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Article

Pretest-Posttest Control Group Design of Discovery Learning-Based Content Learning System in The Materials of Atomic Structure and Periodic Elements System of Class X Vocational Schools To Improve High-Level Thinking Ability

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Abstract. A learning process in the form of electronics employing online learning and merging discovery learning learning models is known as a discovery learning-based content learning system. This study sought to determine the efficacy of a content learning method based on discovery learning for class X SMK students studying periodic systems and atomic structure material. This study employs the ADDIE development model, which is only applicable to the implementation stage and whose efficacy is being evaluated on a limited scale. Higher-order thinking abilities and student learning outcomes are impacted by the findings of measuring the efficacy of the discovery learning-based content learning system, as shown by an increase in the average score from the pretest to the posttest. The results of the t-test showed sig (2-tailed) 0.05, indicating that there is a significant difference between the learning outcomes and HOTS of students who use and don't use a content learning system based on discovery learning. This implies that content learning systems based on discovery learning on content related to atomic structure and the periodic system of elements are effectively designed to enhance student learning outcomes and higher-order thinking skills.

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1. Introduction

The current technological developments and advances are extraordinary, of course there are those that can produce positive and negative impacts. One of the positive impacts is that the use of media and information can be accessed in various places that have internet connections [1-3]. In the current era of globalization, information technology is developing rapidly, and its impact on the educational landscape is unavoidable. Global demands require the education sector to continue to adjust technical progress in efforts to improve the quality of education, especially changes in the use of information and communication technology for the education sector, especially in the learning process [4-5].

Technology can be used as a learning tool that absorbs equity in education without being separated by space, distance and time. One of the integrations between technology and education is e-learning [6-7]. E-learning is information technology that is applied to the field of education in digital form and is bridged with networks as a change in learning in educational institutions. In order for the quality and sustainability of the use of courageous learning to be improved and educational goals continue to be achieved, clear planning is required for its implementation [8-9].

The characteristics of e-learning are independent of place and time, offering more interesting opportunities for exchanging information and visualizing information [10]. E-learning is part of online learning and aims to transform the teaching and learning process into a digital format connected by online technology. The purpose of this web learning focuses on the effectiveness of teaching and learning [11].

LMS or better known as the Learning Management System is a software or software for administrative purposes, documentation, activity reports, teaching and learning activities that are carried out online (connected to the internet), E-learning and training materials, and all that is done online [12-14]. MOODLE (Modular Object-Oriented Dynamic Learning Environment) is one of the most widely used types of Learning Management System (LMS). Moodle is an open source application that is used because it is very easy to use in the learning process and can be configured as needed in learning [15-18].

Chemistry learning is learning that emphasizes abstract concepts and abstract concepts that are difficult to explain with concrete examples [19]. Even though the phenomenon in this concept can be observed visually, for further explanation a special method is needed that can describe the phenomenon clearly and easily understood [20]. One of the methods carried out is by using a learning model that can improve critical thinking and student learning outcomes according to a scientific approach, one of which is the discovery learning model [21-23] .

Atomic structure material and the periodic system of elements are included in the chemistry subject of class X SMK. This material discusses the development of the atomic model, atomic structure and electron configuration. To be able to understand this material students have to do a lot of exercises to make it easier for students to understand the concept and how to arrange electron configurations and place elements in the periodic system [24]. Therefore, this material must be truly understood by students by studying it repeatedly and doing lots of practice questions.

From the results of the researcher's interviews with several chemistry teachers at SMK in the field of technology and engineering expertise, information was obtained that the hours of chemistry lessons at SMK were few while the material that students had to master was quite a lot. For this reason, it is necessary to have additional learning so that students better understand the concepts in chemistry material. With the existence of a content learning system based on discovery learning, students can learn anywhere and anytime without any limitations of space and time.

2. Experimental Section

The research method uses a quasi-experimental method [25]. The research subjects were class X students of SMKN 5 Solok Selatan and SMKN 1 Pantai Cermin. The research sample was selected by means of simple random sampling, using observation, interviews, and documents. This study uses

a learning achievement test instrument that contains high order thinking skills (HOTS) questions. The research design is a pretest-posttest control group design, which is illustrated as follows.

Table 1. Research design

	Preliminary Test	Treatment	Final Test
Experiment Class	TA_1	X1	TB_1
Control Class	TA_2	Y1	TB_2

Information
X : Learning with CLS
Y : Learning without CLS
TA : Initial test
TB : Final test

Based on the above scheme, it can be described that the effectiveness of the treatment can be seen from the difference between (TA1-TB1) in the experimental group and (TA2-TB2) in the control group [26].

Analysis of effectiveness data was obtained from student learning outcomes assessment sheets which included a high order thinking skills test by conducting a pre-test and post-test. Student assessment of the pretest and posttest used the formula.

$$value = \frac{n}{N} \times 100\%$$

n : score obtained
N : maximum score
100 : Fixed number

After the student scores are obtained, the normalized gain value is calculated using the N-gain formula according to Hake (2002) [27], which is as follows:

$$\% \text{ g} = \frac{skor\ post-test - skor\ pre-test}{skor\ maksimum - skor\ pre-test} \text{x}100\%$$

Table 2. Average Gain Score Criteria

Limitation	Criteria
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Middle
$g < 0.3$	Low

The normality test aims to see whether the sample is normally distributed or not. The normality test was carried out using the Kolmogorov-Smirnov test with the help of SPSS software. The homogeneity test aims to determine whether the data in the sample class has a homogeneous variance or not. This test was carried out with the Levene test with the help of SPSS software. Hypothesis testing is carried out using the t-test, if the data is normally distributed and homogeneous. The significance value that is used as a reference is the value for equal variances assumed. If the data is normally distributed but not homogeneous, then hypothesis testing is still carried out using the t-test but the significance value that is used as a reference is the value for equal variances not assumed.

