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Experiment-based Learning in The Topic of Natural Acid-Base Indicators During a Limited Face-to-face Learning Process

Sonny Rohimat [1 *]
[1] SMA Negeri 6 Kota Serang, Serang, Banten, Indonesia
[*]E-mail: albaregbegi@gmail.com

Abstract

The implementation of limited face-to-face learning is carried out while still complying with health protocols to prevent the spread of Covid-19. The curriculum used is the 2013 curriculum for emergency conditions. The implementation of the distance learning policy for more than two years has caused various problems for both teachers and students. In the subjects of the natural sciences, including chemistry, one of the problems that arises almost everywhere is the achievement of basic competency skills that require the implementation of experimental learning methods. This research was conducted to overcome these problems in line with the policy of implementing limited face-to-face learning by applying practical learning on natural acid-base indicator material. The research was conducted descriptively with the research subject as many as 19 students on a limited schedule of face-to-face learning at school. The research consisted of two stages, i.e., the preparation stage which consisted of curriculum analysis, student analysis, analysis of learning resources, and preparation of learning tools, and the implementation stage, i.e., the experimental learning process through natural acid-base indicator practicum activities which is carried out in the laboratory using a discovery learning model. All stages of learning were carried out well and all students showed a positive attitude towards the competence of activeness and cooperation.

Keywords: Discovery Model Learning, Experiment-based Learning, Limited Face-to-Face Learning, Natural Acid-Base Indicators

INTRODUCTION

After more than two years since the implementation of the learning from home (Ministry of Education and Culture of the Republic of Indonesia, 2020), the government has finally opened space for limited face-to-face learning (Ministry of Education, Culture, Research and Technology, 2022). Through a circular letter, the government regulates the implementation of limited face-to-face learning related to school readiness, implementation time, educator conditions, and the number of students.

In the implementation of limited face-to-face learning, educators and students must continue to comply with health protocols such as wearing masks, maintaining distance, washing hands, avoiding crowds, and limiting mobility (Ministry of Health, 2020). Among the steps taken so that educators and students continue to comply with health protocols, schools must prepare adequate hand washing facilities, rearrange lesson schedules, and arrange student schedules for face-to-face learning. The number of students allowed in one session of face-to-

face learning activities is 50% of the total number of students.

The curriculum used during learning during the Covid-19 pandemic is the 2013 Curriculum for emergency conditions (Research and Development and Books Agency, 2020). This curriculum is a simplified 2013 curriculum as an adjustment step to emergency conditions where learning cannot be carried out normally as before the emergence of the Covid-19 outbreak. In every subject, including chemistry at the high school level, there are several basic competencies that are omitted in this curriculum.

Based on various studies, there are problems that arise during online learning (in the network). Among these problems are internet network constraints, high plagiarism in doing assignments or assessments (Saefulmilah & Saway, 2020), teacher limitations in mastering online media, and difficulty understanding material content (Wahyuningsih, 2021). In chemistry and other science subjects, learning that requires the use of experimental methods cannot be implemented properly. Although there are many available online or virtual practicum applications (Purwanto & Muhidin, 2020), the competency skills of students cannot be achieved properly.

Although there are studies that show that online learning is still effective, experimental problems are still considered problematic (Rohimat, 2021). Other research actually shows that online learning is not effective, especially in subjects that require learning using experimental methods or practical activities (Zahrawati & Indah, 2021). In fact, research with wider respondents shows that most high school students do not do laboratory practical activities, and the rest do practice at home (Sari, Sinaga, Hernani, & Solfarina, 2020). The limited face-to-face learning policy is good news for overcoming the problem of learning that has been ineffective so far, especially in the basic competencies of skills that require the implementation of experiments.

Experiment is a learning method in which students carry out experimental activities or trials to learn through experience and evidence (Helmiati, 2012). Learning by providing such direct experience can help students gain a better understanding in the field of natural sciences (Saadah & Susanti, 2020).

In the experimental method, students are required to try, experience, and draw conclusions from what they experienced so that students believe more in the truth or conclusions based on experiments (Hunaepi, Samsuri, Asy'ari, & Sukaisih, 2014). The experimental method is one of the methods that demands several basic competence aspects of skills in the subjects of the natural sciences, including chemistry. In chemistry subjects, the experimental method is carried out through practical learning activities. Practical learning requires certain tools and materials, and its implementation requires guidance and supervision from the teacher.

