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Critical review on mathematics virtual classroom practice in private university

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Abstract

A study has proven the benefits of mathematics classes learning mathematics at university. However, there is still a lack of evidence regarding its benefits in mathematics teacher education programs. This study aims to test the flipped class in a mathematics teacher education program at a private university in Indonesia. The data source comes from thirty-one students of the mathematics education program in this study. Various data methods were used, including observation, journals, and tests. Then the data were analyzed quantitatively and qualitatively. The findings showed that a reverse classroom encourages students to learn independently, with students working together with peers and increasing learning awareness. However, some of the challenges presented in flipped classroom applications include technical issues, record editing skills, and longer time consumed. The recommendations offered to refer to the findings.

Keywords: Mathematics, Virtual Classroom, Education, University.

1. Introduction

Recently, both synchronous and asynchronous virtual learning has become increasingly popular in classroom teaching. Three studies have documented virtual learning in the International Journal of Interactive Mobile Technologies (iJIM), for example, the studies. Another study has shown that mixed learning as part of virtual learning offers alternative benefits methods for traditional learning environments, where learning is face-to-face and bold [6]. A study from Sapto Adi and Abi Fajar [2], also stated that blended learning allows students to control their learning process both offline and online. It enables them to build knowledge through the learning resources that have been provided.

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According to Putri et al., such control can help students focus and improve learning activities without face-to-face learning but still follow the learning process [22, 5]. In addition, blended learning allows students to build communication skills individually and collaboratively with peers and their teachers [29, 30].
Previous research showed that the flipped classroom provides versatility to meet students' various needs in mathematics learning, potentially maximizing the time available to enhance students' comprehension of mathematical concepts. The flipped class application includes video resources, explanations of certain concepts, exercises, and other tutorial material that offer students flexible assistance. As an outcome, this type of assistance allows students to take more responsibility for their learning, increasing their mathematics learning autonomy.

2. Literature Review

2.1. Virtual Classroom

Recently, virtual classroom developments had been transformed into educations cultures. Virtual classroom enforced the teachers to improve their technological and computers competences gradually. This is mainly because teachers nowadays should provide teaching material before class and uploaded into specifics websites. It is allowed students not only to have extra time to learn before class[25, 12]. By providing the online materials, students will be an able repeat and revisited the lesson as required. Students who are willing to give extra time to learn will have more opportunity to have more understandings. Who stated that students who give extra time for learning in virtual classroom practice would comprehend the material than their peers [1].
Although the material was well-explanations and prepared, most of the students still required to be explained by teachers in the virtual classroom, in the virtual mathematics classroom, teachers should prepare the materials and the supporting materials such as video explanations. Previous studies show evidence that learning mathematics in a virtual classroom should be accompanied by video explanation. Video explanations contain the supporting explanations related to the material[32, 4]. in mathematics, virtual classroom plays an essential role in guiding students to understand the lesson.

2.2. Instructional delivery methods

The virtual classroom combined three primary learning sources: written materials, video explanations, and virtual meeting classrooms [30, 8]. As designed for our virtual classroom practices, written materials were intended to provide guidelines for learning while, video explanations were aimed 1) to support the written materials classroom, and 2) to facilitate students to understand the written materials. The virtual classroom was done once a week, with 150 minutes durations for every session. There were twelve topics to cover the entire sessions in conducting virtual classroom. The entire virtual classroom sessions procedures will be explained, as follows;
Objective: The purpose of learning Non-Euclidean Geometry using software Cabri.
Assist students in visualizing problems related to geometric proofs

1. Helping students to understand geometric theorems
2. Helping students in determining steps in constructing mathematical conjecture
3. Helping students in constructing formal geometric proofs

Textbook: Greenberg, M. J. (1993). *Euclidean and non-Euclidean geometries: Development and history*. Macmillan.
Time: Thirteen sessions, 150 minutes per procedure:

1. The Problem Exploration Stage (25 Minutes). Students construct the evidentiary problem given by the lecturer by creating the geometry theorem on the Cabri worksheet. Students manipulate the pictures they have built on the worksheet by using the software, including labelling, determining side sizes, angles, et cetera. Next, students draw connections by labelling the causal effects between them for evidence construction on the worksheet.
2. Evidence stage (20 Minutes). Students highlight the connection by labelling the causal effects on the worksheet for evidence construction. Students develop a proof of geometric construction. Students then re-examine the proof of geometry they have constructed. Students validate the evidence that has been constructed by using Cabri.
3. Presentation stage (15 minutes). Students present their work in the form of evidence that has been constructed using Cabri to visualize the evidence.
4. Discussion stage (10 minutes). Students participate in a question and answer session related to presentations.
5. Teacher feedback (25 minutes). Lecturers provide feedback and clarification related to presentation and discussion materials.
6. Exercise assignment (40 minutes). The lecturer provides exercises related to geometric proof. Students complete the exercises by using Cabri.
7. Teacher feedback (15 minutes). The teacher provides feedback on the presentation of the exercises that have been done and presented by the students.

3. Method

3.1. *Reflective Teaching*

Reflecting our self-teaching was very challenging situations for continuous teaching development. This is mainly because in reflective teaching practices, teachers not only teach the materials but also they need to take notes if required. They also required to have allocated time for reflections [23, 28]. Teachers should pose a question to themselves such as “What is my weakness in this weeks?”, “What if I change my teaching model?” and many others. By implementing instructional reflection, teachers will be able to acknowledge their drawbacks and positive feedback. Additionally, reflective actions give various tools for teachers to provide alternative solutions related to classroom problems. For example, most of the students could not understand the given materials in the virtual classroom. By reflecting our teaching, teachers asked what I need to develop my instructional delivery in the virtual classroom. They asked students to write a specifics feedbacks related to their teaching model. The feedbacks will be sent in the link google form [9].

3.2. *Participants*

All participants who enrolled in the virtual classroom practices will be required to satisfy good technical computers and internet issues. The participants were tested to use Laptop and cell-phone during the first virtual meeting. The participants who can fulfil the minimum components consisted of 25 per cent males and 75 per cent females. Most of the participants using Laptop and handphone approximately about 55 per cent while only 15 per cent of participants use handphone. Although the participants have the same semesters, there are three different ages categories consisted of 20 percents participants were less than 19 years old, and 65 per cent were more than 19 years and 20 years old. The short descriptive corresponding to demographics will be presented, as follows;

Table 1: Demographic Participant Features

Characteristics	Percentage	Characteristics	Percentage
Age		**Gender**	
< 19 years	20 %	Male	25 %
19 – 22 years	65 %	Female	75 %
> 22 years	15 %		
Techonology Competence		**Learning Facilities**	
Low	10 %	Laptop	30 %
Medium	62 %	Handphone	15 %
High	28 %	Laptop & Handphone	55 %

3.3. Data Collections and data analysis

Data collection in Geometry virtual classroom reflections was conducted using three main instruments: self-observations, peer-reviewed, and students' journals [25, 31]. The purpose of using self-observations was to encourage team teaching for continuing improvements. In implementing self-observations, we write both several drawbacks that should be taken over the solutions properly and the positive feedbacks that should keep it for the next various virtual meeting. Our team encourages our colleagues to join the virtual meeting classroom[14]. Our colleagues had been joined the entire meeting to take notes, if possible. Usually, the peers' feedback was very constructive because they could communicate to us how the virtual meeting should be improved. Lastly, students journals were also performed a primary role in conducting reflective teaching. Students' journals were vital in improving our virtual meeting qualities[30, 25, 24]. Students' notes related to teaching practice give us a beautiful insight on conducting virtual classroom properly.

4. Result and Discusion

Helping the visualization process of the problem to be proven. Constructing a geometric proof requires combining two representations, namely the verbal expression of geometric properties and the visual expression of the geometry [19]. In the research, Cabri helps students visualize the problems to be proven in the learning process. The images that are constructed on Cabri's worksheet will be more accurate so that students will better understand the visualization of the problems that are being proven. In the learning process, students are much helped to construct drawings using Cabri appropriately and accurately. Some students can visualize mathematical situations that exist in the problem to be proven to represent known information to be used as an initial idea to determine the proof's steps. The exploration process using Cabri can help students visualize the problem's correct geometric shape. This process is fundamental, due to the correct image construction can determine deductive reasoning as the initial idea of proof. The use of construction drawings is a tool for determining deductive reasoning to create a geometric visualization of the problem that needs to be proven..

