

Implications Project-Based Learning (PjBL) Assisted Flipped Classroom on Critical Thinking Ability of Gender-Based Students on the Concept of Water Pollution

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Article Info

Article history:

Received July 07, 2023

Revised September 11, 2023

Accepted October 02, 2023

Keywords:

Critical Thinking,
Flipped Classroom,
Gender,
PjBL.

ABSTRACT

Students' critical thinking abilities are still low for both female and male students. Initial data results obtained from the pretest, female students with a percentage of 35% and male students with a percentage of 27%. The aim of this research is to determine the effect of the project-based learning model assisted by the flipped classroom on gender-based junior high school students' critical thinking abilities on the concept of water pollution. This research uses a quantitative type of research with a sample of class VII students at SMPN 6 Sukabumi City, even semester of the 2022/2023 academic year. The instrument used is a critical thinking skills test. The results obtained show that the average posttest score for female students is 74.2 ± 12.6 and male students is 69.0 ± 11.0 . Both of them have increased from the pretest and posttest, but the female scores are superior. The percentage per ability indicator based on gender in indicators 1,2,3 shows that women are superior to men. However, in indicators 4 and 5, women and men are the same. Overall, the data shows that there is no significant difference in learning using the Project Based Learning model assisted by Flipped Classroom between female and male students. However, based on indicators, female students are superior to male students.

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1. INTRODUCTION

In Indonesia, the teaching method continues to emphasise theoretical learning as opposed to practice. As with the learning process at school, most teachers in Indonesia still use a theoretical learning model in class then students are given homework, so students feel bored if the teacher uses a model like that. Teachers have so far failed to introduce a technology supported learning model that encourages students to be involved in the teaching process. The observation data collected at SMPN 6 City of Sukabumi, which remain a lecture method that makes students lose interest in the lessons they are being taught, support this view.

Various studies have been conducted to examine the effect of gender children's educational progress (Fawaiz *et al.*, 2020) because there are so many different classes, they all have their own characteristics. There are many reasons for the differences in experience between boys and girls at school. In many ways students and their professors differ from one another, but they do not realize it. Gender is not just based on sex but gender is the socially and culturally constructed traits, roles, behaviours and characteristics that distinguish men and women Nur (2020). Boys are often bigger and stronger than girls, but despite this, almost all girls reach sexual maturity before boys. A stereotypical view of boys and girls is that boys have better spatial abilities.

Critical thinking capacity is essential for problem solving in the 21st century and in everyday life (Lestari *et al.*, 2015) while their critical thinking capacity is not yet maximally mature. In particular, a number of factors contribute to the fact that women tend to be more thorough and careful than men (Putri *et al.*, 2018) In addition, three factors are needed to give a child the confidence to think critically: 1) parents' education level, 2) societal environment, in particular support from peers, and 3) Environmental effects of logical mathematical intelligence (Ardiansyah, 2020)

Critical thinking is a way to think about things where you use logic and reason in order to make decisions. On the basis of research, there are still a lot of students in Indonesia with poor cognitive skills, particularly those who go to secondary school. Indonesia ranked 74th out of 79 countries in 2018 on the PISA international student evaluation programme, with a scientific competence score of 396. This is lower than the average OECD score of

489. Students around the world (Schleicher, 2018) complete exams organized by the Program for International Student Assessment (PISA). Four key skills essential for success in the 21st century: creativity, critical thinking, communication and teamwork are assessed by (Pisa, 2018)

One of the skills we need to face the era of globalization is the ability to think critically. The importance of critical thinking in the twenty-first century has been widely recognized (Cahyono, 2017) Critical thinking is a skill that can be nurtured through the use of effective learning approaches. Project-assisted learning is one of the cutting-edge teaching methods that emphasizes the development of critical thinking, promotion of teamwork, and improved management of data sources. Students in Project based learning (PjBL) courses are actively engaged in learning by investigating concepts, creating conceptual maps, and acquiring knowledge about phenomena. The goal is for students to collaborate on a product or service that addresses an issue they find personally interesting. Project based learning (PjBL), as described by (Krajick, 2018) is an educational approach that emphasizes individual learners and tackles real-world problems. Thus, PBL is instruction where the instructor acts as a facilitator and encourager. Through the study of concepts, creating conceptual maps and studying phenomena, students from Project Based Learning courses are active learners. The aim is to involve students in working together on products or services that address an issue which interests them personally. That's why PBL is instruction in which the teacher serves as a facilitator and an advocate.

