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Improving Student Learning Outcomes by Applying the Discovery Learning Model to the Acid-Base Titration Material of Senior High School

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Abstract

The acid-base titration topic has links between concepts, equations of reactions, and calculations. Therefore, the lack of mastery related to this topic will affect the low learning outcomes. This study aimed to improve student learning outcomes on the acid-base titration topic by applying the discovery learning model. The sample of this study was students of class XI MIPA SMA Negeri 5 Palu, consisting of class XI MIPA 5 as experimental class 1 (n = 35) and class XI MIPA 6 as experimental class 2 (n = 33). The effectiveness of applying the discovery learning model can be seen from the average N-gain value in the experimental class. For experimental class 1, the average N-gain value was 0.67, which is included in the medium category. While the experimental class 2 was 0.63, which is included in the medium category. Based on the results of data analysis, the average value of student learning outcomes for experimental class 1 was 76.42 and experimental class 2 was 75.3. This value was greater than the average student learning outcomes before the treatment, which were 65. So it can be concluded that applying the discovery learning model can improve students' learning outcomes in class XI MIPA on acid-base titration topics in SMA Negeri 5 Palu.

Keywords: Discovery learning, acid-base titration, learning outcomes

Introduction

Curriculum is an essential element of education in Indonesia. The 2013/2014 school year was the beginning of the government's implementation of a new curriculum in the field of education. The curriculum in question is the 2013 curriculum as a replacement for the KTSP used for the past six years. The curriculum changes are made as an effort to improve the education system in Indonesia to compete internationally and also as an effort to overcome the changes that occur due to globalization. This aligns with Mulyasa's (2004) opinion that the national education system must constantly be developed by the needs and developments that occur at the local, national, and global levels. The learning process in the 2013 curriculum for all levels is carried out using a scientific approach. Learner-centered learning approach that has criteria for learning materials based on facts or phenomena that can be explained with certain logic or reasoning, encouraging and inspiring learners to think critically, analytically, accurately in identifying, understanding, solving problems, developing rational and objective thinking patterns in responding to materials and applying learning materials (Southworth, 2022).

Education is one of man's absolute needs to educate the nation's generation. Education teaches various disciplines as a basis for thinking to make a change. The effort that must be made is to use the proper learning process. A significant problem in the current learning process is the lack of efforts to develop thinking that leads students to solve problems. This problem can affect students' learning outcomes, especially in chemistry subjects.

The discovery learning model can be used as an alternative to improve student learning outcomes. According to Munna & Kalam (2021), discovery learning involves students in mental activities such as exchanging opinions, discussions, seminars, reading, and trying themselves, so that children can learn by themselves. Students actively find their concepts in learning with sufficient guidance from the teacher.

Understanding concepts, meanings, and relationships through an intuitive process is the goal of the discovery learning approach (Pasaribu et al., 2019). In the application of the discovery learning model, the teacher acts as a guide by

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providing opportunities for students to learn actively, as the role of the teacher must be able to guide and direct student learning activities, following learning objectives. According to Joolingen (1999), discovery learning is learning where students build their knowledge by experimenting and making conclusions about rules/concepts from the results of their experiments.

Rosnidar et al. (2021) explain that the discovery learning model emphasises the importance of understanding a concept through active student involvement in the learning process. This learning model emphasises the formation of student knowledge from experiences during learning.

Several studies explain that Discovery Learning is an appropriate learning model to increase students' interest and learning achievement. Mahmoud (2014) explains that Discovery Learning helps to obtain activities where students learn for themselves and apply what they know in new situations, leading to effective learning. With this learning model, students are expected to understand better the concepts of the material being studied, which will affect their learning achievement. Research by Akinbobola & Afolabi (2010) explains that the source of students' interest in science and technology can be achieved through discovery learning. Thus, it is expected that students' interest in learning chemistry will increase, so that their learning achievement can also increase.

The advantages of the discovery learning model over other cooperative models are that students are active in teaching and learning activities. The student thinks and uses their abilities to find the final result. Students understand the learning material because they experience the process of finding it themselves, which can cause a sense of satisfaction (Ningrum et al., 2022). Hence, it encourages students to make more discoveries to increase their interest in learning. Students who acquire knowledge through the discovery method will more easily transfer it to different contexts; this method trains students to learn more independently (Novantri et al., 2020).

