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Effectiveness Discovery Learning and Learning Cycle 5E Integrated Virtual Lab on Learning Outcomes in Acid-Base

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***Abstract*:** *This study was conducted to determine the effectiveness of the Discovery learning and Learning Cycle 5E learning models and to see the differences in academic performance from the two models. The method used is experimental. The population in this study were students of class XI Science at SMAN 17 Medan and the samples were class XI Science 4 as experimental class 1 and XI Science 3 as experimental class 2. The research results show that the Discovery Learning model is effective in improving academic performance as evidenced by the average N-gain value of 0.759 in the high category, the Learning Cycle 5E model is effective in academic performance as evidenced by the average N-gain value of 0.751 with high category and there is a significant difference in the academic performance of students who are taught using the Discovery Learning and Learning Cycle 5E models integrated with virtual labs on acid-base material as proven by carrying out by Independent Sample T-test so the output can obtained value of sig is 0.011<0.05.*

***Keywords*:** *effectiveness; discovery learning; learning cycle 5e; virtual lab; acids and bases*

INTRODUCTION

One important element in nation building that requires special attention is education, because education will boost the quality of human resources which are the main capital in carrying out development. Education must focus on the moral potential and abilities of students. The concept of education becomes increasingly important when someone enters society and the world of work because people must be able to apply what they learn at school to overcome the problems they face now and in the future (Djonomiarjo, 2020). Teacher competency is a crucial thing that must be improved in through training or seminars to improve the education system. Other things that need to be considered are strengthening students' initial understanding, improving the curriculum, providing adequate facilities, improving the quality of learning and evaluating learning (Fatma et al., 2020).

Chemistry is part of scientific science thatrequires analytical skills in studying it. This is because chemistry will study the structure, properties and composition of matter as well as the energy that accompanies these changes (Fatmawati et al., 2022). The

chemical concept related to reactions is the acid-base concept. The chemical concept related to reactions is the acid-base concept. Acids and bases are two extremely essential chemical compounds in daily life. In general, substances with a sour taste contain acids, whereas compounds with slippery properties and a bitter flavor contain bases (Nasution & Jahro, 2023). Acid-base material contains knowledge with factual, conceptual and procedural dimensions. When the learning process is complete, learner should expected to be able to master acid-base theory, how to identify acid-base compounds with indicators and be capable to determine the pH of acid-base compounds with certainty (Isdayanti et al., 2022).

The observations and interviews that the researcher conducted with one of the chemistry teachers at SMA Negeri 17 Medan, led the researcher to a result where it was discovered that chemical abilities as seen from students' chemistry learning outcomes are still far from successful, as seen from the students' completeness in the acid-base material. which is still below 50%. The problem identified is the use of media and models that are not yet optimal. The model commonly used by teachers in teaching is the conventional model using PowerPoint media. An important aspect that teachers miss during learning is practicum. Limited tools and materials often become obstacles in carrying out practicums. Not only that, students' lack of discipline in using practicum tools is also the reason teachers do not carry out practicums.

One of the efforts to change education is by making changes to the curriculum in stages by applying models and methods innovate learning (Purba et al., 2024). to put the quality of learning in a better direction, especially in acid-base material, can be done by implementing the Discovery Learning model. This will also affect the improvement of stud ent academic performance. Discovery Learning creates situations where students' understanding will be discovered by themselves through the learning path that has been designed by the teacher (Azhara et al., 2020). This research is strengthened by research that had previously been carried out by (Jannah et al., 2020) which states that the Discovery Learning model can develop students' skills to learn and can support student learning outcomes with the percentage of student completion in the experimental class is 44.44% and in the control class is 8.33%. Apart from that, a model that can also be used by teachers to addjust learner more creative in learning is the Learning Cycle 5E. This learning model is d is designed very carefully and well so that learner can do it competencies in a constructivist manner and find their own ideas (Widianingrum et al., 2018). Previous research also strengthens this research, (Cylindrica et al., 2021) say that which states that the Learning Cycle 5E model assisted by e-scaffolding provides increased student learning outcomes.