One of the learning models that can be done with a scientific approach and experimental method is the discovery

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learning model (Devi, 2016). Discovery learning is a learning model that encourages students to participate actively in gaining learning experiences and allows them to find facts and concepts (Nurdyansyah & Fahyuni, 2016). The discovery of this fact or concept can be done through practical activities and following scientific procedures. At the high school level, especially before students have never carried out practical activities, learning must be under the direct guidance and supervision of the teacher.

This research was conducted to address the limited face-to-face learning policy in overcoming learning loss in the achievement of student competency skills by applying practical learning to natural acid-base indicator material. The existence of face-to-face learning opportunities, after more than two years of not being implemented, must be utilized as well as possible. For more than two years, students have never participated in face-to-face learning resulting in ineffective learning of basic competency skills using the experimental method.

METHOD

This research is a descriptive research. Descriptive methods can be used to explain things related to activities, attitudes, or processes that occur (Samsu, 2017). The study was conducted in the fourth week of January 2022. The subjects of this study were 19 students of SMAN 6 Serang City, that is 50% of the total students of class XI MIPA 5. Only 50% of the students who were the subjects of the study were with the implementation of a limited face-to-face learning policy.

The research consisted of two stages, namely the preparation stage and the implementation stage. The steps taken in the first stage are curriculum analysis, student analysis, analysis of learning resources, and preparation of learning tools in the form of learning implementation plans, student worksheets, and observation sheets, as well as delivering information to students regarding the learning to be carried out. At the implementation stage, the activity steps are adjusted to the syntax of the discovery learning model, namely providing stimulation, problem identification, data collection, data processing, proof, and drawing conclusions (Devi, 2016).

Furthermore, the effectiveness of practical learning is obtained from the results of the questionnaire. Effectiveness is calculated using the following formula.

$$SA = \frac{\sum NRS}{NRS\,\max} x100\%$$

(Suryanda et al., 2019)

Note :
NRS = total score

Based on the results of the data analysis, the effectiveness of learning can be concluded by adjusting to the following categories in table 1.

Table 1. Criteria for learning effectiveness

Score (%)	Criteria
85% < score	Very good
70% < score ≤ 85,00%	Well
50% < score ≤70%	Not good
score ≤ 50%	Not good

RESULT AND DISCUSSION

The learning preparation stage begins with an analysis of the basic competencies of lessons in the 2013 curriculum for emergency conditions. The next step is the analysis of students who are research subjects, analysis of learning resources, and the preparation of learning tools. The final step in the preparation stage is the delivery of information to students regarding the lesson plans to be carried out.

Based on the results of the 2013 curriculum analysis for emergency conditions, there are several basic competencies in the 2013 curriculum that are omitted for learning in emergency conditions. However, the first basic competence for even semesters in class XI chemistry subjects is still the same as the basic competencies in the 2013 Curriculum under normal conditions.

The basic competence in the aspect of knowledge is to explain the concepts of acids and bases as well as their strengths and ionizing equilibrium in solution. The basic competence in the skill aspect is analyzing the pH change trajectory of several indicators extracted from natural materials through experiments. The material that will be the focus of learning in this research is basic competence in the skills aspect. The skill competency in the form of an experiment requires the use of experimental learning methods.

The second step in the preparation stage is the analysis of students, especially students of class XI MIPA 5 who are research subjects. The number of students in class XI MIPA 5 is 38, consisting of 13 boys and 25 girls. In limited face-to-face learning, the number of students who do face-to-face learning is 50%, while the other 50% do distance learning. So the number of students in class XI MIPA 5 who attends one meeting is a maximum of 18 people. The division of student groups for the limited face-to-face learning schedule and distance learning is carried out based on the order of the student attendance list.

In addition to the curriculum and students, another factor analyzed at the preparation stage is learning resources. Learning resources are adjusted to the basic competencies in the skills aspect in the form of trajectory analysis of changes in pH of several acid-base indicators which are extracts from natural materials through experiments. In addition to textbooks, other learning resources needed are experimental or experimental tools and materials. The main ingredients needed are acidic solutions, alkaline solutions, and natural materials that can be used as acid-base indicators. Natural ingredients that can be used as acid-base indicators include colored flowers, purple cabbage, turmeric, and mangosteen rind. The materials are quite easy to obtain, even in the school environment and its surroundings.