3. Results and Discussion

The difference between the two samples lies in the teaching materials used. The experimental class uses a content learning system, while the control class does not use a content learning system. In this study the effectiveness of the content learning system was assessed on student learning outcomes and higher order thinking skills.

The results of this effectiveness test can be seen by comparing the final scores obtained by the experimental class and the control class. The learning process in the experimental class uses a content learning system as teaching material, while in the control class the content learning system teacher carries out learning as usual without using a content learning system. The value of student learning outcomes can be seen in Table 3.

Table 3. Value of Student Learning Outcomes

School	Class	N	Pretest Average	Post Average	Pretest-Postest	N-Gain
SMK N 5 Solok Selatan	Experiment	31	22.26	81.61	59.35	0.76
	Control	33	18.79	72.42	53.64	0.62
SMK N 1 Pantai Cermin	Experiment	33	18.64	78.94	60.30	0.74
	Control	35	15.29	67.71	52.43	0.61

Based on Table 3 it is known that the average value of pretest and posttest learning outcomes in the experimental class is higher than the control class. This proves the statement that the learning outcomes of students before and after using the content learning system showed an increase during the initial test and the final test. The N-gain value of students who learn with a content learning system is higher than those who do not use a content learning system. Increased understanding of students is due to the provision of chemical phenomena at the macroscopic, microscopic, and submicroscopic levels which make students learn and master knowledge and skills [28-30].

The effect of using content learning systems on student learning outcomes can be seen from the results of the Hypothesis test. The control class and the experimental class have normal and homogeneous distribution, so the t-test is used to test the hypothesis with the help of SPSS software. The hypothesis test data is contained in Table 4.

Tabel 4. Results of Hypothesis Testing on Sample Class Learning Outcomes

School	Class	A	Sig.(2- tailed	Ket.
SMK N 1 Solok Selatan	Experiment Control	0.05	0.025	Tolak H_0
SMK N 1 Pantai Cermin	Experiment Control		0.000	Tolak H_0

Furthermore, a hypothesis test was carried out to see the effect on student learning outcomes by using the t-test with the help of the SPSS statistical application. Based on Table 4 the results of the analysis that has been carried out obtained the decision that H0 was rejected with a sig value of <0.05, which means that the learning outcomes of students in the experimental class (using the content learning system) are higher than the results of students in the control class (not content learning system). . This effectiveness is because students who study with content learning systems have a scientific attitude and desire to find concepts so that students can improve learning outcomes. To see

whether the use of this content learning system can improve students' higher-order thinking skills, it is measured through a learning achievement test which includes HOTS questions. The results of the students' HOTS scores can be seen in Table 5 below.

Tabel 5. Students' High Order Thinking Skills Score

School	Class	N	Pretest Average	Post average	Pretest-Postest	N-Gain
SMK N 5 Solok Selatan	Experiment	31	35.06	64.12	29.06	0.53
	Control	33	35.10	47.67	12.57	0.12
SMK N 1 Pantai Cermin	Experiment	33	34.23	61.53	27.30	0.48
	Control	35	34.32	50.25	15.93	0.10

Based on Table 5 it is known that the average value of higher order thinking skills in the experimental class is higher than the control class. This proves the statement that students' higher order thinking skills before and after using the content learning system show an increase during the initial test and post test. To find out the effect of using the content learning system on students' higher-order thinking skills, a hypothesis test was carried out, which can be seen in Table 6 below.

If the significant value is > 0.05 then accept H ¬ 0 and vice versa. The decision to reject H0 means that the high-level thinking skills of students who learn by using the content learning system are significantly different. The average higher order thinking skills of students who use content learning systems are higher than those of students who do not use content learning systems.

Tabel 6. Hypothesis Test Results Against the Sample class

School	Class	A	Sig.(2- tailed	Ket.
SMK N 5 Solok Selatan (Sedang)	Experiment	0.05	0.014	Tolak H_0
	Control			
SMK N 1 Pantai Cermin (Rendah)	Experiment		0.026	Tolak H_0
	Control			

Then a hypothesis test was carried out using an independent sample t-test with the help of the SPSS 23 statistical application. Based on Table 6 the results of the analysis that had been carried out obtained that the H0 decision was rejected with a sig (2-tailed) value <0.05, which means that the participants' high-order thinking skills were average. students in the experimental class higher than students in the control class. This is because learning uses a content learning system that includes macroscopic, microscopic, and symbolic aspects, as well as the existence of a virtual laboratory that can improve students' understanding of concepts and reasoning. A good understanding of concepts is the main capital of students to improve higher-order thinking skills [31-33].

4. Conclusion

The results of research on the effectiveness of discovery learning-based content learning systems were obtained from two data, namely from student learning outcomes and students' higher-order thinking skills. Learning to use a content learning system based on discovery learning significantly increased both from student learning outcomes and from students' higher order thinking skills. This means stating that the content learning system based on discovery learning on the atomic structure material

and the periodic system of elements developed is effective for improving learning outcomes and students' higher-order thinking skills.

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