Service Learning: A Review of Literatures," *KOLOKIUM Jurnal Pendidikan Luar Sekolah*, vol. 9, no. 2, pp. 121–132, Oct. 2021, doi: 10.24036/kolokium-pls.v9i2.493.
8. Y. Helsa and A. K. Kenedi, "Edmodo-Based Blended Learning Media in Learning Mathematics," *Journal of Teaching And Learning In Elementary Education (JTLEE)*, vol. 2, no. 2, Jul. 2019, doi: 10.33578/jtlee.v2i2.7416.
9. I. Sever, B. Öncül, and A. Ersoy, "Using flipped learning to improve scientific research skills of teacher candidates," *Universal Journal of Educational Research*, vol. 7, no. 2, pp. 521–535, Feb. 2019, doi: 10.13189/ujer.2019.070225.

10. Y. Miaz, A. K. Kenedi, S. W. Monfajri, and Y. Helsa, "Educative Learning Media for Elementary School Students," 2019.
11. M. Yullys, H. Ary, K. Kenedi, and U. N. Padang, "Al-Quran Based Learning Strategy in Teaching Mathematics at Primary Education Elementary School Teaching Learning Elementary School Teaching Learning Elementary School Teaching Learning," 2018.
12. A. Kiswanto Kenedi, Y. Helsa, Y. Ariani, M. Zainil, S. Hendri Universitas Negeri Padang, and J. Hamka Air Tawar, "Mathematical Connection of Elementary School Students To Solve Mathematical Problems," *Journal on Mathematics Education*, vol. 10, no. 1, pp. 69–80, 2019.
13. J. P. Ekonomi, R. Sahara, and R. Sofya, "Pengaruh Penerapan Model Flipped Learning dan Motivasi Belajar Terhadap Hasil Belajar Siswa", [Online]. Available: http://ejournal.unp.ac.id/students/index.php/pek/index
14. D. Ramadhani, A. K. Kenedi, M. F. Rafli, and C. Handrianto, "Advancement of STEM-Based Digital Module to Enhance HOTS of Prospective Elementary School Teachers," *Jurnal Pendidikan Progresif*, vol. 12, no. 2, pp. 981–993, 2022, doi: 10.23960/jpp.v12.i2.202245.
15. S. Ahmad and A. Kiswanto Kenedi, "Instrumen HOTS Matematika Bagi Mahasiswa PGSD." *Jurnal PAJAR (Pendidikan dan Pengajaran)*, vol. 2, no.6, pp. 905-912, 2018.
16. M. K. Seery, "Flipped learning in higher education chemistry: emerging trends and potential directions," *Chemistry Education Research and Practice*, vol. 16, no. 4, pp. 758–768, 2015.
17. İ. Karagöl and E. Esen, "The effect of flipped learning approach on academic achievement: A meta-analysis study," *Hacettepe Egitim Dergisi*, vol. 34, no. 3, pp. 708–727, 2019, doi: 10.16986/HUJE.2018046755.
18. İ. Karagöl, and E. S. E. N. Emrullah,"The Effect of Flipped Learning (Revised Learning) on Iranian Students' Learning Outcomes," *Advances in Language and Literary Studies*, vol. 6, no. 5, Aug. 2015, doi: 10.7575/aiac.alls.v.6n.5p.209.
19. S. P. Sánchez, J. López-Belmonte, A. J. Moreno-Guerrero, J. M. Sola Reche, and A. F. Cabrera, "Effect of bring-your-own-device program on flipped learning in higher education students," *Sustainability (Switzerland)*, vol. 12, no. 9, May 2020, doi: 10.3390/su12093729.
20. S. Meyliana, B. Surjandy, and A. N. Hidayanto," Flipped learning effect on classroom engagement and outcomes in university information systems class. Education and Information Technologies", 1-19, 2021.
21. N. Yamamoto, "An interactive learning system using smartphone: Improving students learning motivation and self-learning," in *Proceedings - 2014 9th International Conference on Broadband and Wireless Computing, Communication and Applications, BWCCA 2014*, Institute of Electrical and Electronics Engineers Inc., Jan. 2014, pp. 428–431. doi: 10.1109/BWCCA.2014.125.