The next step is the preparation of learning tools that are adapted to the results of curriculum analysis, student analysis, and analysis of learning resources. The learning tools prepared at this stage are the lesson plan, student worksheets, and student observation sheets. The lesson plan is a technical design for the lesson

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to be implemented. Student worksheets are learning media that will be used as a guide as well as assignments for students during the learning process. The student observation sheet is an instrument that will be used to assess the attitudes and skills of students during learning activities.

The lesson plan is adapted to the latest simple format, only one sheet is enough. The learning implementation plan contains identity, learning objectives, learning steps, and assessments. The identity that is included in the lesson plan made consists of the name of the school, subject, subject matter, submaterial, class/semester, time allocation, and learning model. The learning objectives are adjusted to the basic competencies in the skills aspect. As for the assessmentthe type of instrument used is included in the observation sheet.

Student worksheets are made simple and adapted to the method used, namely practicum. Student worksheets are arranged in a simple manner so that they are easily understood by students. This student worksheet is the result of improvements and adjustments from student worksheets that have been used in previous years when learning was carried out a full face-to-face learning, prior to the implementation of learning from home due to the Covid-19 outbreak. Student worksheets consist of titles, student identities, experimental objectives, tools and materials, experimental steps, observation tables, discussions, and conclusions. Student worksheets are printed and distributed to each group.

Student observation sheets are used as an instrument for assessing the competence of students' attitudes. Attitude competencies assessed in this study are social attitudes in the form of student activity and cooperation. The assessment consists of four criteria, namely very good, good, sufficient, and poor. A very good indicator is that students show an active attitude and work together in all stages of learning activities. A good indicator is that students show an active and cooperative attitude in most stages of learning activities. An adequate indicator is that students show an active attitude and work together in a small number of stages of learning activities. Less indicators are students do not show an active attitude and work together in all stages of learning activities.

The final step in the preparation stage is the delivery of information to students regarding the lesson plans to be carried out. The delivery of information was carried out for the first time during the implementation of limited face-to-face learning, two weeks before the implementation of practical learning. Information was resubmitted one day before the implementation of practicum learning by the class leader through the Whatsapp group. The information contains the time, place, group formation, and tasks that must be done by each group.

The implementation stage of learning is carried out according to the limited face-to-face chemistry lesson schedule. The learning model used is the discovery model with the syntax of giving stimulation, problem identification, data

collection, data processing, proof, and drawing conclusions. Learning is carried out through practical activities to identify natural materials that can be used as acid-base indicators.

Learning is carried out face-to-face limited in class XI MIPA 5. Learning is attended by 50% or as many as 19 students who get a face-to-face learning schedule (outside the network). Learning is carried out in a natural science laboratory in the school because it uses experimental methods through practical activities.

The first step is to provide a stimulus or stimulus to students. Giving stimulation is done through demonstration activities of acid-base reactions by adding an acid-base indicator. The acid solution used is a solution of vinegar or CH3COOH, while the base solution is a solution of caustic soda or NaOH, both of which are made qualitatively. Vinegar solution and NaOH solution are colorless solutions. The acid-base indicator used is phenolphthalein which is a white powder. In this activity, students observed color changes when NaOH solution was added to a vinegar solution that had been given a phenolphthalein indicator. At first the vinegar solution which had added phenolphthalein indicator was colorless, but the color changed to pink after the addition of NaOH solution.

In addition to the demonstration of the color change of the phenolphthalein indicator in the vinegar solution before and after the addition of NaOH solution, students were also stimulated by reviewing their knowledge of litmus paper. In general, students already know that one of the indicators of acid base is litmus paper. Some of them have also tested acid and base solutions using litmus paper at their previous education level. Litmus paper will turn red when placed in an acidic solution and blue when placed in an alkaline solution.

The second step is problem identification. After observing the demonstration, students identify questions related to the demonstration presented. These questions include the following; First, why can phenolphthalein powder and litmus paper be used as acid-base indicators? Second, are there any natural ingredients that can be used as acid base indicators other than phenolphthalein powder and litmus paper?

The third step is collecting data through practicum activities for natural acid-base indicators. In this practicum, students are divided into groups of four or five members. During practicum activities, all students are encouraged to always comply with health protocols. Students keep their distance, wear masks, and get used to washing their hands with running water. In terms of maintaining distance, students are asked to do the division of tasks well so as to minimize direct physical contact between them.

Practical activities are carried out according to the instructions given on the student worksheets. Each group gets tools and materials according to their needs. The tools used by each group are available in the laboratory, namely test tubes and their tube racks, 100 mL beakers, dropper

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pipettes, and mortar and pestle. The materials used are distilled water, vinegar solution, caustic soda solution, and various natural ingredients that will be used as acid-base indicators. Aquades, vinegar solution, and caustic soda solution are available in the laboratory, while natural ingredients such as various flower crowns and mangosteen rind are provided by each group of students.