In essence, theoretical and practical learning in the laboratory are interdependent activities (Wulandari & Vebrianto, 2017). Based on the results of observations, it is known that in chemistry lessons at school, the majority of chemical phenomena are not investigated but only exemplified or told. The solution that can be used to overcome the above problem is the use of a virtual lab. This virtual lab can be used to help the learning process in order to improve students' understanding of the material, and is also suitable for anticipating unpreparedness in real laboratories. This research is increasingly trusted through previous research conducted by (Clarinda et al., 2022) which states that the use of virtual labs can improve learning outcomes. The virtual lab used in this research is Phet Interactive Simulations. models and learning media work together to improve student learning outcomes (Panggabean et al., 2023).

LITERATURE REVIEW

Discovery Learning

The process of understanding ideas, meaning, and relationships through an intuitive process to reach a conclusion is known as Discovery Learning (Kristin, 2016). The problem solving process is the main focus in this model to develop student abilities (Agustina et al., 2023). Discovery learning is a model characterized by individuals exploring their own learning concepts through the learning process (Marisya & Sukma, 2020). This model is better known as a context-based inquiry approach that develops student independence in learning. In determining a goal, there are definitely stages that must be gone through, just like implementing the Discovery learning model, there are 6 stages that must be carried out, namely: (1) stimulation; (2) Statement of the Problem; (3) Data Collection; (4) Data Processing; (5) Verification; (6) Generalization (Sinuraya et al., 2024).

According to (Haerullah & Hasan, 2017) The advantages that will be obtained if you apply this model are: (1) Develop students' cognitive skills and processes; (2) Sharpen students' problem solving skills; (3) Strengthening self-concept. Despite the advantages offered, this model also has several obstacles in its application, namely: (1) Incompatibility with the time provided at school because implementing this model requires more time because teachers are required to change their teaching habits from generally providing information to being facilitators, motivators and guides; (2) some students' rational thinking abilities are still limited.

Learning Cycle 5E

This Learning Cycle 5E is based on the constructivist view of Piaget, which assumes that in learning knowledge is built by children themselves in cognitive structures through interaction with their environment (Pratama et al., 2023). The model uses direct experiences that are cyclical and gradual to help students master concepts. The characteristic of this learning model is that each student discusses actively in small groups to remember and communicate their basic understanding of a material, then together with their learning group build relationships in the material being taught, then the teacher as a facilitator will supervise and provide direction. as well as corrections if there are errors in their understanding (Pratiwi et al., 2022).

The advantages of the Learning Cycle learning model according (Haerullah & Hasan, 2017) include the following: (1) Stimulates students to remember the lesson material they have received previously; (2) Foster students' curiosity which will motivate students to learn; (3) Train students' analytical skills to determine their own learning concepts through practical activities. Behind the advantages above, the Learning Cycle learning model has several weaknesses as follows: (1) Teacher effectiveness is low if the teacher does not master the material and learning steps; (2) Requires more time and energy to plan and implement learning.

Virtual Laboratory

Virtual lab is the latest learning innovation that makes it possible to carry out face-to-face practical activities via computerized devices. What most characterizes a virtual laboratory is a virtual reality simulation that is very interactive with laboratory activities (Haryoko & Hendra, 2014). The use of virtual labs makes it possible to carry out chemistry and physics practicums with the help of cellphones through applications, so that learner can realize abstract concepts into concrete ones (Rokhim et al., 2020).

Several advantages of using virtual laboratories, namely: (1) virtual laboratories are a new technological phenomenon; (2) virtual laboratories will save costs; (3) virtual laboratories will strengthen students' learning concepts. Apart from the advantages provided by virtual laboratories, there are also disadvantages, including: (1) virtual

laboratories will take students out of the reality of conventional equipment; (2) there is no direct face-to-face interaction between teachers and students.

Learning Outcomes

Learning outcomes include 3 things including cognitive aspects, affective aspects and psychomotor aspects (Christiano et al., 2023). Learning outcomes are behavioral modifications produced through the learning process. Academic performance can be used as a determining indicator of success in learning (Yandi et al., 2023). Learning outcomes are the level of completeness students obtain after following the learning process given to achieve certain goals. Mudjiono and Dimyati explained their thinking which states that learning outcomes are an observation process carried out to see the extent to which students can understand the learning material after participating in teaching and learning activities. Learning outcomes can be identified through agreed numbers, letters and symbols.

