

Project-Based with Flipped Learning: A Challenge to Enhance Students' Achievement on Chemistry

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Abstract—Chemistry learning at high school should be able to facilitate students to solve real-world problems and improve their learning achievement. However, the reality of students' achievement is still low, which is reflected in the results of the 2019 chemistry national evaluation. For this reason, improving the quality of the learning process is a must. One of the innovative models is project-based learning model (PjBL). Taking a long time to implement is one of the weaknesses of the PjBL model. However, this can be overcome by combining PjBL with flipped learning, so that it becomes a project-based flipped learning (PjBFL) model. This study aims to describe the effect of PjBFL model on student achievement in learning chemistry at high school. This quasi-experimental study used the pretest-posttest non-equivalent control group design. The population was 4 classes (119 students) grade XI students of SMAN 1 Bebandem Karangasem Bali. Two classes of sample were selected by random assignment technique. Students' achievement data was collected by an expanded multiple-choice test. Research data were then analysed by ANOVA. The results showed significant differences in students' achievement between students who learned with the PjBFL model and those who learned with DFL. Students' achievement in learning with PjBFL ($M = 38.7667$; $SD = 5.79348$) is significantly higher compared to those learning with DFL ($M = 34.5333$; $SD = 8.32004$). Chemistry learning in 11th grade student with PjBFL was effectively enhanced the students' achievement.

Keywords—project based flipped learning, direct flipped learning, students' achievement

I. INTRODUCTION

The problems in learning chemistry at high school are the huge number of basic chemistry competencies that should be achieved in relatively short time. This causes the class does not provide opportunities for student to develop thinking skills. moreover, many chemical concepts are classified as difficult and abstract concepts. With the characteristics of such concepts, it takes more time to understand them, while the time available is very limited. In addition, the readiness of student to learn is inadequate, so that students have difficulty being actively involved in mutual discussion. Meanwhile, students spend more time for playing gadgets at home without learning. the lack of application of chemistry knowledge in everyday

contexts is another weakness in learning chemistry. due to time constraints, students were finally assigned to do problem solving at home, without guidance from the teacher.

Finally, the weakness of teachers in teaching chemistry in high school makes learning take place in a direct mode, where the teacher becomes more active than students [1]. Sixth, the learning strategies applied in chemistry learning have not facilitated students to practice critical thinking skills, since the methods used are still conventional, teacher-centred learning, and less technology is used [2]. As a result, the results of the 2019 high school level chemistry national exam obtained an average score 50.99 [3]. The low national exam result indicates students know the concept but cannot apply it in answering questions or solving problems.

These learning problems cannot be overcome by changing the learning time in class because it is in accordance with the applicable curriculum structure, but the learning model can be changed. The model needed is a model that can optimize face-to-face time and stimulate students to work on chemistry itself through real-world projects. The appropriate learning model is the Project Based Flipped Learning (PjBFL) model.

The PjBFL model is a learning model that combines the Project Based Learning model with the flipped classroom strategy. The differences between the PjBFL and Direct Flipped Learning (DFL) models can be described as in figure 1.

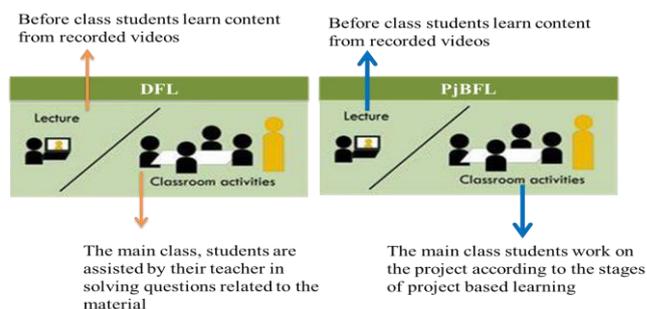


Fig. 1. DFL v.s PjBFL [4].

The steps of the Project Based Flipped Learning model [5] are presented in Table I.

