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Problem-Based Learning dan *Flipped Classroom*: Dapatkah Meningkatkan Prestasi Siswa?

Lutfiyati Mardiyah[1*], Anis Sunarsi[2]
[1,2]SMK Negeri 6 Surakarta, Indonesia
E-mail: diyahlupi03@gmail.com[1], 44nniesz@gmail.com[2]

Abstrak

Rendahnya prestasi belajar siswa masih menjadi permasalahan dalam dunia pendidikan. Penerapan model pembelajaran yang kurang inovatif menjadi permasalahan utama. Penelitian ini bertujuan untuk menguji: (1) perbedaan pengaruh model pembelajaran gabungan Problem Based Learning dengan Flipped Classroom dan model pembelajaran Problem Based Learning terhadap prestasi belajar siswa; (2) perbedaan pengaruh kemampuan akademik terhadap prestasi belajar siswa; dan (3) pengaruh interaksi model pembelajaran dan kemampuan akademik terhadap prestasi belajar siswa. Teknik pengambilan sampel menggunakan sistem cluster random sampling. Instrumen yang digunakan adalah tes yang meliputi pretest dan posttest yang berfungsi untuk mengetahui tingkat kemampuan berpikir kritis dan kemampuan akademik siswa. Penelitian ini menggunakan metode eksperimen dengan desain faktorial 2x2 sehingga terbentuk empat kelompok belajar. Teknik analisis data menggunakan uji Two Way Anova dengan frekuensi sel tidak sama. Hasil penelitian menunjukkan bahwa: (1) terdapat perbedaan pengaruh model pembelajaran gabungan Problem Based Learning dengan model pembelajaran Flipped Classroom dan Problem Based Learning terhadap prestasi belajar siswa; (2) terdapat perbedaan pengaruh kemampuan akademik terhadap prestasi belajar siswa; dan (3) tidak terdapat pengaruh interaksi antara model pembelajaran dan kemampuan akademik terhadap prestasi belajar siswa. Penelitian ini diharapkan mampu mengatasi permasalahan rendahnya prestasi belajar siswa melalui penerapan model pembelajaran inovatif yang mampu mengembangkan kemampuan akademik siswa.

Kata Kunci: *flipped classroom*, kemampuan akademik siswa, model pembelajaran, prestasi belajar, *problem-based learning*

Problem-Based Learning and Flipped Classroom: Can it Improve Student Achievement?

Abstract

The low learning achievement of students is still a problem in the world of education. The application of learning models by less innovative teachers is the main problem. This study aims to examine: (1) the difference in the effect of the combined learning model of Problem-Based Learning with Flipped Classroom and the Problem-Based Learning learning model on student achievement; (2) differences in the effect of academic ability on student achievement; and (3) the effect of the interaction between learning models and academic abilities on student achievement. The sampling technique used a cluster random sampling system. The instrument used was a test which includes a pretest and posttest which functions to determine the level of students' critical thinking skills and academic abilities. This study used an experimental method with a 2x2 factorial design so that four learning groups were formed. The data analysis technique used the Two-Way ANOVA test with unequal cell frequencies. The results of the study show that: (1) there were differences in the effect of the combined learning model of Problem-Based Learning with Flipped Classroom and Problem-Based Learning learning models on student achievement; (2) there were differences in the effect of academic ability on student achievement; and (3) there was no interaction effect between learning models and academic abilities on student achievement. This research is expected to be able to overcome the problem of low student achievement through the application of innovative learning models that can develop students' academic abilities.

Keywords: *flipped classroom; learning achievement; learning model; problem-based learning; students' academic abilities*

INTRODUCTION

Education aims to change a person's character and develop all of his potential abilities to advance the country as a whole in the long term (Nurkholis, 2013). If all the potential of these students can be used consistently to advance national development, then this is certainly a good thing. The existence of a quality learning process can also be evidence of great human resources. Three dimensions, namely the cognitive, emotive, and psychomotor domains can be used to evaluate the quality of learning (Magdalena, Islami, Rasid, & Diasty, 2020). One way that can be used to measure the cognitive domain is through student achievement (Djazari & Sagoro, 2011; Nabilah, Stepanus, & Hamdani, 2020; Prasetya, 2012; Putri, Susiani, Wandani, & Putri, 2022).