Helping the process of preparing the intended evidence conjecture. One of the difficulties in constructing geometric proofs is the lack of students' ability to write the evidence steps they want; [27]. In the learning process that has been carried out with Cabri and students being able to visualize the geometric shape of the problem to be proven, students can also manipulate the images that have been constructed to determine the conjecture of the evidence steps to be constructed. Students manipulate images by dragging, adding geometric elements such as lines, angle sizes, segment sizes, et cetera), enlarging or reducing the image's size to get the conjecture or alleged steps of the intended evidence. This analysis is in line with the study of Maarif et al.'s research, which revealed that manipulating constructed geometric shapes can help students find conjectures and justify the conjectures that have been made [17, 3]. The learning process using Cabri also allows students to validate the truth of the conjectures that have been made. Some students who have made conjectures related to the evidence steps can then validate the conjecture's correctness and error. Some students conducted a dragging process on the constructed images using Cabri to validate the written evidence. Thus, the process of controlling the written evidence step becomes more effective.

Helping the justification process of the geometry theorem. Assuring the truth of a geometric theorem will help students understand axiomatic geometric systems [26]. Student confidence will be passed through the process of justifying the geometric theorems that will be used in compiling geometric proofs. Before constructing evidence is carried out, each student in the process is trained to justify geometric axioms and theorems using Cabri. This step aims to convince students of the theorem so that the theory's sense to be used is stronger.
Some students justify the theorem by constructing the image and then determining each geometric shape's length and angle. For example, to justify the theorem " two sides and one angle of two triangles are equal, then the two triangles are congruent" by using Cabri, the student constructs two triangles with two equal sides and the same angle. Furthermore, students determine the size of the other elements' sides and angles using the distance or length button. Furthermore, students conclude the exploration process, namely that each element in the two triangles has the same size and that they are mutually congruent. So, in the end, students will construct knowledge of geometry theorems through an exploration process with Cabri. This finding is following Marriott's research results, which revealed that Cabri's justification process could justify a geometric theorem [18].

4.1. Techincal Issues

There is no detection service for the geometry theorem in Cabri. Determining the theorems that will be used in constructing a geometric proof is very important. Students will carry out the proving process smoothly if they are right in choosing the theorems used in the proof of step idea[11, 17]. The Cabri program only justifies constructed geometrical drawings and cannot identify the existing theorems of constricted geometric shapes[18, 10]. For example, some students tried to construct a drawing from the congruent theorem of two triangles. It would be beneficial for students if there is a tool that shows the identification of Cabri's tools to the related theorems and displays them in the window. So, what students can do in the learning process is to write the theorems related, which then to be used in the proving process.

Lack of devices that support the labelling of the geometric proof supporting elements on Cabri. In proving geometry, students are strongly encouraged to make geometric constructions of the problem, which is proven complete with its label. This finding is consistent with what Ye said that to determine the initial idea of evidence, and students must represent it in a diagrammatic form with the correct label [33, 7]. However, the tools in Cabri have not been able to optimize labelling in the constructed geometric shapes. For example, in constructing an equilateral triangle, two equal sides' labelling is not available; only the angle congruence label is available. It becomes an obstacle for students in proving to determine congruent elements in the constructed geometric form.
Some students have difficulty identifying the geometric shape of the problem because Cabri's device identifies it. For example, students find it challenging to identify by giving labels to two congruent triangles, whereas the concept of the congruence of two triangles is crucial in preparing geometric