Students in each group divide the tasks and carry out the practicum according to the practicum instructions listed on the worksheet. After all the tools and materials are available, students make an extract from one of the available natural ingredients. At the same time, another group member prepared three test tubes and each was filled with a different substance. The first test tube is filled with about 10 mL of distilled water, the second test tube is filled with about 10 mL of vinegar solution, and the third test tube is filled with about 10 mL of caustic soda solution. In each test tube, 4-6 drops of natural extract were added. Students record the color produced in each test tube in the observation table provided on the worksheet.

The practicum is carried out three to four times using different natural materials. Based on the results of the experiment, it is known that various natural materials give different results. There are natural materials that give the same or almost the same color in the three test tubes, some give different colors between acids and bases, and some even give different colors to the three test tubes containing a solution of acid, aquades, and a base solution.

The next step is processing data from the lab results of natural acid-base indicators. The data processing of the practicum results is carried out through group discussions in filling out student worksheets. On the student worksheets, each group is required to answer several questions related to the experimental data. These questions lead to the objective of the experiment, which is to identify natural materials that can be used as acid-base indicators.

The step of data processing data from lab results of natural acid-base indicators is followed by proof or verification. The verification process is carried out through discussions and questions and answers with subject teachers related to the data found from the results of the practicum. Each group representative conveys the results of his group discussion in accordance with the experimental data that has been carried out. Each group is also allowed to ask questions or respond to the results of other groups' experiments. If there are things that need to be clarified, the subject teacher directs the students' answers to match the concepts being studied.

The last step in the discovery learning model is drawing conclusions. After carrying out the experiment, processing and verifying the experimental data, students draw conclusions. This conclusion relates the learning objectives, experimental results, and verification results to related concepts. Each group writes the results of their conclusions on

the student worksheets.

Based on the results of observations, all students showed a very good attitude or good in the competence of activeness and cooperation. In the activity competence, as many as 57.9% of students showed a very good attitude and 42.1% showed a good attitude. On the competence of cooperation, as many as 73.7% of students showed a very good attitude and 26.3% showed a good attitude. This data shows a positive attitude of students in participating in practical learning activities.

The results also show that practical learning with the discovery model has good effectiveness. Discovery learning is a learning model that directs students to be able to analyze problems, find solutions, and ultimately find and understand concepts independently. The discovery learning model is also a series of learning activities that involve students' overall ability to investigate problems through scientific methods critically, systematically, and logically so that students can find an understanding of knowledge, attitudes, and skills independently (Kristin, 2016).

In contrast to conventional learning models, discovery learning or discovery learning is more student-centered. Direct experience received by students in the learning process is the main goal to be achieved (Istikomah, et al., 2017).

As it is stated that the discovery learning model is a learning model that focuses more on the experience received by students directly and prioritizes the process rather than learning. Based on the description above, it can be concluded that discovery learning-based practical learning is learning that can guide students to actively gain an understanding of their own knowledge (Fitria, et al., 2018).

The results also show that this learning is effective, because it is supported by the advantages of the discovery learning model, including: 1) can guide students to improve mastery of skills in cognitive processes, 2) help students to acquire knowledge individually, 3) can increase student learning motivation. , and 4) provide opportunities for students to develop according to their respective abilities.

Based on the description above, it can be concluded that learning with the discovery model on Natural Acid-Base Indicator material is carried out well using the experimental method. Therefore, it is necessary to carry out practical learning on other materials on an ongoing basis.

CONCLUSION

Based on the research that has been carried out, it can be concluded that learning with the discovery model on Natural Acid-Base Indicator material is carried out well using the experimental method. Experimental learning methods are carried out through practical activities using natural materials obtained from the surrounding environment. Students also follow all stages of learning with activeness and positive cooperation.

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BRIEF PROFILE

The author was a graduated from Chemical Education Study Program on Indonesian Education University in 2009. In 2009-2014 became a teacher at SMKN 1 Cidaun-Cianjur, and since 2014 until now he has been a chemistry teacher at SMAN 6 Kota Serang. Currently the author is active as the Secretary of the Chemistry Subject Teacher Consultation (MGMP) of High School Kota Serang and Deputy Chair of the Indonesian Chemical Science Educators Association (PPSKI) Banten Province.

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