The effect of flipped classroom model on student’s physics learning outcome in work and energy concept

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Abstract. This study aims to knowing the effect of 10 grade students of physics learning outcome on concept of work and energy by using flipped classroom model. This research using quasi experimental research design version with non-equivalent control group pre-test and post-test design. The flipped classroom model is a type of learning model that revenge the learning activity, which is in this model students do not get the learning material from teacher in class directly, however they watched video in the class. The data collected with test of learning outcome techniques that earned from pre-test and post-test. The research result shows of student’s outcomes of the students who taught in flipped classroom model higher than the students who taught in conventional model. The result of this study showed that the average score of the students in control class reached 37.53 (pre-test) and reached 70.7 (post-test), however the experiment class reached 37.88 (pre-test) and reached 78.47 (post-test). It was statistically test using t test showed t stat 3.08 and t-table 1.996. Since t stat > t table, H0 was rejected. As the conclusion, flipped classroom model can improve physics learning outcome on concept of work and energy.

1. Introduction

Learning is the process whereby knowledge is created through the transformation of experience. This definition emphasises several critical aspect of the learning process as viewed from experiential perspective [1]. Cognitive theory can be helpful as it relates to the role of information processing and the areas involved in processing such as memory, organization and the cognitive connections a learner makes when processing information it can be argued that, to a great extent, effectiveness of learning can depend on the ability and skills the learner has in making this cognitive connections. An effective learner can make connections. The main area for making connections is between previous learning and new learning and make learning efficient [2]. Model of teaching, like plans, patterns or blueprints, present sequential steps in teaching and learning experiences to bring about a desired outcome in both teachers and pupils [3]. Active learning techniques can help students develop a deeper understanding of the material by requiring students to become engaged in the learning process [4].

In examining physics advances in high school, most students consider physics a difficult and difficult lesson to understand. The higher the level of education the more complex the material that teach. Lack of interest in students' learning on physics resulted in low student physics learning achievement. International learning achievement according to the PISA (Program of International Student Assessment) data in the Indonesian science aspect has increased from 382 points in 2012 to 403 points in 2015 [5]. Nevertheless, Indonesia is still ranked at the bottom 10. While the students' cognitive
abilities in the TIMSS data (Trend in Mathematics and Science Study) TIMSS 2015 results in the field of physics showed Indonesia obtained an average cognitive score of 32% while the international reach 48% this shows that Indonesia is weak in cognitive aspects [6].

Cognitive ability is important to knowledge acquisition, more quickly understanding new ideas and using more effective problem-solving strategies. All these skills are involved in some form or other in educational settings, so it is expected that cognitive ability has a strong relationship with a range of educational outcomes [7].

Implementation of learning in the classroom is one of the main tasks of teachers. However, it doesn’t mean that teacher has more active role than the students. In the conventional teaching pattern the teacher more plays a role while the students only as a listener of the material, so students tend to be passive. The conventional teaching pattern has set students to pay attention to the teaching of teachers in the classroom. Once the material presented is fulfilled students are usually given a homework to show mastery of topics that have been achieved by students as an assessment of success in learning. Usually this kind of teaching pattern, students only study at home if there is homework given by teachers, the rest if the teacher does not give the task then the students will not learn. So that students only learn when the process of teaching and learning process takes place. Things like this will result in students who only learn when the process of Teaching and Learning Activities (KBM) takes place only get a little material compared with students who before the process of Teaching and Learning Activities (KBM) took place first to learn at home. In the implementation of the curriculum 2013 teachers are not as the center of the learner again but the students who serve as the center of learning (student center). But the teacher keeps preparing the materials before the course begins and the teacher is fell free in using the learning model, method or approach as long as the objectives of the Curriculum 2013 are to make the student as the learning center and the students play an active role in the learning process. In explaining a theory, teacher is not easy to explain to students only in the form of language. So that teachers need a medium in the delivery of theory. One of the media that can be used is to utilize technology that is in the form of visualization media in the form of video learning. Models that utilize the media in the form of this video is a model of learning flipped classroom.

Flipped classroom is a strategy that can be provided by educators by minimizing the amount of direct instruction in their teaching practice while maximizing interaction with each other [8]. This strategy utilizes technology that provides additional supporting learning materials for students who can be accessed online and offline provided directly by the teacher a few days before the learning process takes place. In the flipped classroom model, before students start learning in the classroom, students watch the video and learn the material at home where the video that they downloaded can be studied repeatedly, can be displayed at the part that has not understood and write down the material. When there is material that is perceived as less understood by the students, then they can ask directly to educators when the process of learning in class.