TABLE I. LEARNING STEPS WITH PROJECT BASED FLIPPED LEARNING MODEL

Steps	Before class	During class	After class
I	Starting with essential questions and learning materials from videos /ppt / other provided by the teacher The teacher stimulates students to analyze the video so that it can stimulate students' critical thinking	Students present and share the problems they get after watching the video The teacher evaluates, provides input and motivates students Learners plan and design project plans	Learners decide on a project topic Students make a schedule
II	Students make the project Learners collect data	Project progress monitoring Provide input on projects	Learners improve the project
III	Students complete the project	Test project results Evaluating experience	Prepare reports on project experiments Preparation for assessment of learning outcomes

Many research reports on the successful use of PjBL in learning. Project-based learning showed a positive effect on students' three-dimensional animation learning outcomes [6]. PjBL has a significant positive impact on achievement scores [7]. The creativity of students who are taught using the PjBL model is better than students who are taught using the STAD type cooperative learning model [8]. PjBL learning affects learning outcomes of student to write descriptive text [9]. Students who study physics with PjBL showed higher students' achievement than those who learn with direct instruction [10]. Furthermore, research on the combination of PjBL with the flipped classroom approach has been carried out with results in science subjects showed that the combination of the flipped classroom and the PjBL model has a positive effect on students' critical thinking skills [5]. In addition, a project-based learning approach with flipped classrooms helped in improving students' achievement in learning mathematics in various cognitive styles [11]. Chemistry subjects are in the same subject family as mathematics and science, so that this learning model is expected to give the same effect on chemistry learning achievement.

II. METHODS

The quasi-experimental research was used with a non-equivalent control group pretest-posttest design. The study population was 5 classes (119 students) XI MIPA SMA Negeri 1 Bebandem. The research sample consisted of 2 classes. Learning achievement data were collected using an expanded multiple-choice test. The expanded multiple-choice test consists of 22 items using a rubric with a measurement scale of 0-5 for each item. The instrument has been validated before use. After being tested and considering the content validity,

internal consistency of test items, difference power index, item difficulty index, trick effectiveness and test reliability, 15 items were determined as research instruments. The reliability of the 15 test items was 0.888 including the very high category. The research data were analysed descriptively and analysis of variance (ANOVA). Before testing the hypothesis, an assumption test is carried out, namely the variance homogeneity test and the normality test. All assumption tests are carried out at the 5% significance level.

III. RESULTS AND DISCUSSION

A. Descriptive Analysis Results

This section contains the results of a descriptive analysis of student achievement using a project based flipped learning model and a direct flipped learning model. Furthermore, the explanation is as follows.

Data on the mean score and standard deviation of student achievement from the posttest results (dependent variable) in the 2 groups are presented as follows.

TABLE II. STUDENTS' ACHIEVEMENT DATA

Model	N	M	SD	95% Confidence Interval for Mean		Min	Max
				Lower Bound	Upper Bound		
PjBFL	30	38.7667	5.79348	36.6033	40.9300	27.00	50.00
DFL	30	34.5333	8.32004	31.4266	37.6401	18.00	47.00
Total	60	36.6500	7.42151	34.7328	38.5672	18.00	50.00

A bar chart comparison of the average learning achievement scores of students with the PjBFL and DFL models is presented in Figure 2.

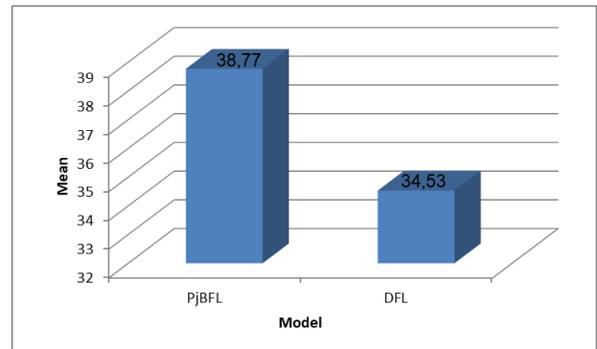


Fig. 2. Students' achievement for each group of learning models.

Based on table II and Fig. 2, the students' achievement with the PjBFL model is significantly different compared to the DFL model. Students' achievement is better in the PjBFL model than the DFL model.

B. Assumption Test Results

Homogeneity testing of variance between independent groups shows that the statistical significance of the Leven's

Test of Equality of Error Variance is greater than 0.05. This means that the variance between learning models in all units of analysis is homogeneous.