Chemistry is one of the subjects that discusses matter and the changes that occur in it. Chemistry is a major contributor to the development of science and technology. In our daily lives, we cannot be separated from chemistry, from the air we breathe to the food and drinks we consume daily, which are all compounds or chemicals (Oktariani, 2018). The objectives and functions of chemistry subjects in SMA and MA listed in the content standards include the promotion of scientific attitudes, which include being critical of scientific issues, namely not believing easily without the support of empirical observations, understanding chemical concepts and their application to solve problems in everyday life (Sausan et al., 2020).

One of the chemistry materials that students of Class XI SMA Negeri poorly master 5 Palu is acid-base titration material. Based on the results of interviews with a chemistry teacher at SMA Negeri 5 Palu, it was revealed that the average student score so far is 65. This is because students experience a lack of mastery of the material. The lack of mastery of the material is the main factor that leads to students' difficulties in solving reaction equations and calculations, especially in acid-base titration material. This can be seen in the students' inability to distinguish between titration of a strong acid with a strong base, titration of a strong acid with a weak base, titration of a weak acid with a strong base, and titration of a weak acid with a weak base.

Learning chemistry should be fun because it is related to everyday life. However, chemistry is one of the branches of mathematics and science that is still considered difficult (Wasonowati et al., 2014).

Based on the above description, researchers are interested in researching how to Improve Student Learning Outcomes by applying the Discovery Learning Model to Acid-Base Titration Material Class XI SMA Negeri 5 Palu.

Methods

This study used pre-experimental research, which is a type of research because there is no equalisation of characteristics (random) and no control of variables (Sukmadinata, 2012). The research design is a one-group pre-test-post-test (Sugiyono, 2015).

Table 1. One group pretest-posttest design

Class	*Pretest*	Treatment	*Postest*
Experiment 1	O_1	X	O_2
Experiment 2	O_1	X	O_2

Description:
X: Treatment using the discovery learning model
O_1 : *Pretest*
O_2 : *Postest*

The place of research was carried out at SMA Negeri 5 Palu, Palu city, Central Sulawesi Province, and the time of this research was conducted from April to May 2019 of the 2018/2019 school year. The population of this study was XI grade students of SMA Negeri 5 Palu who were enrolled in the 2018/2019 academic year, in as many as six classes. The sample in this study consisted of 2 classes, namely XI MIPA 5 class as experimental class 1, which amounted to 35 students and XI MIPA 6 class as experimental class 2, which amounted to 33 students.

The sampling technique is done purposively, meaning that the researcher determines the sample because of specific

considerations. So, the sample is taken not randomly but determined by the researcher.

The instruments used in this study are RPP, LKPD, and an observation sheet. The learning outcomes test was given twice during the pretest and posttest. The learning outcome ability test was a multiple-choice test that had previously gone through the theoretical and empirical validation stages. The data analysis used in this study is cognitive learning outcomes data and N-gain analysis.

Results and Discussion

The results obtained in this study are student learning outcomes and assessment of the teaching and learning process per the model applied. The sample in this study was the XI MIPA class of SMA Negeri 5 Palu, consisting of XI MIPA 5 as experimental class 1, totalling 35 students, and XI MIPA 6 as experimental class 2, totalling 33 students. Both classes applied the same learning model, namely the discovery learning model.

The instruments used in this study were lesson plans (RPP), student worksheets (LKPD), observation sheets, and learning outcomes tests in the form of multiple-choice questions. The problem consists of 25 items that are validated in two ways, namely theoretically and empirically. The validation results were obtained from 20 questions that were used as standardised tests.

Student learning outcomes

Pretest

The initial test was conducted to determine students' ability before the learning process was carried out on acid-base titration material. Table 2 shows the results of the calculation of the average value of the initial test of student learning outcomes on acid-base titration material for experimental classes 1 and 2**.**

Table 2 Student preliminary test analysis (pretest)

Description	Class XI MIPA 5	Class XI MIPA 6
	Experimental Class 1	Experimental Class 2
Number of Samples	35	33
Minimum Value	10	10
Maximum Value	40	55
Average Score	24	30.6

Posttest

The final student test was conducted to determine student learning outcomes after applying the discovery learning model. Table 3 shows the results of the calculation of the average value of the final test of student learning outcomes on acid-base titration material for experimental classes 1 and 2.