There is a shift in face-to-face class time, ranging from teacher-centered interaction to student-centered interaction. So the time to learn in the class is no longer used to discuss the material but used for discussion and working on the matter of matter that is about business and energy. Benefits of using multimedia tools such as videos given to students before the classroom learning are students can watch, play back or speed up according to the needs of each student. Simply put, the flipped classroom is a principled concept for exchanging activities in the classroom such as teacher explanations usually done in the classroom, with activities usually done outside the classroom like doing homework. The Flipped Classroom model is a model where in the learning-teaching not process & students learn the subject matter at home before the class starts and teaching and learning activities in class in the form of doing the task, discuss about the material or problems that students have not understood [9]. The flipped classroom learning model is famous for the term inverted learning model, which is usually in the conventional model, the teacher gives the material in class and when the lesson ends the students are given Homework on the material that has been discussed in the classroom this is used to measure the extent to which the student understands materials that have been obtained during the process of learning in the classroom. In the revised bloom taxonomy in cognitive level, the use of traditional learning model
of time is only used in the classroom where teachers interact with students face to face and produce lower cognitive and understanding grades than students using the flipped classroom model and the use of the flipped model The classroom offers students to engage in higher cognitive levels i.e. application, analysis, evaluation, and synthesis of knowledge [10]. A successful flipped classroom should have three goals: (1) allow the students to become critical thinkers, (2) fully engage students and instructors, and (3) stimulate the development of a deep understanding of the material. The flipped classroom model includes teaching and learning methods that can appeal to all four generations in the academic environment [11]. In addition, many previous studies have demonstrated the advantages of using flipped classroom models: the flipped classroom is effective for testing students' creative attitudes, responsibilities and learning skills [12]. In addition, by having more opportunities to interact and work with individuals, a teacher can easily locate students' point of view and correct misconceptions and validate student learning [13]. CJ Mortensen and AM Nicholson in his research argued that "Many classrooms in higher education are still on a transformative approach to teaching where the students attend lectures and earn course grades through examination. In the modern age, traditional lectures are argued by some as the needs of today's students. An emerging pedagogical approach is the concept of the flipped classroom. The flipped classroom can be asynchronous video lectures on their own and then engaging in active learning during scheduled class times [14]. Nevertheless, it is likely that less motivated students to apply the flipped classroom model were less successful. Because they did not do the instruction the teachers had given and did not watch the home learning videos but they also rarely completed homework in the traditional model [15]. Thus, the teacher should prepare as well as possible, so that when the implementation of students get good learning outcomes. Based on the description that has been exposed, purpose of learning by using the flipped classroom model can affect the learning outcomes of high school physics class X on business and energy materials at 31 Senior High School Jakarta.

2. Experimental method
This research used experimental method quasi experiment type using Non-equivalent Control Group Design. This design is identical to the pre-test post-test design in all respect except for the random assignment of subjects to group. The procedures for this design are the same as for a true design except that intact groups are used which generates the threat of selection (due to lack for randomisation) [16].

2.1. Type, time, place and sample research
This type of research is Quasi Experiment with non-equivalent control group design pre-test and post-test. This research was conducted at SMAN 31 Jakarta from January to February 2018. The population of this research is all students of class X SMAN 31 Jakarta and the sample of this research is X class MIA 4 students as experiment class and class X MIA 1 as control class.

2.2. Research procedures
This research started by doing research preparation that is preparing teaching materials and learning device that will be used. Then survey to the school and form sample of research of collecting data is divided into three stages, that is: first stage is measurement stage of students’ initial ability test (pre-test) in group experiments and control groups. The initial ability test (pre-test) aims to determine the extent to which the subject material that will be taught has been known by the students. The second stage is the treatment of the experimental group with the flipped classroom model with guided discussion and treatment of control classes using the usual model with lecturing, discussion and homework methods. The third stage is the measurement of students’ final ability (post-test) in the experimental group and control group after learning the work and energy. The final ability test aims to determine whether all the subject material that has been taught is well-understood by the students.

This research conducted in six times meeting. At the first meeting, the two classes were given pre-test questions, where the pre-test question had previously been tested for validity and reliability of the each question. Then at the second meeting until the fifth meeting the two classes are given different
treatment in both classes. Where in experiment class is given treatment with flipped classroom model and guided discussion. Table 1 show the treatment of control class and experiment class table and steps in learning by using the flipped classroom model are: (1) Students watch the video first; (2) in learning process at the classroom, the students do discussions, exercises, problem solving or tests; (3) teachers act as facilitators and assist students in guided discussions; (4) conduct an understanding assessment at the end of the meeting. While in the control class is given treatment with conventional model. At the sixth meeting the two classes were given post-test questions, the question of this post-test was used to measure students' cognitive learning outcomes and before being given to the students the post-test has been tested for validity and reliability of questions. Next, analysing the students' pre-test and post-test results in both classes and summarize the results.