However, the data shows that overall, the learning achievement of Indonesian students aged 15 is in the bottom 10th out of 79 countries surveyed by the Organization for Economic Cooperation and Development (OECD) in 2019 in three subjects, namely mathematics, reading, and science. One of the factors that influence learning achievement is the academic ability of students (Basri, 2022; Briones, Dagamac, David, & Landerio, 2022; Lastri, Kartikowati, & Sumarno, 2020). Academic ability is the personal mastery of knowledge acquired through formal schooling (T. H. Setiawan & Aden, 2020). Students in the high academic group have strong basic knowledge that can help them achieve better learning achievements than students with medium and low academic abilities (Mahanal, Zubaidah, Sumiati, Sari, & Ismirawati, 2019). Therefore, academic ability is a factor that teachers need to pay attention to when choosing a learning model so that there is no gap in learning achievement between students.

Based on the results of initial observations at a Surakarta Vocational School, shows that learning achievement in mathematics is relatively low. Mathematics is a subject that is considered difficult and uninteresting so the learning achievement of students in class X PM is low. This is shown by the achievement data of the X PM class students under the Learning Objectives Achievement Criteria (KKTP). The results of the formative mathematics assessment in class X PM 1 out of 36 students were 66.67% which had not been completed namely 24 students while in class X PM 2 out of 36 students there were 55.55% which had not been completed namely 20 students so that the average achievement of both classes of 61.11%. Furthermore, the categorization of academic abilities is based on the Riinawati formula (Riinawati, 2021) shows that students who have high academic ability get good and sufficient criteria, while students who have low academic ability get less and very less criteria, and students who have low academic ability get very lacking criteria. This shows that there is a gap in academic abilities between students who have high, medium, and low academic abilities. In addition, based on the results of observations during class learning, the condition of learning mathematics in class is still conventional by using lectures, students are less active and creative, the learning process uses the Teacher-Centered Learning (TCL) approach as if the teacher is a source of information, and students only listening to the explanation from the teacher without any feedback from the students themselves.

Education is an alternative way to solve problems and problems faced by a country to continue to improve the quality of education both in terms of the learning process and human resources (Istanto, 2014). To achieve this, the development of education must at least lead to a constructivist view of learning. Gita & Apsari (2017) argue that the Problem-Based Learning (PBL) learning model is a learning model that adheres to constructivist concepts involving students in learning to solve problems in real life. Research conducted by Syamsiah, Latri, & Fadillah (2022); Rahmawatiningrum, Kusmayadi, & Fitriana (2018); Jamaan, Musnir, & Syarial (2020) shows that the application of the PBL learning model can improve learning achievement. The learning process does not only involve the PBL learning model but can be combined with certain learning models, one of which is flipped classroom learning (Tsai, Shen, & Lu, 2015).

The concept of the Flipped classroom model is to reverse learning activities in class with assignment activities carried out at home (Al-Samarraie, Shamsuddin, & Alzahrani, 2019). Learning material will be studied by students at home through learning content that has been provided by the teacher which is generally in the form of learning videos, while learning in class will be focused on group discussion and problem-solving activities (Sailer & Sailer, 2021). The flipped classroom model is based on the scaffolding theory initiated by Jerome Bruner. In the flipped classroom there is the

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concept of scaffolding, namely the interaction between students and the teacher or between students and the subject matter provided by the teacher. In-class contact between students and teachers can be improved by using a flipped classroom. Learners' understanding of the subject matter will increase as a result of the exchange of information and knowledge during this engagement (Al-Samarraie et al., 2019; Awidi & Paynter, 2018). Bruner argues that interpersonal interaction can help students become more adept at solving problems (Nantha, Pimdee, & Sitthiworachart, 2022). In addition, Flipped classroom engages students in enhancing their learning (Sailer & Sailer, 2021). Based on these benefits, it is hoped that the flipped classroom will be able to strengthen the shortcomings of the PBL model and improve student learning achievement.

The Problem-Based Learning (PBL) model combined with the flipped classroom is a learning approach that can be used to overcome the problem of low student achievement. PBL can hone learning achievement analysis, synthesis, assessment, and conclusion (Tsai et al., 2015), while the Flipped classroom is a form of blended learning that utilizes technology in the form of learning videos in its implementation (Al-Samarraie et al., 2019). Based on these characteristics, the combination of the two learning models is thought to have the potential to improve student achievement. Based on the explanation of the two learning above, both the PBL and Flipped classroom learning models increase learning achievement. If the two studies are combined, it will produce better learning achievement than using only one type of learning model.

