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# Comparing the Effectiveness of Flipped Classroom and Online Learning on Improving Critical Thinking Skills in High School Physics Learning

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***Abstract*. This study aims to see the impact of applying the flipped classroom to improve students critical thinking skills. The research design was the pretest-posttest controlled group design which consists of three groups taught different learning. Teacher applied direct instruction learning at the control group. Two other groups taught using a flipped classroom approach or online using Google Classroom. The participants of this study were 10th-grade students in physics subjects. Samples are taken randomly simple to determine groups. The analysis technique used is ANOVA to know the effect of learning strategies on critical thinking skills. Measurement of critical thinking skills is carried out using critical thinking test questions in the form of descriptions that have previously tested for difficulty and power of difference.**

***Keywords**: flipped classroom, online learning, physics education, learning technology, educational technology, learning media, learning innovation.*

## INTRODUCTION

The 21st century is marked as a century of openness or a century of globalization, meaning that human life in the 21st century experienced fundamental changes that were different from the system of life in the previous century. Learning that was implemented in the 21st century requires participant-centered learning students [1],[2]. The goals to be achieved are not just learning outcomes, but the learning processes experienced by students. This goal is indeed not an easy challenge for a student; they encounter many difficulties in the learning process. Students who are millennial who feel comfortable with gadgets need a different approach to learning today [3],[4]. The tendency of modern learning leads to virtualization, thematic, and learning networks [5],[6]. This trend needs to be anticipated with appropriate learning innovations so that the potential of learners can develop optimally. One approach that is developing today is the application of the flipped classroom concept.

The learning approach with the concept of the flipped classroom allows students to explore learning material independently or in groups outside the classroom with various learning videos prepared by the teacher [7]-[9]. In the classroom, students conduct discussions and problem-solving sessions that will impact on students' critical thinking [10],[11]. One technology that significantly changes both the way students study and how to teach teachers is video technology [12]. Videos made by the teacher become potential students to remember, understand and apply. The lessons/subjects in the classroom are more holistic and comprehen sive; so as a millennial teacher, flipped classrooms and online learning using the animation (Powtoon for example) become potential media to support teaching and learning activities [13].

There are two essential elements in a teaching and learning process namely teaching methods and learning media. One of the media used in the learning process of the flipped classroom model is audiovisual learning media [7]. This media is a medium that is not only heard but seen simultaneously. Audiovisual media is a medium that has sound elements and elements of images. There are several audiovisual learning media used in activities, one of which is Powtoon, an animation software, presentations, videos that are very supportive in this process, because the peculiarity of the flipped classroom model is the learning video, and the material used is thermodynamic material, due to the material this, rarely practiced so students can better understand the visual process.

Powtoon is a web-based animation software that allows you to quickly and easily create animated presentations with your students by manipulating pre-created objects, imported images, provided music and user create voice-overs. From this definition can be interpreted Powtoon is an online service-based software animation that allows users to quickly and easily create animated presentations by manipulating objects, inserting images, entering music and can also enter the user's voice recordings. Powtoon is a company that sells cloud-based software (SaaS) to create animated presentations and animated explanation videos. PowToon is a web-based animation software that allows users to create animated presentations by manipulating previously created objects,

imported images, music and user-generated sounds. Powtoon uses the Apache Flex engine to generate XML files that can be played on the Powtoon online viewer, exported to YouTube or downloaded as MP4 files.

The flipped classroom is a learning model that reverses the way classroom teaching [14]. In this method, digital media learning material in the form of video or e-book must be learned by students at home before learning, so that when in the classroom the instructor does not explain the material, but immediately exercises the questions or other activities such as role play, debate, presentations, or other methods whose material has been studied previously [15]. The core of flipped classroom learning is twofold: providing more time in class to assimilate material in the form of practice questions, or other activities and accommodate various student differences regarding motivation, ability to absorb, and prior knowledge [7],[10],[16].

On the other hand, the demands for changes in learning in the 21st century encourage a shift in measuring the success of learning in higher-order thinking skills; one of them is critical thinking skills [17]. Critical Thinking is a regular mental activity carried out by tolerant people with an open mind to broaden their understanding [18]. Critical thinking skills can be developed through the process of observing, comparing, grouping, hypothesizing, collecting data, interpreting, concluding, solving problems, and making decisions [19],[20]. There are several indicators to measure the critical thinking skills. Critical thinking is the process by which someone thinks things more deeply, focuses on deciding what to believe or doing by defining problems, assessing and processing information related to problems, and making simple conclusions. Students who have critical thinking skills will always ask themselves in every face all the problems to determine the best for themselves [21], [22].