| Meeting | Experimental Group (Using Flipped Classroom Model) | Control Group (Using Traditional Classroom Teaching) |
|---------|-----------------------------------------------------|-----------------------------------------------------|
| 1       | ● The students given a pre-test                      | ● The students given a pre-test                      |
|         | ● The students introduce to the ideas of flipped      | ● The students introduce to the ideas of traditional |
|         | classroom model and given a video on the teaching     | At school                                           |
|         | material                                            |                                                     |
|         | At school                                           |                                                     |
| 2       | ● The students discuss their understanding on the     | ● The students are given an explanation on the       |
|         | materials learned at home.                          | teaching material and homework to write a            |
|         | ● The students start working on their student        | narrative text                                      |
|         | worksheet with a group and have peer checking and    | At home                                             |
|         | teacher’s assistance.                                |                                                     |
|         | At home                                             |                                                     |
| 3       | The students watch video lectures, read online       | The students work on their homework.                |
|         | materials, finish a quiz related to the information  |                                                     |
|         | gotten from the video lectures and reading materials  |                                                     |
|         | learned                                            |                                                     |
|         | At School                                           |                                                     |
| 4       | ● The students discuss their understanding on the    |                                                   |
|         | materials learned at home.                          |                                                     |
|         | ● The students start working on their student        |                                                     |
|         | worksheet with a group and have peer checking and    |                                                     |
|         | teacher’s assistance.                                |                                                     |
|         | At home                                             |                                                     |
| 5       | The students watch video lectures, read online       |                                                     |
|         | materials, finish a quiz related to the information  |                                                     |
|         | gotten from the video lectures and reading materials  |                                                     |
|         | learned                                            |                                                     |
|         | At School                                           |                                                     |
| 6       | The students given a post-test                       | The Students given a post-test                       |
From the comparison table above can be seen that in the conventional class, learning time is widely used to deliver the material. So sometimes when entering the time for guidance and training participants used for deliver the material, because the material has not fulfilled the indicators’ achievement of students. So it is not uncommon for teachers to provide homework for students to find out how far the students’ understanding of the material that has been delivered. In fact, not a few students who do homework just by seeing the results of his friends. In addition, in learning using model flipped classroom, learning time is used entirely for discussion, question and answer even until guidance and training time. Because the delivery of the material has been given to students either accessed online or offline (in the form of soft copy or CD Rom / DVD Rom) before going to the material will be discuss and the students asked to study the materials before the course is start, this can create active and student-center learning. So the teacher can know directly, the level of understanding of students in the class, and if there are students who have not understood yet about the material can be directly asked to the teacher at that time.

2.3. Data analysis techniques

Data analysis technique in this research use normality and homogeneity test. In the normality test in this research using Lilliefors test with the data that used is the result of student learning in the experimental class and control class. This can be presented by Table 2.

Table 2. Data normality test.

| Group   | L-value | L-table | Status |
|---------|---------|---------|--------|
| Experiment | 0,0813  | 0,1485  | Normal |
| Control  | 0,1044  | 0,1485  | Normal |

Table 3. Homogeneity test.

| Sample     | n  | dk (n-1) | S    | S^2  | F-value | F-table | Analysis |
|------------|----|----------|------|------|---------|---------|----------|
| Control    | 34 | 33       | 10,22| 104,45| 1,067785| 1,78782 | Homogent |
| Experiment | 34 | 33       | 10,56| 111,53|         |         |          |

In table 3. The results of the tests that have been obtained, F_{stat} 1, 0677 and F_{table} 1.787 because the value of F_{stat} is lower than the F_{table}. Then the data obtained from the test of student learning outcomes of the two classes (experiment and control class) is normally distributed and derived from homogeneous population.

3. Results and discussion

Table 4. The descriptive data of result of pre-test from experiment and control class.

| Statistic         | Control class | Experiment class |
|-------------------|---------------|------------------|
| n (number of students) | 34            | 34               |
| Minimum value     | 24            | 24               |
| Maximum value     | 60            | 60               |
| Range             | 36            | 36               |
| Average           | 37,53         | 37,88            |
| Variants          | 77,59         | 85,56            |
| Standard deviation| 8,81          | 9,25             |

Table 4 shows, in the control class the maximum value is 60 and the minimum value is 24 and the average value is 37.53 while in the experimental class the student's maximum score is 60 and the minimum value is 24 and the average score is 37.88. Based on the pre-test result the state of the two classes before being given treatment is not much different.
Table 4 shows descriptive data of post-test results from both classes. The result of this post-test is the learning outcomes both classes that have been given in different treatment. Where the experimental class is given treatment by using the flipped classroom model while in the experimental class is given treatment by using conventional model. The post-test results of both classes serve as a benchmark of the improvement results in both classes by comparing the mean values in the two classes. Post-test result data in both classes can be seen in table 5 below.