About learning mathematics, material in learning mathematics cannot only be taught in theory but also requires examples of actual application so that students master the material and can apply it well when working later. PBL can accommodate these needs through the actual problems contained therein. PBL will make students aware of the relationship between classroom learning and actual implementation in the real world, as well as provide relevant experiences for them in the process of integrating new knowledge and concepts (Gita & Apsari, 2017). The existence of group discussion activities in this model is also expected to be a means of peer tutoring where students in high academic groups can help students in medium and low academic groups to better understand the material.

Research by Wahyu, Kurnia, & Syaadah (2018) shows that PBL succeeded in growing learning achievement. This, according to Wahyu et al. (2018), occurs because of the ability of the PBL model to increase students' motivation, help them concentrate on actual problems, and encourage them to carry out investigations with a scientific mindset. The findings of this study are in line with the findings of Narmaditya & Winarning (2017) who found that PBL can improve student learning achievement and problem-solving. A study by Paryanto, Hidayat, & Harjanto (2019) and by Aidoo & Boateng (2016) shows that PBL is very helpful in increasing learning achievement in terms of the capacity to debate, gather information, ask questions, and draw conclusions.

Based on the research of Haruehansawasin & Kiattikomol (2017), the PBL learning model is more suitable for children with high academic abilities. If PBL is used on students who have low academic abilities and are not motivated to learn, it will become a particular difficulty. Haruehansawasin & Kiattikomol (2017) also demonstrate how to implement the PBL learning model so that it can be followed by all students, even for students who have low academic ability by using scaffolding in learning. The most effective scaffolding for PBL implementation is group work. Through group collaboration, students have the opportunity to play a more active role in class.

This study tries to combine the PBL model with the Flipped classroom model to overcome the shortcomings of the PBL model. Research by Tawfik & Lilly (2015) and Ramadhani, Umam, Abdurrahman, & Syazali (2019) found that the Flipped classroom model can support the success of PBL in assisting problem-solving processes, and cognitive skills, and training students to always think analytically, and be creative in learning. Research by Damayanti, Santyasa, & Sudiatmika (2020) states that the combination of the PBL model with the Flipped classroom has a significant effect on the ability to think creatively. Furthermore, research by Bintang, Darnah, & Masta (2020) produces a combined PBL-FC learning model capable of increasing conceptual, procedural, and metacognitive knowledge in learning. The novelty of this study is the combination of the PBL-FC learning model which, to the best of the researchers' knowledge, has not been widely studied to date. This study will also examine whether the combination of the PBL-FC model can reduce the learning achievement gaps of the high, medium, and low academic groups.

METHOD

A quantitative research approach is used in this research. This research is experimental research, namely research that examines the effects of a given treatment by considering other factors that might influence the research results (Cresswell, 2014). This study uses a 3x2 factorial design. In a factorial design, the sample is randomly selected and given a pretest before being given a treatment (Sugiyono, 2016). The following is the factorial design used in this study.

Table 1. Research design

Academic Ability (A)	Learning model (B)	
	PBL-FC (b_1)	PBL (b_2)
High Academic Ability (a_1)	a_1b_1	a_1b_2
Moderate Academic Ability (a_2)	a_2b_1	a_2b_2
Low Academic Ability (a_3)	a_3b_1	a_3b_2

The population in this study were 211 students in the marketing expertise competence of SMKN 6 Surakarta. The sample in this study will be taken in as many as 2 classes, namely class X PM 1 and X PM 2. The sampling technique uses cluster random sampling. Two classes will be taken randomly with one class as the experimental class and one class as the control class. The sample obtained must then undergo an equivalence test to see whether the two classes to be studied have equal abilities. This equivalence test uses the t-test. Prerequisite tests that must be carried out before the equivalence test include normality and homogeneity tests.

The normality test used in this study is the Shapiro-Wilk test. The significance level used was 0.05. If the significance value is > 0.05, it is concluded that the data comes from a normally distributed population. The results of the normality test showed that the significance value for class X PM 1 was 0.145 and class X PM 2 was 0.125. The value of the two classes is greater than 0.05, meaning that the learning achievement data for the two classes is normally distributed. Furthermore, the data will undergo a homogeneity test.