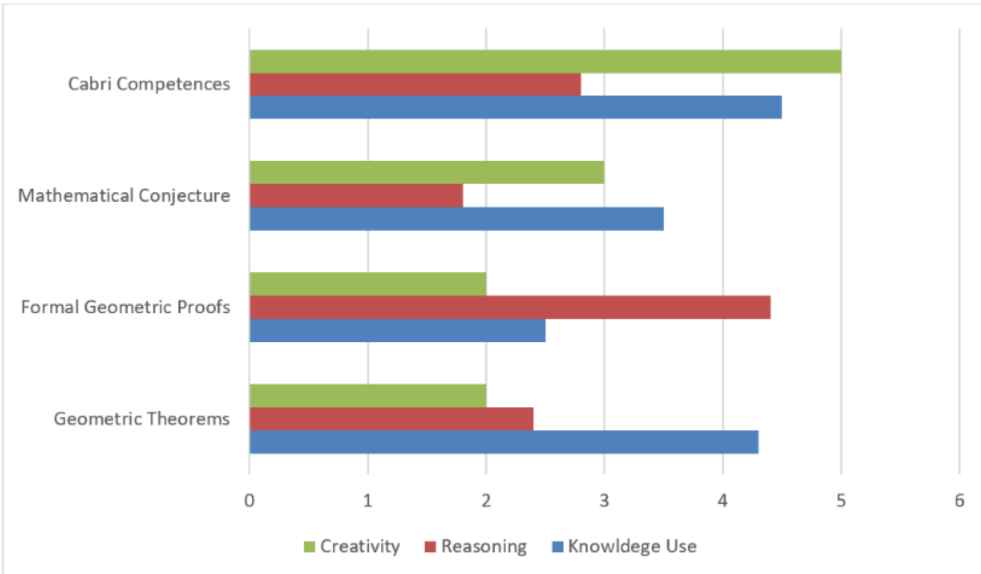

Figure 1: Descriptive Statistics of Ability to Construct Geometry Evidence

proofs. Thus, students tried to reproduce on paper to complete geometry labels that were not available in Cabri.

Qualitative Data

In quantitative data analysis using the SPSS 19 program, descriptive statistics data were obtained from the ability to compile geometric proofs as follows:

Before carrying out the t-test, the normality and homogeneity tests were carried out as a prerequisite for testing. Following are the results of testing for normality and homogeneity of data. From the test results, it was found that the data were normally distributed and homogeneous. Furthermore, the prospective teacher students completed a test to construct geometric evidence from geometry learning[10]. Students who explored geometry by the *dynamic geometry Cabri II plus software* are the experimental class, and students who received conventional learning is the control class. It is in line with the research results, which reveal that the use of Cabri in the conjectured process is beneficial and helps students express the idea of geometric proof and helps students in the creative process of constructing geometric proofs [17, 13].

Table 2: Comparison Test Result on the Average Ability to Construct Geometry of Experiment Class and Control Class

Reconstructing Geometrical Proof		T	df	*p-value* (1-tailed)
Post-test	Equal variances assumed	3.434	70	.002
	Equal variances not assumed	3.434	68.654	.002

From table 2, it can be seen that the significance is 0,002 < from α = 0,05. It rejects H_0, which means that the ability to construct evidence of geometry for students that used geometry exploration software *Cabri II plus* (experimental class) is better than students who receive conventional learning (control class). Furthermore, the effect size test was performed to see the effectiveness of geometry exploration using the dynamic geometry software *Cabri II Plus* in constructing geometric proofs[10]. The test results obtained ES value = 0,645, which is in the medium category. It indicates that geometry exploration activities using dynamic geometry software Cabri II plus are more effective than conventional learning in constructing student teacher candidates.

5. Conclusion

The results showed that learning geometry exploration using dynamic geometry software Cabri II plus was effectively implemented to encourage students' ability to construct geometric proofs. Some of the advantages of using dynamic geometry software *Cabri II plus* include: helping students in the process of visualizing the problems to be proven; assist students in the process of drafting the intended evidence conjecture; and building students in the process of justifying the geometry theorems to be used. However, there are still several obstacles in the learning process: there is no detection service for the geometry theorem in *Cabri II plus* and a lack of tools supporting labelling the supporting elements of geometric proof in *Cabri II plus*. Regarding these findings, it is essential to improve the Mathematics Teacher Education Study Program's learning process, especially the geometry subject, continuously to develop the learning process to make it better and more effective. So, the student candidate teacher's competence can be increased according to the predetermined graduate profile.

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