**Table 5.** The descriptive data of posttest result from experiment and control class.

| Statistic            | Control class | Experiment class |
|----------------------|---------------|------------------|
| n (number of students) | 34            | 34               |
| Minimum value        | 56            | 60               |
| Maximum value        | 88            | 96               |
| Range                | 32            | 36               |
| Average              | 70.7          | 78.47            |
| Variants             | 104.45        | 111.53           |
| Standard deviation   | 10.22         | 10.56            |

Table 5 shows that based on post-test result in both classes, obtained data in the experimental class the maximum value is 96 whereas the minimum value is 60. So it gives a range of 36 and the average value of the experimental class is 78.47 with 111.53 and deviation standard 10.56. There were also 38.23% of students who were below average and 61.76% of students above average.

While the value in the control class has a maximum value of 88 and a minimum value of 56 so, to provide a range of values 32. In the control class with variants 104.45 and standard deviation of 10.22 yields an average value of 70.7. In the control class as much as 52.94% of students are below average and 47.05% of students who achieve above average value. This condition is lower than the value in the experimental class.

From the post-test result both classes can illustrated in diagrams below:

![Data Distribution of Posttest Score in Experiment Class](image)

**Figure 1.** Diagram of experiment class learning outcome.
The results of this study show the results of physics learning by using the flipped classroom model is higher than using conventional learning model, this can be seen from the average results in the two classes. Then from the value of the average equality test of the two classes with the significance level \(5\alpha = 0.05\) with degrees of freedom \((df) = n1 + n2 - 2 = 34 + 34 - 2 = 66\) obtained \(t_{stat} = 3.08\) and the value of the table of 1.996. Since the price of \(t_{stat}\) is bigger (3.08) than the price of \(t_{table}\) 1.996 it can be concluded that \(H_0\) is rejected and \(H_a\) accepted. Thus there is an effect of the learning model by using flipped classroom against the results of physics class X study at 31 Senior High School Jakarta. Other studies by Nicola Sales who revealed that with the flipped classroom model students have responsibility for their learning when they see videos at home or when organizing learning in class [17].

4. Conclusion
Based on the results of by using the flipped classroom model there is interaction between each students or students with teachers during the learning process. While in the traditional class students tend to be passive so that the class condition is very passive, only one-way learning is the teacher to students. This has an impact on student learning outcomes, by applying active learning conditions and students looking for previous sources of information, the learning outcomes of students increases compared with students who only get the material and study only at the school.

References
[1] Zuber O S 1997 Professional Development In Higher Education (A Theoretica Framework for Action Research) (London: Kogan Page)
[2] Reid G and Shannon G 2009 Effective Learning (London: Continuum)
[3] Vishwanath H N 2006 Models of Teaching in Environment Education (New Delhi: Discovery Publishing Horse)
[4] Hoyt G M and Kim M Mc G 2012 International Handbook on Teaching and Learning Economics (Cheltenham: Edward Elgar)
[5] OECD 2018 PISA 2015 Result in Fus: What Students Know and Can Do (Boston Collage: Publishing International Study Center)
[6] Mullis IV S, Martin M O, Robitaille D F and Foy P 2012 TIMSS 2015 International Results in Mathematics (Boston, MA: TIMSS and PIRLS)
[7] Marks G N 2014 Educational, Social Background and Cognitive Ability (New York: Routledge)
[8] Bregmann J and Aaron S 2012 Flipp your Classroom: Reach Every Student and Every Class Every Day (United State: The International Society For Technology In Education)
[9] Karlson G and Janson 2016 *The Flipped Classroom: a Model For Active Learning* (Sweden: Swedish Institute of Computer Science)

[10] Ramnanan C and Pound D 2017 *Advances in medical education and practice: student perceptions of the flipped classroom* (Canada: University of Ottawa)

[11] Gillispie V 2016 Using the Flipped Classroom to Bridge the Gap to Generation Y *Ochsner Journal* 16 1 32-36

[12] Herry N D and Sutama 2016 Efektivitas Flipped Classroom terhadap Sikap dan Keterampilan Belajar Matematika di SMK *Journal ums* 11 2

[13] Johnson L W and Renner J D 2012 *Effect of the flipped classroom model on a secondary computer applications course: Student and teacher perceptions, questions and student achievement. Unpublished dissertation* (Louisville: University Louisville)

[14] Mortensen J and Nicholson 2015 The flipped classroom stimulates greater learning and is a modern 21st century approach to teaching today’s undergraduates *Journal Animal Science*

[15] Hanover R 2013 *Best practices for the flipped classroom* [online] retrieved from http://www.hanoverresearch.com/2013/10/bestpractices-for-the-flippedclassroom accessed 15 October 2017

[16] Avdhesh S J 2014 *Social Research Methods* (India: McGraw Hill Education)

[17] Nicola Sa Flipped the Classroom: Revolutionising Legal Research Training *Cambridg Journals* 13 231-235