In current learning, developing high-level thinking skills that include analytical thinking skills is important. Education is not only the acquisition of knowledge but also consists of the ability to integrate existing experiences into something new and more meaningful. Critical thinking skills can be improved through problem solving activities. This can be developed through learning by encouraging complex problem solving. The problem is complex is a problem that is not directly solved by certain procedures or perspectives, but requires high-level thinking skills to be able to find and combine various concepts or facts to get to find the connection of concepts or facts into new knowledge. Critical thinking is a multidimensional construction. In learning, essential thinking skills can be seen in skills using a combination of various concepts, formulas, principles, rules to solve complex problems. By paying attention to the nature of each aspect of experience, in the process of measuring critical thinking skills can be developed problem tests or contextual questions that are appropriate to the learning objectives.

These skills are essential to get a deeper understanding of various natural phenomena. These skills are very in line with the expectations contained in the 2013 National Education Curriculum of Indonesia. The problem in this new changing of information and communication technology is the lack of technology used in the science learning that considering the new learning competencies. Based on the opportunity to use information and communication technology in learning through a flipped classroom learning strategy, this study aims to see the effect of learning strategies on critical thinking skills in high school students.

## METHOD

### Research Context

The research was a quasi-experimental design with a pretest and posttest controlled group design. The population of the study was all eleventh-grade students of a state senior high school in Yogyakarta, Indonesia. The sampling technique was random cluster sampling. Two classes with the total number of 67 students were used as the samples. The independent variable was the learning strategy including flipped classroom (IVAR1) and online learning (IVAR2); the dependent variable was critical thinking skills (DVAR). Data were collected using validated test. The test instrument of prior knowledge (PKW) was 20 multiple choice questions. In this research, the instrument for measuring the critical thinking is an essay question. This problem contains 5 items with maximum score is 100. Each problem measure the C4 (Analysis) and C5 (Synthesis) of Bloom taxonomy.

All the items tested were reliable. Further, the researcher used pretest and posttest to measure the students' improvement. Before applied the statistical analysis, the data was checked for the validity test, the reliability test, and the difficulty level test. To analyze the data, the researchers applied T-test and ANOVA on the data of posttest.

### Learning Phases

In flipped classroom learning, students will get videos that have been prepared by the teacher to learn at home before school learning is done. In this video explained the physics material in the form of animation that has been developed using the Powtoon application. Students can repeat the animation several times to be able to understand the physical phenomena that will be discussed in class both related to concepts, theories and their application in seclusion. When in class at the next meeting, students discuss together to resolve a problem related to the video that has been seen at home. The teacher's ability to manage this discussion is important for the success of learning. The teacher facilitates the learning process in the classroom so that it can foster critical thinking skills through several problems solved collaboratively.

The mechanism or the procedure of the implementation of the flipped classroom learning model is: 1) The teacher prepares and provides a short video created using Powtoon that students will watch and learn about at home; 2) Students watch the video and learn the

instructions given by the teacher through the video so that they are familiar with the concepts and material that will be presented at the next meeting; 3) In the classroom, students work on tasks based on instructions that have been delivered previously via video. In this case, students can focus more on the difficulties in understanding the material or its ability to solve problems related to the content, and 4) The teacher acts as a facilitator who accompanies students in working on the task.

In learning that uses Google Classroom, the stages used are reading physics material that has been provided, working on some practice exercises, discussion in forums related to the material, giving problems to be done individually. An important phase in online learning is when discussions. In this forum the teacher ensures that all students understand the material according to the specified standards. The results of students in working on several exercises are used as a basis for designing discussions that can encourage the improvement of critical thinking skills. The questions given at the end of the stage are questions that can measure these skills. The main features used in this learning activity were Assignments and Events, Tests and Quizzes, and Discussions: 1) Assignments and Events allow the teacher to create a variety of different assignments that include content from a hard-drive or the web; 2) Tests and Quizzes allow instructors to create a variety of different types of questions for quizzes and test. These test and quizzes can include a wide range of media as well, making it easy to personalize and differentiate tests with ease, and 3) Discussions allow the teachers to set up a threaded discussion which would enable for natural response and organizations. Posts can include a variety of files as well.

## RESULT

The pre-test is given in the multiple choice questions to find out the student's understanding on some concepts of physics. The T-test was applied to compare the results of the pre-test between the two groups to ensure that the two groups were not significantly different from the prior knowledge (PKW).

Table 1 shows the mean and standard deviation between IVAR1 and IVAR2 for PKW scores.

Table1. The Descriptive of the Prior Knowledge (Pkw)

| | N | Mean | Std. Deviation | Std. Error | Min. | Max. |
|---|---|---|---|---|---|---|
| Flipped Classroom (IVAR1) | 30 | 46.90 | 3.49 | .64 | 38.00 | 55.00 |
| Online Learning (IVAR2) | 30 | 45.73 | 3.76 | .69 | 35.00 | 53.00 |
| Total | 60 | 46.32 | 3.64 | .47 | 35.00 | 55.00 |

From Table 1, the mean of prior knowledge for IVAR1 (46.90) is greater than one for IVAR2 (45.73). Whereas for standard deviation of prior knowledge for IVAR1 (3.49) is smaller than one for IVAR2 (3.76). The results of the homogeneity test with Levene statistics (Sig. = .66), the difference in mean of PKW between the two groups was not significant (alpha= 0.05). These results indicate that the two groups were homogeneous. To see further this average difference, it was tested by the mean difference test as shown in Table 2.