A person's learning outcomes cannot be separated from various factors that influence them. In learning which leads to obtaining learning outcomes, there are two influencing factors, namely factors from within a person/internal factors and factors from outside a person/external factors. According to Slameto, internal factors that influence learning outcomes are interest, talent, and motivation and external factors that influence learning outcomes are the school environment, family and community.

METHODS

The research conducted at SMAN 17 Medan was quantitative research and the method chosen was the experimental method with The Two Group Pretest Posttest Design. The sampling technique used purposive sampling so that class XI IPA 4 was obtained as experimental class 1 and class XI IPA 3 was obtained as experimental class 2. The independent variables in this research are the Discovery Learning and learning cycle 5E models, the dependent variables are learning outcomes, and students, teachers, and acid-base material are used as control variables.

The test instrument in this research is 20 multiple choice questions with five Alternative answers that can be chosen are: a, b, c, d, and e which are valid and reliable. Apart from test instruments, non-test instruments are also used in the form of interview sheets which are used to obtain information on learning problems in the classroom. Pre-test and post-test scores will be processed using SPSS 26 for Windows into quantitative data.

RESULT AND DISCUSSION

This research aims to see the effectiveness of the Discovery Learning model, the effectiveness of the Discovery Learning model and whether or not there are differences in learning outcomes from the application of the two models. For this purpose, 20 multiple choice test questions were used that met the feasibility test consisting of validity, level of difficulty, differentiation, distractors and reliability. The results of the pre-test and post-test analysis of students in experimental class 1 and experimental 2 can be seen in table 1.

Table 1. Average and standard deviation of pre-test and post-test data for experiment 1 and experiment 2 classes

Statistics	Experiment 1		Experiment 2	
	Pre-test	Post-test	Pre-test	Post-test
Average	30.69	83.75	26.80	78.89
Standard deviation	11.28	9.57	6.90	8.71

Table 1 shows that experimental class 1 has higher learning outcomes compared to experimental class 2. Experimental class 1 experienced an average increase of 53.06% while experimental class 2 experienced an average increase of 52.09%. The Discovery Learning model has higher results in improving learning outcomes. This is in accordance with the literature study presented regarding the advantages of the Discovery Learning model, namely that it

can improve and enhance cognitive skills and processes and increase students' ability to solve problems. Meanwhile, the Learning Cycle 5E model places greater emphasis on discovering one's own concepts based on experiments.

Furthermore, the pre-test and post-test data from experimental class 1 and experimental 2 were subjected to prerequisite tests in the form of normality and homogeneity tests.

Normality Test

To determine whether the data is normally distributed or not, the Shapiro-Wilk test was carried out with SPSS 26 for Windows at a significance level of 0.05.

Table 2. Normality test experimental class 1 and experimental class 2

Class	Data	Sig. Data	Sig. Level (α)
Experiment 1	Pre-test	0.109	0.05
	Post-test	0.053	
Experiment 2	Pre-test	0.056	
	Post-test	0.052	

In table 2, the pre-test and post-test normality data for experimental class 1 and experimental 2 are shown. Where the sig. value obtained for each class in the pre-test and post-test > 0.05 so it can be concluded that the learner pre-test and post-test results in the two experimental classes were normally distributed.

Homogenity Test

In research, the samples used must be homogeneous or not show inequality so a homogeneity test must be carried out. Levene Test is the homogeneity test method chosen via SPSS 26 for windows at a significance level of 0.05. Data is said to be homogeneous if the sig (based on mean) value is ≥ 0.05.

Table 3. Post-test homogeneity test results for experimental class 1 and experimental 2

Class	Data	Sig. Data	Sig Level (α)
Experiment 1	Post-test	0.236	0.05
Experiment 2	Post-test	0.236	

Based on table 3, the sig value (based on mean) is > 0.05 (0.236 > 0.05), Therefore, the two samples used came from homogeneous populations.

Hypothesis Test

To validate the potency of the model Discovery Learning model and the Learning Cycle 5E, the N-gain value was calculated for each class. N-gain calculations were carried out using SPSS 26 for Windows.

