

The development of buffer solution material through flipped classroom model

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Abstract. Buffer solution is one of the abstract chemical concepts so it needs deep study and optimal time to learn it. The purpose of this research is to describe the development of buffer material through flipped classroom learning model. The method used is pre-experiment with one group pretest-posttest design. Research subjects are chemistry education study program students of second semester. The results showed that students are able to respond to the phenomenon and explain the buffering buffer technique based on the working principle; responding to the calculation result of buffer process; and predict the pH of blood in the body based on the effect of activity. This is achieved because students explore the material optimally outside the face-to-face with the help of learning videos, and then discussed in the classroom. Thus the material of the buffer can be studied optimally. The development of buffer materials through the flipped classroom model can contribute to higher order thinking skills.

1. Introduction

The buffer is one of the abstract of chemical concepts [1]. The material of buffering is quite complex, there are many concepts, calculations, and applications in everyday life [2, 3]. The curriculum demands in this material is that the student must be able to design and experiment as to identify buffer, calculate buffer's pH, and can explain its function in living organism [4].

The buffer materials consist of factual knowledge, conceptual knowledge, and procedural knowledge. Material cannot be understood with the dimensions of the low-level cognitive processes, because to achieve it needs process of analyzing, evaluating, and synthesizing. This is also because the buffer material has many applications in everyday life, both in human bodies and industrial [5]. Therefore, the material of the buffer needs to be developed optimally in order to be well-understood by the students.

In general, the high-order thinking skills have been applied in lectures, but the results are not optimal. This is because students are memorizing concepts rather than understanding concept. In addition, the learning time in the classroom is limited that the lecturer is difficult to guide the students to develop the material of buffer in order to improve their high-level thinking ability.

Along with today technology development, there is a learning model that can be applied to develop learning materials, namely the model flipped classroom [6]. This learning model utilizes supportive technology learning materials to be accessed both online and offline [7] [8]. The flipped classroom model applies the home learning process as the initial learning to understand the material using technology in the form of computer or internet gateway and network which then to be continued in the



class with a discussion about the material that has not been understood [6] [9]. Thus, the students do not have to always face to face with the lecturers in studying the material of buffer, simply by accessing the material that has been provided by lecturers by online.

In addition, students can access learning materials flexibly, can be anywhere and anytime. Simply put, flipped classroom model of learning reverses the process of learning in the classroom in the form of understanding the material be at home, and learning at home in the form of completing assignment be in class [10].

By using the flipped classroom model, the buffer material can be optimally developed, since the time used to understand the material is considerable. Thus, the development of buffer materials using the flipped classroom model can contribute to improving students' high-order thinking skills.

2. Method

This research used pre-experimental method with design one group pretest-posttest. So, a pretest was conducted at the beginning of learning to know the level of inability to initial critical think of the students. After that, a treatment was given namely application of the flipped classroom learning model on the subject matter of the buffer. Then, the researchers conducted posttest at the end of the learning. The study design can be described as follows.

Table 1. pre-experimental method.

Pre-test	Treatment	Post-test
O ₁	X	O ₂

Description

- O₁ : Pre-test
- X : Treatment, i.e. learning with using the flipped classroom model
- O₂ : Post-test

Researchers conducted the pre-test at the beginning of learning to know the ability of students' high-order thinking. After the pretest, the treatment of the model of learning flipped classroom on the buffer material was given, then the post-tests was conducted. The result of pretest and post test results was compared to draw a conclusion.

Instruments used in this study include learning descriptions, learning videos, social media of *instagram*, and the problem device. Meanwhile the data collection technique was done by the test to know the improvement of students' high thinking ability.

Students were said to have had high-level thinking skills if there was a difference after the application of the flipped classroom model. If there was difference, then analysis the calculation of the value of $\langle g \rangle$ to determine the extent of the difference between pretest and posttest value after application of the flipped classroom learning model.

3. Results and discussion

The material of buffer is quite complex, but in general there are 3 following aspects that the students must master: 1) working principle, 2) synthesis, 3) application. Development of buffer material by applying flipped classroom model.

Students generally do not understand the working principle of buffer. The evidences are the students' answers during the pretest. Students state that when the buffer is added acid, then the H⁺ of the acid will react with the acid again contained in the buffer system. In addition, students also consider that the addition of acids or bases into a buffer will change the pH of the buffer system. Percentage increase of students' understanding in buffer material can be seen in table 2 below:

Table 2. Percentage of improved materials of buffers.

No.	Material Indicator	Increase Percentage
1	Know the working principle of buffer	60%
2	Create buffer with a certain pH	2%
3	Create an experimental procedure of buffer	28%
4	Know the application of buffer in life	22%
5	Know the comparison of buffer component	5%

According to the table 2 then after flipped classroom model is developed, there is an increased understanding of the students as much as 60%. The students know that the addition of acid into the buffer will be neutralized by the conjugate base in the buffer system. In addition, students also understand that buffers can maintain the pH of a slight addition of acids or bases.