Normality test was done using Kolmogorov-Smirnov test and the Shapiro-Wilks test. The tests were carried out on pre-test and post-test data on 2 analysis groups. The result shows that the posttest data has sig > 0.05, which means the data is normally distributed.

C. Anova Test Results

TABLE III. SUMMARY OF MANCOVA ANALYSIS RESULTS

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	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	268.817	1	268.817	5.231	0.026
Within Groups	2980.833	58	51.394		
Total	3249.650	59			

The analysis showed that the statistical value of $F = 5,321$ with a significance value of $\text{sig} = 0.026$. The significance number is smaller than 0.05, so H_0 who states, "there is no difference in students' achievement between students who study with the project-based flipped learning (PjBFL) model and those who learn with direct flipped learning (DFL)", was rejected. In other words, there are significant differences in students' achievement between students who study with the PjBFL model and those who study with DFL. Students' achievement in learning with PjBFL ($M = 38.7667$; $SD = 5.79348$) is significantly higher compared to those learning with DFL ($M = 34.5333$; $SD = 8.32004$).

D. Discussion

The purpose of this study was to analyse differences in chemistry learning achievement between students who studied project-based flipped learning with direct flipped learning. To achieve this goal, the fourth hypothesis testing was carried out using ANOVA analysis and supported by descriptive analysis.

The result is that there are differences in chemistry learning achievement between students learning with the PjBFL model and students learning with the DFL model. The results of further analysis showed that the achievement of chemistry learning achievement was greater in students who studied with the PjBFL model compared to the DFL model.

The results of research on the effect of learning models on learning achievement are in line with the results of research [6-12] which found that students who studied in a project-based learning model had higher academic achievement compared to students who studied in direct instruction or models. conventional learning.

The contribution of flipped learning in this study, both project-based flipped learning and direct flipped learning to learning achievement, is that before learning in class begins, students listen to acid-base material in google classroom by downloading the learning videos provided, listening to, and

studying the learning videos. independently and record important things learned from the video. The activities of students at this stage are reading, listening, seeing pictures / diagrams, watching videos / films, and seeing demonstrations. The contribution of flipped learning in student achievement will not cause a difference between the PjBFL and DFL models because the two groups of students receive the same treatment. The achievement of this stage is in accordance with Dale's cone of experience [13] based on the activities carried out by the absorption of students, which is about 30% of the total knowledge to be achieved. However, the role of flipped learning here is very important, because with flipped learning the problem of limited learning time can be overcome. Especially with a project model that has weaknesses, it takes a relatively long time. The existence of a flipped learning strategy in learning causes students to prepare themselves to learn content before learning so that learning time in class is more effective for project work.

The next stage in PjBFL, students work on student worksheets in groups. Students must dig up information from the videos and literature they have and find solutions to problems given in the LKPD in groups. Activities at this stage are more discussion. According to Dale's cone of experience [13] based on the activities carried out, the absorption of students is about 50% of the knowledge to be achieved. Whereas in DFL students do exercises with student worksheets carried out with teacher guidance. The teacher continuously checks understanding and provides feedback through class discussions. With this stage, students are not given the independence to learn to find their own knowledge. Students only accept the knowledge provided by their teacher without trying to dig from other sources. Based on this, the knowledge acquisition of students is not optimal.

In the next stage, students in the PjBFL model will work on real-world-based projects, while students in the DFL model will work on question exercises guided step by step by the teacher. This stage will have a different impact on student achievement. The achievement in the PjBFL model by working on real-world-based learning projects in accordance with Dale's cone [13] students can absorb at least 90% of knowledge. This is supported by Sani [14] which states that project-based learning is applied to deepen the knowledge and skills obtained by making works or projects related to teaching materials and competencies that are expected to be possessed by students.

Project-based learning is essentially a learning model that places students as builders of the knowledge they have based on previous knowledge. As a result, students become active learners. Students have high academic involvement if they learn with a project-based learning model because they are facilitated with projects that are interesting, challenging, related to everyday life phenomena and relevant to problems in society [15]. High academic involvement if students learn stimulates them to elaborate on the knowledge, they already must complete the project. Besides, students continue to try to dig and collect information to complete their projects, be critical in

responding to new things that are found so that their learning becomes more meaningful.