The homogeneity test used in this study is the Levene test. Testing using the help of SPSS 25 Software with a significance level of 0.05. The homogeneity test results show a significance value of 0.383. This value is greater than the significance level of 0.05, so it can be concluded that the data on the learning outcomes of the two classes is homogeneous. Furthermore, after the data is declared to be normally distributed and homogeneous, a t-test can be performed in the form of an Independent Sample T-Test with a significance level of 0.05. The following are the results of the t-test in this study.

Table 2. Class X PM 1 and X PM 2 Equivalence Test Results

t-test for Equality of Means				
t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
-1.038	60	.303	-871	.807
-1.038	57.992	.304	-871	.808

Based on the table above, the significance values for the two classes were 0.303 and 0.304 or greater than 0.05 so it can be concluded that classes X PM 1 and X PM 2 have equivalent abilities. Each class is then divided into three groups, namely groups of students with high, medium, and low academic abilities. The grouping was carried out using the Odd Semester Summative Assessment value data for the 2022/2023 Academic Year. Based on the calculation results, it was obtained that the X PM 1 class group consisted of 4 students who had low academic abilities, 21 moderate academic abilities, and 6 high academic abilities. The class X PM 2 group consisted of 3 students with high academic ability, 25 students with medium academic ability, and 3 students with low academic ability. Even though they are divided into several groups, all students in one class will receive the same treatment. This study measures the learning achievement and academic abilities of students. Data on learning achievement and academic ability variables in this study were collected through pretest and posttest questions that students had to work on. Based on the results of the pretest and posttest, students' scores will be known to produce quantitative data types that must be tested using statistical calculations.

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This study measured the variables of student achievement and academic ability. Data on learning achievement and academic ability variables in this study were collected through pretest and posttest questions. Based on the results of the pretest and posttest, it will be known the scores or grades of the students to produce a type of quantitative data that must be tested using statistical calculations. To determine student achievement and academic ability, an instrument is used in the form of a test. The instrument used was the pretest sheet which was given before the treatment and the posttest sheet which was given after the treatment. The results of the pretest and posttest will be analyzed to see which learning model makes a significant (significant) difference in learning achievement. The results of the pretest and posttest will also be compared between high, medium, and low academic groups. The form of the test in this study is a matter of description that is adjusted to the learning achievement indicators.

RESULTS

Research result

The data in this study are in the form of learning achievement test scores consisting of pretest and posttest. The pretest and posttest questions were in the form of multiple-choice written questions totaling 30 questions on trigonometry material. The data was taken from two classes with a total sample of 72 students from class X Marketing 1 and X Marketing 2 SMK Negeri 6 Surakarta for the 2022/2023 academic year. The results of the determination randomly obtained class X Marketing 1 as the experimental class and would apply the PBL-FC learning model and class X Marketing 2 as the control class would apply PBL learning. Data on the results of the pretest learning achievement of students with high academic ability (high KA), moderate academic ability (moderate KA), and low academic ability (low KA) in the PBL-FC and PBL combination learning model are presented in the following table.

Table 4. Distribution of Pretest Results of Students with High, Medium, and Low Academic Ability Based on the Learning Model

Interval	PBL-FC Combination Learning Model			PBL Learning Model		
	High Academic Ability	Moderate Academic Ability	Low Academic Ability	High Academic Ability	Moderate Academic Ability	Low Academic Ability
31-35		1	2		1	1
36-40		1	3		3	2
41-45		2	4		1	2
46-50		0			1	
51-55	2	6		4	7	
56-60	3	4		2	6	
61-65	5	3		3	3	
Total	10	17	9	9	22	5

Table 4 shows the distribution of pretest scores of students with different academic abilities in different learning models. The maximum pretest score obtained by students in the PBL-FC combination class respectively, namely the high and medium academic groups reached the 61-65 range of 5 and 3 students, and the low academic group reached the 31-35 range with 1 and 2 students. Meanwhile, the maximum pretest scores obtained by students in PBL classes respectively were the high and medium academic groups reaching the range of 61-65 with the number of 3 students each, while the low academic group achieved the range of 31-35 each amounted to 1 learner.

The frequency distribution of the highest pretest scores in the PBL-FC combination class respectively, namely the high academic group occupies the range 61-65 with a total of 5 students, the medium academic group occupies the range 51-55 with 6 students, and the low academic group occupies the range 41-45 with a total of 4 students. The frequency distribution of the highest pretest scores for PBL classes respectively is the high and medium academic groups reaching the 51-55 range of 4 and 7 students respectively, and the low academic group occupying the 36-40 and 41-45 ranges of 2 for each learner.