One of a number of teaching approaches that can be used to enhance the PjBL framework is the flipped classroom model. A concept known as "flipped learning" has been introduced some time ago. This kind of education has been growing at an accelerated pace, as technology advances and the world continues to evolve from Covid 19 onwards. To prepare for classes, students in flipped class can view videos and make online resources available to them from their teacher like the ones shown at You Tube and other internet sites Julanta, (2015).

With the flipped classroom approach, students will be able to prepare for their problems by watching educational videos on their own time at home. In the flipped classroom learning model, students are asked to complete tasks that are normally assigned as homework in the course of the school year (Suripta *et al*, 2022)

The unique Flipped Classroom Assisted Project Based Learning (PjBL) learning paradigm can create a more engaging classroom environment for students to learn. In this way, students are supposed to be able to deal with problems arising during school hours by describing what they learn in teacher's provided educational videos which they watch at home. In addition, the combination of a flipped classroom approach and Project Based Learning BL can have beneficial effects on students' critical thinking skills as described by (Andrini *et al*, 2019)

The purpose of the research work titled "Implementation of Project Based Learning (PjBL) Assisted Flipped Classroom on Critical Thinking Skills of Gender-Based Junior High School Students on the Concept of Water Pollution" is to gain insight into the posttest scores of students from one of the secondary schools in Sukabumi City with respect to their critical thinking skills related to the topic of water pollution.

2. RESEARCH METHOD

Twelve seventh and ten year old girls and seven year old boys participated in a single group prepost study. The method of data collection where a sample has been chosen according to certain criteria is the use of quantitative sampling, as defined by Sugiyono (2017). This study took place in June 2023. The researchers were able to gather information by asking the players to respond to questions which aimed at test their ability to think critically, (Ennis,2015. The development of plans and strategies, the availability of more explanations, drawing conclusions or developing fundamental skills are indicators of critical thinking. In the test, there were ten multiple choice questions and each question was assessed as a reflection of one of the five aspects of subjective thinking by students. In order to determine the key thinking skills that have been used in this study, criteria for students' grade levels with highest, middle and lowest scores were applied on the post test. The results of the pretest and posttest data calculations were processed using the N-Gain formula with the following calculation (Hake, 1998) :

$$N - Gain = \frac{S_{posttest} - S_{pretest}}{S_{maks} - S_{pretest}} \times 100\%$$

Description:

post-test score : Setis learning test score
Pretest score : Test score before learning
Max Score : Maximum score

Table 1. N-Gain improvement category

N-Gain Coefficient	Improvement category
N-Gain \geq 0,71	High
0,30 \leq N-Gain \geq 0,70	Medium
N-Gain \leq 0,30	Low

Student response questionnaire to the Flipped Classroom Assisted Project Based Learning (PjBL) learning model consisting of 12 statements categorized into 6 indicators, namely: 1. Student interest in the Project Based Learning (PjBL) model on the concept of water pollution, 2. Student assessment of Project Based Learning (PjBL) model on the concept of water pollution, 3. Students' interest in the flipped classroom on the concept of water pollution, 4. Student assessment of the flipped classroom on the concept of water pollution, 5. Critical thinking ability on the assisted Project Based Learning (PjBL) model students' flipped classroom on the concept of water pollution, 6. Student assessment of the Project Based Learning (PjBL) model assisted by a flipped classroom on the concept of water pollution with a Likert scale, namely SS, S, TS, and STS. The percentage of questionnaire distribution is calculated using the formula:

$$R_{\text{Questionnaire}} = \frac{\text{Total student score}}{\text{The number of students}} \times 100\%$$

$$\% \text{ Score} = \frac{\text{Total student score}}{\text{Maximum score}} \times 100\%$$