The second indicator measured in the development of buffer material is the students' ability to make buffer with specific pH. Before the flipped classroom model is developed, students had difficulties in determining the number of moles needed to make buffer, but after developing there is a 2% increase in students' ability.

The third indicator measured is the ability of students in designing experiments of making buffer. Some students have been able to determine the amount of material needed to experiment the buffer but are still confused in the experimental procedure. This is indicated by the student's answer when the pretest only answers how to find the amount of material to be prepared. After flipped classroom model is developed, the students' ability to create buffer experiment procedure increases by 28%. Students have the ability in designing the right experiment with a buffer.

The fourth indicator measured is the student's ability to analyze the application of buffer in the human body. Prior to applying the flipped classroom model in material development, students generally understand that respiratory distress will lead to alkalosis. This answer is erroneous because it should lead to acidosis resulting from accumulation of CO₂ inside the body. Some students have the right answer, but the percentage is still low. Once applied the flipped classroom model, the students' ability to analyze the application of buffer in human body increases by 22%. Students have better understanding the application of buffer in the human body.

The fifth indicator measured is the student's ability in determining component comparisons in the buffer system. When the pretest was given, the students were having difficulty determining the amount of mole of base and conjugate acid so that it can not determine the component ratio. Only a few students are able to answer correctly. Once developed through the flipped classroom model there is an increase of 5%. Students become more skilled in performing the calculation of buffer so as to determine the comparison of its components.

The material development process is outlined in 2 steps. The first stage was at home, while the second stage was in the classroom. At the first stage students are given learning videos to study at home. At this stage, students have an optimal time to understand the many materials that must be mastered. Besides, the students have the opportunity to seek references from the literature such as textbooks, e-books, or websites.

After studying the material at home, the students proceed to study in the classroom. During the classroom activity, the students discussed the material of the buffer that they did not understand yet. Then several practice questions are given to solidify the understanding of the concept.

Students generally face challenges doing analysis, evaluation and synthesis. The cause of all these is the lack of students' mastery level due to class activity's limited time. Only 18% of the students are able to analyze, 31% of the students are able to evaluate and 12% of the students are able to synthesize.

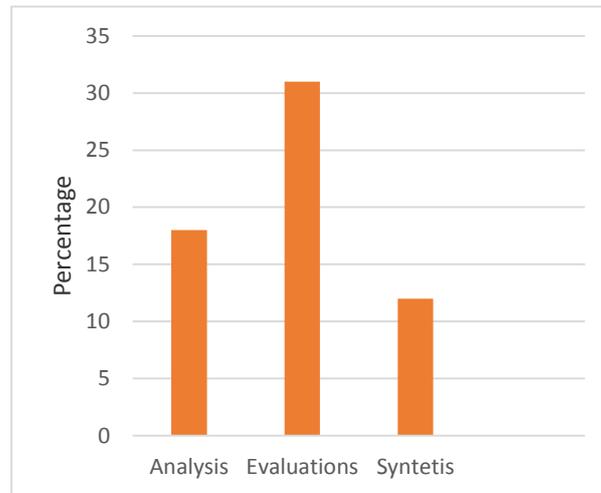


Figure 1. Percentage of students' high-level thinking ability after pretest.

After the Flipped Classroom model is applied, the students' ability to answer the test using the high-order thinking skill increased. 20% of the students are able to analyze the principal of buffer, 60% of the students are able to answer the questions at evaluation level, and 40% of the students are able to synthesize the buffer.

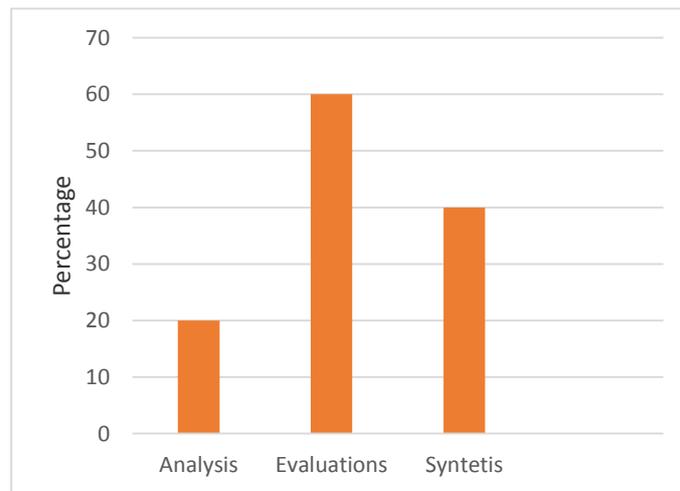


Figure 2. Percentage of students' high-level thinking ability after post-tes.

4. Conclusion

The buffer material can be developed with the flipped classroom model. Application of this model can improve students' understanding of the working principle of buffer, application of buffer, and able to design experiment of buffer. So the application of this model can contribute to the improvement of students' high-level thinking skills.

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