Data on the results of the posttest learning achievement of students with high academic ability, moderate academic ability, and low academic ability in the PBL-FC and PBL combination learning model are presented in Table 5 below:

Table 5. Distribution of Posttest Results of Students with High, Medium, and Low Academic Ability Based on the Learning Model

Interval	PBL-FC Combination Learning Model			PBL Learning Model		
	High Academic Ability	Moderate Academic Ability	High Academic Ability	Moderate Academic Ability	High Academic Ability	Low Academic Ability
61-65			2			1
66-70		1	3		3	2
71-75		6	2		4	2
76-80	1	7	1	1	4	1
81-85	1	3		2	4	
86-90	5	1		4	3	
91-95	2	2		3	2	
Total	9	20	8	10	20	6

Table 5 shows the distribution of the posttest scores of students with high, medium, and low academic abilities in the PBL-FC and PBL combination learning models. The maximum posttest scores achieved by students in the PBL-FC combination learning model were high and moderate academic ability reaching the range of 91-95 with 2 students each. While low academic ability reaches a maximum value in the range of 76-80 for 1 student. The maximum post-test scores in the PBL learning model are high and moderate academic ability reaching the range of 91-95 with a total of 3 and 1 student respectively, while low academic ability reaches a maximum value in the 76-80 range of 1 student.

Furthermore, the highest distribution of posttest scores was in the PBL-FC combination learning model, namely, the high academic group occupied the 86-90 range with a total of 5 students, the medium academic group occupied the 76-80 range of 7 students, and the low academic group occupied the 76-80 range. 66-70 as many as 3 students. The frequency distribution of the most posttest scores in the PBL class at high academic ability occupies the range 86-90 for 4 students, the moderate academic group occupies the range 71-75, 76-80, and 81-85 each for 4 students, and the academic group low students occupy the range 66-70 and 71-75 each with 2 students.

A comparison of the average pretest and posttest scores of students' learning achievement in classes using the PBL-FC combination learning model and classes using the PBL learning model is presented in the following table:

Table 6. Comparison of Average Pretest and Posttest Scores of Student Achievement in the PBL-FC and PBL Learning Models

Learning Model	*Pretest*	*Posttest*	Difference
PBL-FC	47.31	82.28	34.97
PBL	49.14	76.92	27.92

Table 6 shows the difference in mean or average pretest and posttest scores of students' learning outcomes. The mean was calculated using SPSS 25 software. The calculation results showed that the average pretest value for the PBL-FC combination class was 47.31, while the PBL class was 49.14. The posttest scores in the PBL-FC combination class reached an average of 82.28, while those in the PBL class achieved an average of 76.92. The difference in the average pretest and posttest scores in the PBL-FC model combination class was 34.96, while the difference in the PBL class was 26.67. This shows that students who are taught using a combination of the PBL-FC learning model have higher learning achievements than students who are taught using the PBL model.

A comparison of the average pretest and posttest scores of students' learning achievement at high, medium, and low academic ability is presented in the following table:

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Table 7. Comparison of Average Pretest and Posttest Scores of Students' Learning Achievement Based on Academic Ability

Academic Ability	Pretest	Posttest	Difference
High	56,67	87,22	30,55
Moderate	48,22	76,35	28,13
Low	36,15	68,38	32,23

Based on Table 7, shows that the average pretest score for the high academic group is 56.67, while the average posttest score reaches 87.22. The moderate academic group obtained an average pretest score of 48.82, while the posttest average reached 76.35. The low academic group obtained an average pretest score of 36.15, while the average posttest score reached 68.38. The difference in the average pretest and posttest scores for the high academic group was 30.55, the medium academic group was 28.13, and the low academic group was 32.23. These results indicate that the average pretest score of the high academic group's learning achievement is better than the medium and low academic groups. The high academic group got an average score of 56.67, the medium academic group got 48.22, and the low academic group got 36.15. The average posttest score for the high academic group was also better than the medium and low academic group, which was 87.22, while the medium academic group was 76.35, and the low academic group was 68.38.