22. O. M. Burenkova, I. V. Arkhipova, S. A. Semenov, and S. Z. Samarenkina, "Motivation within role-playing as a means to intensify college students' educational activity," *International Education Studies*, vol. 8, no. 6, pp. 211–216, 2015, doi: 10.5539/ies.v8n6p211.
23. T. Khan, K. Johnston, and J. Ophoff, "The Impact of an Augmented Reality Application on Learning Motivation of Students," *Advances in Human-Computer Interaction*, vol. 2019, 2019, doi: 10.1155/2019/7208494.
24. S. A. Raza, W. Qazi, and B. Umer, "Examining the impact of case-based learning on student engagement, learning motivation and learning performance among university students," *Journal of Applied Research in Higher Education*, vol. 12, no. 3, pp. 517–533, Jun. 2020, doi: 10.1108/JARHE-05-2019-0105.

25. C. Santhanasamy and M. M. Yunus, “A systematic review of flipped learning approach in improving speaking skills,” *European Journal of Educational Research*, vol. 11, no. 1. Eurasian Society of Educational Research, pp. 127–139, Jan. 01, 2022. doi: 10.12973/eu-jer.11.1.127.
26. K. Y. Susana and A. A. G. R. Wahyu Brahma, “The Effectiveness of Flipped Learning During the Pandemic to Improve the Writing Competence of STMIK STIKOM Indonesia Students,” *RETORIKA: Jurnal Ilmu Bahasa*, vol. 7, no. 1, pp. 75–84, Apr. 2021, doi: 10.22225/jr.7.1.2883.75-84.
27. D. P. Handayani, H. Sutarno, and Y. Wihardi, “Design e-learning with flipped learning model to improve layout understanding the concepts basic of the loop control structure,” in *Journal of Physics: Conference Series*, Institute of Physics Publishing, May 2018. doi: 10.1088/1742-6596/1013/1/012100.
28. Y. H. Lee, “Scripting to enhance university students’ critical thinking in flipped learning: implications of the delayed effect on science reading literacy,” *Interactive Learning Environments*, vol. 26, no. 5, pp. 569–582, Jul. 2018, doi: 10.1080/10494820.2017.1372483.
29. C. Karaca and M. Akif Ocak, “Effect of Flipped Learning on Cognitive Load: A Higher Education Research,” 2017.
30. A. Orhan, B. E. Üniversitesi, Y. D. Yüksekokulu, Z. / Türkiye, and M. Bilgisi Öz, “The Effect of Flipped Learning on Students’ Academic Achievement: A Meta-Analysis Study Ters Yüz Edilmiş Öğrenme Yaklaşımının Öğrencilerin Akademik Başarısına Etkisi: Bir Meta-Analiz Çalışması”, doi: 10.14812/cufej.400919.
31. Hamimah *et al.*, “Thinking the most convenient analysis of alpha generation by using social science story digital books,” *Elementary Education Online*, vol. 19, no. 1, pp. 78–86, 2020, doi: 10.17051/ilkonline.2020.654895.
32. R. Bezzazi, “The effect of flipped learning on EFL learners’ public speaking in Taiwan,” *Journal on English as a Foreign Language*, vol. 9, no. 1, p. 1, Mar. 2019, doi: 10.23971/jefl.v9i1.1035.
33. B. Cho and J. Lee, “A Meta Analysis on Effects of Flipped Learning in Korea,” *Journal of Digital Convergence*, vol. 16, no. 3, pp. 59–73, 2018, doi: 10.14400/JDC.2018.16.3.059.
34. Y. Kim and C. Ahn, “Effect of Combined Use of Flipped Learning and Inquiry-Based Learning on a System Modeling and Control Course,” *IEEE Transactions on Education*, vol. 61, no. 2, pp. 136–142, May 2018, doi: 10.1109/TE.2017.2774194.
35. P. Guo, N. Saab, L. S. Post, and W. Admiraal, “A review of project-based learning in higher education: Student outcomes and measures,” *Int J Educ Res*, vol. 102, Jan. 2020, doi: 10.1016/j.ijer.2020.101586.