Table 2. Anova result (prior knowledge as dependent variable)

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 20.417 | 1 | 20.417 | 1.553 | .218 |
| Within Groups | 762.567 | 58 | 13.148 | | |
| Total | 782.983 | 59 | | | |

From Table 2, based on the value of the error level (Sig.; last column) it was concluded that the mean of PKW for IVAR1 and IVAR2 was not significantly different; so that further analysis can be applied on the dependent variable (DVAR).

ANOVA is used to see the effect of the independent variable (IVAR) on the dependent variable (DVAR). The number of samples for both groups (IVAR1 and IVAR2) is the same (30 students). Table 3 shows descriptive statistics for the two groups.

Table 3. The Descriptive of the Critical Thinking Skills (DVAR)

| | N | Mean | Std. Deviation | Std. Error | Min. | Max. |
|---|---|---|---|---|---|---|
| Flipped Classroom (IVAR1) | 30 | 76.67 | 8.34 | 1.52 | 55.00 | 85.00 |
| Online Learning (IVAR2) | 30 | 67.17 | 11.35 | 2.07 | 40.00 | 80.00 |
| Total | 60 | 71.97 | 10.97 | 1.42 | 40.00 | 85.00 |

From Table 3, students taught with flipped classroom (IVAR1) have a mean of critical thinking score (76.67) higher than the one (67.17) in students taught by online learning (IVAR2). In addition, the standard deviation of critical thinking skills score (DVAR) for IVAR1 (8.34) is smaller than the standard deviation of one for IVAR2 (11.35).

One-way ANOVA was used to determine the influence of IVAR (learning strategy) on DVAR (critical thinking skills). The results of this analysis are shown in Table 4.

Table 4. ANOVA Result (Critical Thinking Skills as Dependent Variable)

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 1353.75 | 1 | 1353.75 | 13.65 | .00 |
| Within Groups | 5750.83 | 58 | 99.15 | | |
| Total | 7104.58 | 59 | | | |

Based on Table 4, the margin of error (Sig.) was smaller than alpha (.05) indicated that there was an influence of IVAR on DVAR. It can also be concluded that learning with flipped classroom strategy (IVAR1) has higher impact on critical thinking skills (DVAR) than online learning strategy (IVAR2).

## DISCUSSION

Nowadays, science learning has a high tendency to utilize information and communication technology in various forms such as learning management system, learning media, application for data acquisition, or simulation [1]. Teachers are increasingly convinced that this technology can support the achievement of certain learning competencies. In this study, it related to the use of technology in learning as both media or management system. Learning with a flipped classroom strategy has been widely researched and applied to improve critical thinking skills; as well as online learning [7], [8], [10].

This research is not just to see how the impact of different strategies on critical thinking skills, but also to observe what learning factors have an impact on achieving competency (in this case critical thinking skills). From the data analysis, students taught with the flipped classroom strategy had higher critical thinking skills than students taught with online learning strategy. There were several factors that make this difference. There is a general tendency in Indonesia that face-to-face learning in class is a common learning process in every schools. Conversely, online learning is a new approach on learning [23]. Although in this study the level of maturity of the subject had been considered in learning, there was still a different level of comfort or satisfaction between flipped classroom learning compared to online learning.

In many studies it was also found, online learning still encountered many obstacles especially to build a sense of social presence during online [24]-[26]. Online learning is not just uploading material and assignments in cyber, but also needs to build effective interaction between students-students and students-teachers which is comparable to classroom learning. In the flipped classroom circumstances, students still have the opportunity to interact face-to-face directly in class, but there are additional activities done before learning [27]. The provision of learning videos before learning is the main attraction for students to learn improved learning satisfaction.

Another factor that influenced learning strategies is the level of interaction [28], [29]. This result can be seen in the difference in standard deviation. A low standard deviation on the score of critical thinking skills shows that among students have evenly critical thinking skills. In students who are taught with flipped classroom, they have more opportunities to be able to work in groups in the classroom during the problem solving process as a part of the strategy. Students in the group with online learning strategies have a tendency to work individually and low effective forums in the learning process. The difference in the intensity of this interaction caused of the different levels of critical thinking skills distribution among students [15],[28]. Researches on cooperative and collaborative learning explain the process of knowledge sharing between students well.

## CONCLUSION

Students in both groups (flipped classroom and online learning strategy) at the beginning had relatively similar in the prior knowledge. But after taught using certain learning strategy, students in both groups had different level of critical thinking skills. This difference indicated the influence of learning strategies on critical thinking skills. Students taught with flipped classroom strategy tent to have higher critical thinking skills than students taught with online learning strategy. In other words, flipped classroom strategy was more effective in improving critical thinking skills than online learning strategy. Some of the learning factors that influence this difference were the level of interaction between students and the level of satisfaction in learning. These factors need to be explored further to clearly isolate learning variables that influence each other.

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