A comparison of the average pretest and posttest scores of students with high, medium, and low academic abilities in the PBL-FC and PBL learning models is presented in the following table:

Table 8. Comparison of the Average Increase in Pretest and Posttest Scores of High, Medium, and Low Academic Ability Students in the PBL-FC and PBL Learning Models

Learning Model	Academic Ability	Pretest	Posttest	Difference	Enhancement
PBL-FC	Low Academic Ability	37,24	70,50	33,26	Highest
	High Academic Ability	58,51	89,30	30,79	Moderate
	Moderate Academic Ability	50,26	78,25	27,99	Lowest
PBL	Moderate Academic Ability	48,28	78,35	30,07	Highest
	High Academic Ability	54,83	83,14	28,31	Moderate
	Low Academic Ability	35,06	61,16	26,10	Lowest

Table 8 shows an increase in the average pretest to posttest learning achievement of students with high, medium, and low academic abilities in the PBL-FC and PBL learning models. The difference in the average pretest and posttest scores of learning achievement in the PBL-FC learning model is the highest achieved by low academic ability of 33.26. The second increase was achieved by a high academic ability of 30.79. The lowest increase was obtained by a moderate academic ability of 27.99. The difference between the average pretest and posttest scores of students' learning achievement in the PBL learning model is the highest achieved by moderate academic ability of 30.07. The second increase achieved a high academic ability of 28.31. The lowest increase was obtained by a low academic ability of 26.10.

Hypothesis Testing

Before entering into hypothesis testing, please note that this study used a 3x2 factorial design with the averages between cells, and between columns, and the marginal averages are shown in the following Table 9.

Table 9. Factorial Research Design

Academic Ability	PBL-FC combination	PBL	Marginal Average
High	85,1667	85,0000	85,5834
Moderate	76,9524	74,0000	75,4762
Low	71,0000	57,6667	64,3334
Marginal Average	77,7742	73,4839	75.131

Based on Table 9, it is obtained that the marginal average of the PBL-FC learning model is 77.77 or greater than the PBL learning model which only reaches 73.48. Then the marginal average of students with high academic abilities is 85.58, greater than medium and low academic abilities. For students with moderate academic abilities who only reach a marginal average of 75.48 and low students reach 64.33.

Test the hypothesis in this study using Analysis of Variance (ANOVA). ANOVA aims to determine whether there are differences in the effect of several treatments (factors) of the independent variables on the dependent variable. The ANOVA test used in this study is a two-way ANOVA. There are 3 results of hypothesis testing in this study, including 1) Differences in the effect of the PBL-FC learning model and the PBL learning model on learning achievement; 2) Differences in the effect of academic ability on learning achievement; 3) The effect of the interaction of learning models and academic ability on learning achievement.

Table 10. ANOVA Test Results of Student Learning Achievement

Information	df	Average	F	Sig.
Academic ability	2	794.890	17.536	0.000
Learning model	1	231.163	5.100	0.000
Academic ability and learning model	2	95.190	2.100	0.000

Based on the results of the two-way ANOVA statistical test in the table above, the learning model significance value is 0.028 or less than 0.05 (0.028 < 0.05). Then the test decision stated that Ho was rejected and H1 was accepted. This means that there are differences in the effect of the PBL-FC combination learning model and the PBL model on learning achievement. Furthermore, the significance value of academic ability is 0.000 or less than 0.05 (0.000 <0.05). Then the test decision stated that Ho was rejected and H1 was accepted. This means that there are differences in the effect of academic ability on student achievement. Meanwhile, based on Table 10, the significant value of the interaction effect of academic abilities and learning models on learning achievement was obtained by 0.132 or greater than 0.05 (0.132 > 0.05). Then the test decision stated that Ho was accepted and H1 was rejected. This means that there is no interaction effect between academic abilities and learning models on student achievement.

Post-ANOVA Follow-Up Test

The results of the hypothesis testing of the first hypothesis and the second hypothesis resulted in a decision that Ho was rejected and H1 was accepted. This shows that there are differences in the effect of the treatment given. However, it is not yet known which treatment is significantly different from the others. Therefore it is necessary to carry out a post-Anova post-test. Meanwhile, the results of hypothesis testing for the third hypothesis resulted in a decision that Ho was accepted and H1 was rejected. Then post-ANOVA follow-up tests cannot be carried out because the results of hypothesis testing indicate that there is no interaction effect.

The post-ANOVA follow-up test in this study used the Scheffe test. The advantage of the Scheffe test is that it is easier to use than other advanced tests and the most stringent (Budiyono, 2016: 201). The post-Anova follow-up test is used to test learning models and academic abilities.

a. Differences in the Effect of Learning Models on Learning Achievement

The post-ANOVA follow-up test in this section is used to determine the effect of which learning model is stronger on student achievement. This study used two different learning models, namely the Problem-Based Learning combined learning model with Flipped Classroom (PBL-FC) and the Problem-Based Learning (PBL) learning model. The results of the post-ANOVA follow-up test on the effect of the learning model on learning achievement are shown in Table 11.