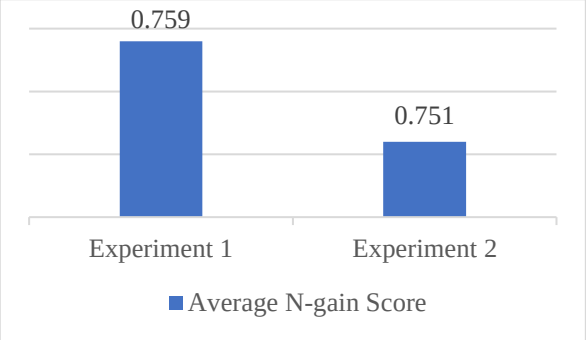

Figure 1. N-gain score in experimental class 1 and experimental 2

Figure 1 shows that experimental class 1 obtained an average N-gain value of 0.759, where this figure is included in the high category. Based on the results of the N-gain test, it was the application of the Discovery Learning Model provides quite effective results in improving academic performance. This is in line with previous research conducted by (Tuski et al., 2023) which obtained an average N-gain Score of 0.67 in the medium category. Therefore, a conclusion is drawn which states that the use of the Discovery Learning model in learning provides effective results in improving the academic performance of class X chemistry redox materials at SMA Negeri 10 Pinrang.

Figure 1 also shows that experimental class 2 obtained an average N-gain value of 0.751, where this figure is included in the high category. Based on the results of the N-gain test, it was decided that the Virtual Lab integrated Learning Cycle 5E model was quite effective in improving learning outcomes. Research conducted by (Abidin et al., 2023) also provided results that were not much different, where an average N-gain score of 0.78 was obtained in the high

category. It can therefore be concluded that the use of the 5E learning cycle model with the Make A Match technique is effective in improving the learning outcomes of class XI MIPA 3 students at SMA Negeri 6 Good in the subject principal of Acids and Bases.

Through the N-gain calculation of the Discovery Learning model and the Learning Cycle 5E, both of these models are successful in making student learning outcomes better. However, even though they are in the same category, namely high, the n-gain values for the two classes are different. These two different models certainly give different results. The differences given may be significant or not significant. Therefore, a statistical test called the Independent Sample T-test was carried out using SPSS 26 for Windows. This test is used because the samples are not paired. This test is used because the samples are not paired. After carrying out the test, a sig value of 0.011 was obtained, where 0.011 < 0.05 so there is acceptance of the alternative hypothesis (Ha) and rejection of the null hypothesis (Ho). Thus, it can be concluded that there is a significant difference in the academic performance of students who are taught using the Discovery Learning and Learning Cycle 5E learning models integrated with virtual labs on acid-base material. This is in line with previous research conducted by (Susilaningrum et al., 2017) provides concrete results that the application of the Learning Cycle 5E and Discovery Learning models makes a significant difference to the achievement of science process skills and cognitive academic performance in Class X Students of SMA Negeri 3 Boyolali.

Media also helps improve student academic performance. In both experimental classes, Phet Interactive Simulation-based Virtual Lab media was used. Using a virtual lab has the advantage that learning is easier and in some cases safer than a physical laboratory (Masita et al., 2020). Phet Interactive Simulation is very practical because it can be accessed via a computer or cellphone so it can be accessed anytime and anywhere. The results of observations of students in experimental class 1 and experimental 2 stated that the majority of students in both classes preferred virtual lab-based practicums because they were not burdened with carrying tools and materials.

CONCLUSION

Through the research and data processing carried out, several conclusions were obtained, namely that the virtual lab integrated discovery learning model is effective in supporting student academic performance as evidenced by the calculation of an n-gain score of 0.759; the virtual lab integrated 5E learning cycle model is effective in supporting student academic performance as proven by the n-gain score calculation of 0.751; and there are significant differences in academic performance between classes that use the discovery learning model with the 5E learning cycle.

By conducting this research, it can be input for readers to choose the right model for teaching, especially in chemistry learning. Apart from that, it is also hoped that this research can provide solutions related to practicum problems which are generally omitted for certain reasons. Practicum implementation in this modern era can be carried out using a virtual lab based on Phet Interactive Simulations.

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