In the DFL model, students are given training and application of concepts in the form of practice questions that are done independently. This learning is not able to encourage student achievement. The ineffectiveness of the DFL model is due to this model the teacher is more active and minimizes the active involvement of students in learning [1].

Based on this, the DFL model does not provide opportunities for students to achieve deep understanding because students only act as recipients of knowledge. Deep understanding can be achieved if the learning process emphasizes activities to build knowledge and think reflective. Thus, the application of the DFL model also does not provide opportunities for students to reflect on each learning process. Reflection activities are very important to be developed so that students can see their shortcomings as a step to improve the quality of learning.

The implementation of learning in both applications of this model utilizes LKPD as a learning medium. In the DFL model, students are given the opportunity to work on LKPD with the concept of completion that they have previously obtained and are assisted step by step by the teacher. In simpler terms, it can be said that the knowledge of chemical concepts obtained by students is based on the teacher's explanation, reading books and examples given at the LKPD which are then applied to solve problems related to everyday life. Whereas in the PjBFL model students are expected to be able to find their own knowledge to complete the project based on their experience or knowledge by collaborating with their friends accompanied by the teacher. In a learning process like this it gives freedom to students to find and create work products by applying the knowledge they have acquired so that their mastery of knowledge is not only at the understanding stage but has entered a higher stage. This is supported by the opinion of Yao et al. [16,17] who found that project-based learning had a positive impact on the learning procedures of students, was able to increase the capacity and knowledge of students and increase the learning acquisition of students.

The PjBFL model can encourage students to take more and more active roles in learning. This is in accordance with the theory of constructivism, which is student-centred learning. In the learning process, the teacher acts as a facilitator or guide, namely by guiding students in learning without helping in project work. Thus, students themselves identify and define projects that are implemented based on the knowledge they have, and they find from various learning sources.

Unlike the PjBFL model, the implementation of DFL tends to emphasize the learning objectives in the form of increasing knowledge. This learning model emphasizes the results so that information from the teacher can be conveyed to students, either through direct instruction, lectures, or giving assignments to practice questions without having to pay attention to the connection of a concept and knowledge with the real life of the students themselves. Students are not free to

develop their talents and abilities. Learning activities that are truly formal like this are certainly less effective in developing student learning achievement.

Based on this explanation, it can be taken a generalization that the PjBFL model is superior to the DFL model in the achievement of students' chemistry learning achievement. However, in this study there were still several problems related to the achievement of students' chemistry learning achievement. This problem is the achievement of individual chemistry learning achievement scores in the PjBFL model has not reached the very good category for all students. This is caused by several factors as follows.

First, students have not been able to adapt to the PjBFL model. Students have not thoroughly understood the steps of the learning activities they have to do. In addition, so far students are accustomed to getting material directly from the teacher, now they are faced with project-based worksheets and following the steps in the PjBFL model with groups to gain knowledge related to the material discussed.

Second, in accordance with the conceptual foundation of constructivism learning that students can construct knowledge with time allocations which are personal and depend on the cognitive structure of the learners themselves. All learners can achieve their learning goals if they are given the opportunity, but achieved in different ways and at different depths, and at different speeds. In this study, learning was only carried out in a short period of time, so that not all students achieved optimal learning outcomes.

Third, group-based learning can trigger the dependence of students on the group. According to Esminarto et al. [18] on cooperative learning, the success of the group really depends on the members of the group. The habit of depending on the rest of the group had an impact on test results because they were used to collaborating with their peers. In addition, in project-based learning that is done with their groups, students focus more on material related to the project they are working on, other materials that do not contribute to their project are ignored.

IV. CONCLUSIONS

Based on the results, it can be concluded there are significant differences students' achievement between students learn in the PjBFL and DFL models. The students' achievement of them learn in the PjBFL model is greater than them learn in the DFL model. The implication of this finding is that learning chemistry will be more meaningful if the teacher facilitates student learning with a project-based with flipped learning model.

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