Table 11. Hasil Advanced Test of Learning Model on Learning Achievement

Learning Model	Mean	Std. Error
PBL-FC	77.708	1.528
PBL	72.202	1.885

Based on Table 11, it is known that the PBL learning model combined with the Flipped classroom (PBL-FC) has a higher average value (mean) than the PBL learning model. The average

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PBL combination learning model with a flipped classroom is 77,708, while the PBL learning model is only 72,202. Based on these results, it can be concluded that the PBL learning model combined with Flipped classrooms is better at increasing student learning achievement than the PBL learning model that is not combined.

b. Differences in the Effect of High, Medium, and Low Academic Ability on Learning Achievement

The post-ANOVA follow-up test in this section is used to test the effect of students' academic ability on learning achievement. Academic ability in this study was divided into three types, namely high, medium, and low academic ability. The results of post-ANOVA follow-up tests on the effect of the learning model on learning achievement are shown in Table 12.

Table 12. Results of advanced test of academic ability on learning achievement

Academic Ability	Average Difference (Mean)	Sig.	Conclusion
High-Moderate	9,76	0,001	There is a difference
High-Low	19,83	0,000	There is a difference
Moderate-Low	10,06	0,002	There is a difference

Based on Table 12, it is found that high and moderate academic abilities have a significance value of 0.001 or less than 0.05 (0.001 <0.05). This shows that there is a difference in the effect of the high academic ability group and the moderate academic ability level on learning achievement. Referring to Table 9, the marginal average of high academic ability is 85.58, higher than moderate academic ability which is only 75.47. So it can be concluded that students with high academic abilities have better learning achievements than students with moderate academic abilities.

Furthermore, between high and low academic abilities obtain a significance value of 0.000 or less than 0.05 (0.000 <0.05). This shows that there is a difference in the effect of the high academic ability group and the low academic group on learning achievement. Referring to Table 9, it is known that the marginal average of students with high academic ability is 85.58 or higher than that of low academic ability which is only 64.33. So it can be concluded that students with high academic ability have better learning achievement than students with low academic ability.

Meanwhile, between moderate and low academic abilities obtained a significance value of 0.002 or less than 0.05 (0.002 <0.05). This shows that there is a difference in the effect of moderate academic ability levels and low academic ability levels on learning achievement. Referring to Table 9, the average marginal average of the medium academic group was 74.48, higher than the low academic group which was only 64.34. So it can be concluded that students with moderate academic ability have better learning achievement than students with low academic ability.

DISCUSSION

Differences in the Effect of the Combination Learning Model of Problem-Based Learning with Flipped Classroom and Problem-Based Learning Models on Learning Achievement

The results of the ANOVA test show that there are differences in the effect of the learning model on learning achievement. The post-ANOVA test results using the Scheffe method showed that the PBL-FC combination learning model was able to improve student achievement better than the PBL model. These results can be seen from the average post-test score of students in the experimental class which is higher than students in the control class. PBL learning is learning that focuses on real-life problems to find the best solutions and solutions based on group work analysis. Student achievement will be better if it is supported by other learning, namely the Flipped Classroom learning strategy which can be combined with the PBL model.

Research by Rombe, Alberta, Yogaswara, & Surbakti (2021) mentions the shortcomings of the PBL model, namely learning material is completely new material and students are not allowed to study it beforehand. This made the discussion process less than optimal because of the limited knowledge of each group member. The combination of the PBL-FC model seems to be able to overcome these problems. Based on the observations of researchers, when learning in class, students in the PBL-FC

class are better prepared to solve problems than those in the PBL class. The discussion process also runs more optimally because each student already has the provision of knowledge that they can study learning content at home. The existence of learning content in the form of videos in the PBL-FC learning model is also very useful for students in understanding the material and solving problems. Students can repeat and pause certain parts of the video that they don't understand. Students can also reopen the video to find solutions in dealing with the complexity of problems when the material or concepts are not explained directly by the teacher. The information in the video helps them find solutions to the problems they have to solve, therefore, learning content in the form of videos is also a form of scaffolding provided by the teacher.