The percentage results of the student questionnaire with the following criteria:

Table 2. Student Questionnaire Interpretation Categories

Percentage Score	Interpretasi
0% - 24,99%	Very Not Good
25% - 44,99%	Not Good
50% - 74,99%	Good
75% - 100%	Very Good

Multiple choice tests with four options a, b, c and d in combination were used to provide the data for this study. The scoring tool consists of ten questions; for each correct answer, one point is awarded and for each incorrect answer, no points are deducted; the total is then converted into a score between zero and one hundred. Cognitive ability test. You can answer a total of 12 questions in this survey, which may be answered by one of four options: SS, S, TS or STS with a maximum score of 4.

3. RESULT AND DISCUSSION

Data are gathered from the critical thinking skills test of students by means of pretest and posttest to be used in this study. The research data obtained using the project based learning model, facilitated by a flipped classroom, have been gathered as test results for students' critical thinking skills. The extent to which students have critical thinking skills about the concept of water pollution has been assessed with multiple choice questions. The results of the experimental class pretest and posttest data are presented in the table below.

Table 3. Pretest-Posttest Score Data by gender

No	Total Statistics	Female		Male	
		Pre-test	Post-test	Pre-test	Post-test
1	Number of Learners	12	12	10	10
2	Number of Values	420	890	270	690
3	Average Statistik	35,0 \pm 12,4	74,2 \pm 12,6	27,0 \pm 11,6	69,0 \pm 11,0

(Source: researcher)

The average of the female and male students' Pretest scores is 35.0 and 27.0, respectively, in the table above. However, female and male learners had an average post test score of 74.2 and 69.0 respectively. Prior to and following implementation of Project Based Learning models, assisted by the flip classroom method, changes were observed in both females and males. Nevertheless, a statistical test conducted on the basis of an Independent Sample t indicates that gender differences do not exist among male and female learners. This is supported by the

significance level (2-tails) of $0.148 > 0.05$. Because H_0 is accepted and H_1 is not, Project Based Learning assisted by Flipped Classroom does not improve students' critical thinking. This can happen because students are not used to doing a learning process that is different from the learning that is usually done. It follows from the results of studies which have shown that pupils learn about this concept through reading and memorization, but there has been no follow up such as use of educational media adapted to different teaching models for examining critical thinking skills in students. In this research, there are no significant differences between female and male students with regard to their critical thinking skills according to what was done by (Miswari *et al*, 2020) According to (Cahyono, 2017) this is due to the absence of significant differences between female and male students in general intelligence subjects, although there are some areas where it can be observed that women and men differ on certain aspects.

Postest scores per indicator based on gender in the experimental class so that the following data is obtained:

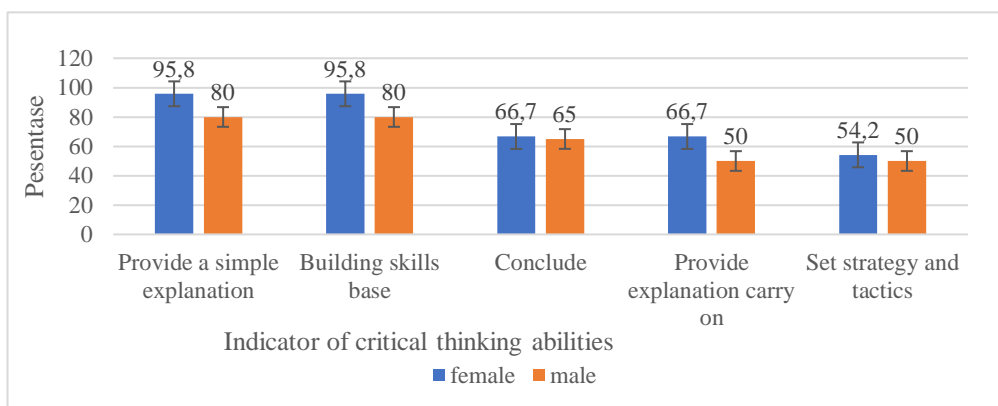


Figure 1. Comparison of critical thinking skills per indicator based on gender

Figure 1 shows the results of gender based data on a range of five critical thinking skills indicators demonstrate that there is an increase in male students compared to females for each indicator. There is virtually no difference between women and men, however, when comparing them with markers 4 and 5. According to research undertaken by (Annisa, 2021) it was found that the critical thinking capacity of male and female students in indicator 4 and 5 is equivalent.

These data show that young people are benefiting from learning in a constructive way and having the opportunity to use their analytical skills. Indicator 1's straightforward explanation showed an improvement of 87.9 in the excellent category, indicator 2's emphasis on developing fundamental skills showed an improvement of 92.9 in the excellent category, and indicator 3 drew the conclusion that the emergence of some significance should be drawn. Score 58.35 on Indicator 4 shows a cause of growth, indicating that there is no capacity for improvement plans and techniques as demonstrated by 52.1 score in indicator 5. Critical thinking skills among students have improved significantly since the PjBL model, which is based on the Flipped classroom strategy, has been adopted in classrooms (Thompson, 2011) The second indicator trains students' ability to observe and reflect on their observations; the third indicator trains their ability to draw conclusions based on data, beliefs, opinions, etc.; the fourth indicator trains their ability to define terms and consider definitions; and the fifth indicator trains their ability to reflect on the implications of their conclusions, which is something that some students have been able to do but others have not, so they remain in the deficient category.

Table 4. Comparison of students' critical thinking skills based on gender

No	Gender	Average value	Criteria
1	Female	71,84	Medium
2	Male	67	Medium

On average, female learners have a higher critical thinking score of 71.84 than male learners, as shown in Table 2. On the other hand, male learners' critical thinking skills are considered to be at medium level. This corresponds to a study by (Miswari *et al*, 2020) which showed that women have more analytical thinking and the ability to think critically in comparison with men. The fact that females scored above men in the ability to infer inferences suggests they are better able to recognize possible premises for establishing hypotheses and reasoning, also factors which have to be taken into account. According to (Novitasari, 2017), the right hemisphere of a man's brain controls his emotions, whereas the left and right hemispheres of a woman's brain work together to generate deep analysis and an accompanying sense of uncertainty.

The results of Safitri's research (2016) suggest that there are differences in gender influence on students' critical thinking skills, where the critical thinking skills of male students are better with a value of 84% with good

criteria. With a value of 78.5%, the ability to think critically in women. According to the results of research (Cahyono, 2017) states that there is an effect of gender differences on the critical thinking skills of male students who are superior to women. The National Assessment Program-Literacy and Numeracy (NAPLAN) found that female students outperform male students in reading, writing, spelling, and processing grammar, while male students outperform female students in mathematics. The results of the study (Fuad et al., 2017) said in the results of his research that there were differences in the critical thinking skills of female and male students. Women's critical thinking skills are higher than men's critical thinking skills.

This research is also supported by the student response questionnaire to the Project Based Learning (PjBL) learning model assisted by the Flipped classroom indicator based on gender in the figure below,