Table 3 Analysis of students' final test (posttest)

Description	Class XI MIPA 5	Class XI MIPA 6
	Experimental Class 1	Experimental Class 2
Number of Samples	35	33
Minimum Value	65	60
Maximum Value	95	90
Average Score	76.42	75.3

N-Gain analysis results

N-gain testing can show that using the discovery learning model improves cognitive learning outcomes. N-gain testing involves describing the data collected based on the achievement of each variable in the relationship between pretest and posttest scores of students in experimental class 1 and experimental class 2. The results of the N-gain calculation can be seen in **Table 4**.

Table 4. N-gain calculation results

Class	Pretest	Posttest	N-gain	Category
XI MIPA 5	24	76.42	0.67	medium
XI MIPA 6	30.6	75.3	0.63	medium

This study was conducted to obtain a description of the improvement of student learning outcomes after applying the discovery learning model. This type of research is a pre-experimental research that aims to improve student learning outcomes by applying the discovery learning model on acid-base titration material in class XI MIPA SMA Negeri 5 Palu. The implementation of research in experimental class 1 and experimental class 2 used the same amount of learning time, namely 6 class hours. The material presented was also the same, namely acid-base titration, with the same order of presentation. This was done to see the success rate of the effectiveness of the applied model in improving students' learning outcomes on acid-base titration material.

Before starting the learning process, the students are given an initial test (pre-test) to see the initial ability of the students before starting the learning process on acid-base titration material. The test is given to the students as validated multiple-choice tests with 20 questions. Furthermore, the treatment (presentation of the material) was carried out by applying the discovery learning model. In the last stage, the final test (posttest) was given to the experimental class, which aimed to see the improvement of the students' learning outcomes after the learning process of the acid-base titration material. Furthermore, the data were analysed using the N-gain test.

The average score obtained by the students in the initial test (pretest) for experimental class 1 was 24, and experimental class 2 was 30.6. The average score obtained by the students in the final test (posttest) for experimental class 1 was 76.42, and experimental class 2 was 75.3. The data on students' learning outcomes in the pretest and posttest of the experimental class by applying the discovery learning model shows an increase in students' learning outcomes greater than 75 (KKM). The N-gain test aims to show increased learning outcomes after the teacher has taught using the applied learning model. Based on the research results obtained from experimental classes 1 of 0.67 and 2 of 0.63, both classes are in the medium category.

According to Ilahi (2012), discovery learning is a learning process that focuses on students' intellectual mentality in solving various problems to find a concept that can be applied in the field. Learning by discovery is learning to find, where a student is faced with a problem or situation that seems odd, so that students can find a way to solve it. Discovery learning can construct students' understanding of materials and information. Discovery learning is also under the development of information and communication technology to obtain references in finding all things related to the description of phenomena displayed by the teacher. Wenning (2010) states that students develop the concepts learned based on their experiences and build their concepts based on their thinking ability.

The discovery learning model can allow students to be more active in learning. Its advantages are that it can develop fundamental concepts in students, improve their memory power, develop student creativity in their learning activities, train students to learn independently, and help achieve the learning objectives desired by the teacher (Nurdin & Adriantoni, 2016). This model emphasises students' active role in learning, while the teacher is only a facilitator in helping students discover and construct the knowledge learned. Students are tasked to conclude a characteristic based on the simulation that has been done (Jong & Joolingen, 1998).

The discovery learning model is based on constructivist theories (Anyafulude, 2013). According to the view of constructivism, learning is an active process of students in constructing meaning, discourse, dialogue, and physical experience in which there is a process of assimilation and connecting experiences or information that has been learned (Rifa'i & Anni, 2011). Students can be actively involved in the learning process because learning in the discovery learning model requires students to be more active and find their answers to the problems in front of them. The problem-solving ability of students who use the discovery learning model is better than that of students who use the conventional learning model (Arifianto & Koeswanti, 2022). This is because the characteristics of the discovery learning model require students to be more active in discovering a concept, while the teacher only acts as a guide or director.

Conclusion

Based on the data analysis of student learning outcomes, it is concluded that applying the discovery learning model can improve student learning outcomes, namely 76.42 in experimental class 1 and 75.3 in experimental class 2. This value is greater than the average student learning outcomes before applying the discovery learning model, namely 65.

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