This research supports research by Wahyu et al. (2018) which states that the PBL model has a strong influence on learning achievement, and research by Syahrul & Kulsuum (2020) which states that flipped classroom learning affects learning achievement. This means that the PBL and flipped classroom learning models can both improve learning achievement, but this study shows that the PBL model combined with the flipped classroom produces better learning achievement than using only the PBL model.

Differences in the Effect of High, Medium, and Low Academic Ability on Learning Achievement

The results of the ANOVA test show that there are differences in the effect of academic ability on learning achievement. The results of the post-ANOVA test with the Scheffe method showed that students with high academic ability had better academic achievement than students with moderate and low academic ability. Students with moderate academic ability have better academic achievement than students with low academic ability. However, even though students with high academic ability had better academic achievement, it was found that the average increase in pretest and post-test scores of students with low academic ability was higher than that of high and medium academic ability. This fact indicates the scaffolding process that is given when learning is running optimally. The form of scaffolding found in both learning models is a group discussion process that creates interaction between students with high, medium, and low academic abilities. This interaction can encourage the activities of peer tutors in high academic groups and can help medium and low academic groups to better understand the material.

Peer tutoring facilities help students with moderate and low academic abilities maximize the zone of proximal development, namely, the zone that connects current student knowledge and potential knowledge that can be maximized through the help of others such as teachers, parents, or peers who are more intelligent (Awidi & Paynter, 2018). These results are to the research of Gita & Apsari (2017) which states that scaffolding in the form of student interaction with their environment can encourage the zone of proximal development which is the key to learning. This study corroborates the research results of Gayatri, Jekti, & Jufri (2013) which state that academic ability influences learning achievement and problem-solving abilities. The results of this study also corroborate the results of Shi & Qu' (2022) which states that academic ability affects the learning achievement of students.

Effect of Interaction Learning Model and Academic Ability on Learning Achievement

The results of the ANOVA test show that there is no interaction effect of learning models and students' academic abilities on learning achievement. This is presumably due to the very limited number of research samples, namely only two classes with a total of 72 students. The limited number of samples resulted in the sample being very homogeneous so it was suspected that there was no interaction effect of the learning model and students' academic abilities on learning achievement. Andrade (2020) explains that a sample that is too small will not have sufficient statistical test power to answer the research problem formulation. The results of the hypothesis testing that were not statistically significant could just be due to inadequate sample size. As a result, there will be a type II error which has a significant effect but the statistical analysis fails to show this effect due to a lack of power so the null hypothesis is incorrectly accepted.

Research by Ramadhani et al., (2019) also used a very limited sample, namely 61 students who were allocated to two classes, namely the experimental class with 33 students and the control class with 29 students. This research also resulted in no interaction effect between learning models and academic abilities on student learning outcomes. It was also explained that the experimental class obtained better

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learning outcomes than the control class at high, medium, and low academic levels.

The results of this study corroborate Setiawan's research results (2020) which state that there is no interaction effect of learning models and academic abilities on learning achievement. Setiawan's research differences from this research is Setiawan's research uses conventional learning models, metacognitive constructivists, and novice constructivists, while in this study using a combination model of PBL-FC and PBL models.

CONCLUSION

Based on the results of data analysis and research discussion, it can be concluded that: 1) there were differences in the effect of the PBL-FC combination learning model and the PBL learning model on learning achievement. The PBL-FC combination learning model has more potential to improve student achievement than the PBL learning model; 2) there were differences in the effect of academic ability on learning achievement. Students with high academic abilities have better learning achievements than students with moderate and low academic abilities; 3) there was no interaction effect of learning models and academic abilities on learning achievement. The learning model and academic abilities together do not have a significant effect on student achievement. This study proves that the PBL-FC learning model can theoretically improve learning achievement better than the PBL model. This study proves that the constructivism theory contained in the PBL-FC combination syntax can develop student achievement. This study also proves that theoretically, students in the high academic group have better academic achievement than students in the medium and low academic groups. The results of this study also provide information that there is no interaction effect between learning models and academic ability on student achievement. The application of the PBL-FC combination learning model can be used as an alternative learning model that can increase learning achievement in learning mathematics, even an increase in the average value of pretest to posttest shows that the low academic ability group experienced the highest increase compared to medium and high academic ability. During the learning process, students also become more active and enthusiastic. The discussion process, which was initially dominated by students with high academic abilities, slowly began to be joined by students with moderate and low academic abilities

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