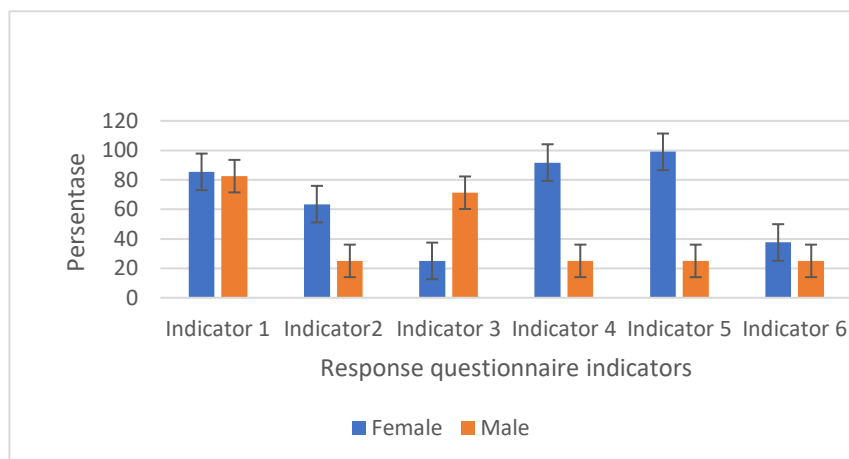


Figure 2. Learner Response Questionnaire based on gender

Description:

Indicator 1: students' interest in the PPA model;

Indicator 2: assessment of the PjBL model;

Indicator 3: Student Interest in Flipped Classroom;

Indicator 4: flipped classroom assessment;

Indicator 5: The use of PjBL assisted by flipped classroom on critical thinking skills;

Indicator 6: The use of PjBL assisted Flipped Classroom for the concept of water pollution.

Based on the results of student response questionnaire data based on gender given at the end of learning which consists of 12 questions, it is known that students have a relatively positive response. The results of the analysis of student response questionnaires based on gender, which indicate that females are 80 % more likely than males to answer indicator 1, and I would be happy to monitor learning with a PjBL model in flipped classroom, it also explains the enthusiasm that males and females have for carrying out learning by applying a PjBL model so as to be able to deal with questions in this area. But, in additional indicators, PPA that is aided by a flip classroom does not produce any positive effects, among them the students' reaction to this model assisted by Flip Classroom, which does not train students to be able to think for themselves, so as to make them more inclined to use normal learning methods. The problem is that students don't have the experience of current practice in teaching techniques.

To prepare for school, students can use Google Classroom as a media source and watch educational videos that teachers have uploaded to it. This is part of the Flipped Classroom learning approach supported by Project Based Learning (PjBL). The teacher should make sure that all students have a Google classroom account and then encourage them to use it in order to learn how to watch the uploaded videos and write comments on those photos, first step towards adoption of LKPD. Second stage, learners are encouraged to analyse the water pollution issue around them and provide relevant questions on a worksheet provided by their teacher all of which may be conducted offline. The students are then able to engage in discussions with their partners and produce ideas on a project by means of collaboration. In the final phase, learners use oil from a nearby restaurant to make their own designs. Presentation of and making use of lessons learned from completed tasks shall be the next step. Each group is presented with the completed projects which are to be followed up by other groups in order to provide feedback. The students use Google Classroom to submit photos of their finished product in the last stage. For each group, the completed projects shall be presented and other groups should pay attention to them and provide feedback. Students are using Google's classroom in the final stage to submit photos of their finished products. All the completed projects of each group shall be presented, and all other groups are expected to take an active part

in providing feedback. Students are using Google's classroom in the final stage to submit photos of their finished products.

4. CONCLUSION

High levels of analytical thinking for indicator 1, 2, fair to indicator 3 and insufficient skills on indicator 5 were identified among students who had learned the concept of water pollution by using a Flipped Classroom project based facilitated learning model. The students' average score of 71.42 on the critical thinking skills test, however, was significantly improved. This was confirmed by a student survey which revealed that, in addition to some notable exceptions, the prospect of adopting Project Based using Learning PBL model for an upside down class had been strongly encouraged by nearly all students. Women had an average critical thinking score of 71.84, beating both men and women. In contrast, a male student's mean score in the same analytical reasoning test was only 67. All the children I taught how to think critically were brilliant.

5. ACKNOWLEDGEMENT

Thanks to a number of parties, especially the parents who prayed and supported the preparation of the journal, the supervisor, the school and the teachers of SMPN 6 Kota Sukabumi.

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