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Implementation Of Additive Chemistry E-Modules Using the Discovery Learning Model on Student Learning Outcomes on Food Coloring Materials

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Abstract: This study aims to determine the effect of the implementation of additive chemistry e-modules using the discovery learning model on student learning outcomes on food coloring materials. This type of research is experimental research. The experimental class was taught with the additive chemistry e-module using the discovery learning model while the control class was taught with the additive chemistry e-module without using the discovery learning model of each class on natural coloring materials in food. The instrument used was a written test in the form of multiple choice to measure student learning outcomes that have been tested instrument validation first. After being treated using the additive chemistry e-module using the discovery learning model, the calculated mean and standard deviation were 14.44 and 2.37, respectively. However, with the treatment using the additive chemistry e-module without using the discovery learning model, the mean and standard deviation were 11.94 and 2.27, respectively. Furthermore, a one-party test with a significance level of 5% was obtained tcount = 4.54 and ttable = 1.983. So it was concluded that there is a significant effect of student learning outcomes with additive chemistry e-modules using the discovery learning model.

Keywords: Discovery Learning Model; E-modules; Student Learning Outcomes.

Introduction

Education is a process of educating, which is a process in order to influence students to be able to adapt themselves as well as possible to their environment, so that it will cause changes in themselves. The more and higher a person's education, the better. In fact, every citizen is expected to continue learning throughout life. Thus, education is a priority factor that needs to be built and improved (Sari et al., 2020). Chemistry learning essentially consists of structures, reactions, and reaction mechanisms. The process of learning chemistry is seen as important as an opportunity to provide meaningful experiences for students to have a way to build knowledge, skills, abilities or other competencies that are considered important. Experimental activities in the chemistry learning process cannot be separated because they can train students in how to think and how to work (Hermanns, 2020).

The development of digital-based science and technology invites educators to design innovative teaching materials to support learner-centered learning. The digital era is an era of disruption where technological and communication advances occur very rapidly. Along with the rapid development of technology towards the digital era, the implementation of learning today needs to be supported by the modernization of learning in schools (Yaniaja et al., 2020). The use of digital media to create teaching materials can foster student interest, motivation and independence to study additive chemistry courses.

Additive chemistry is a course that examines chemical additives in food and chemical additives in industry. Food coloring is one of the materials contained in the additive chemistry course. In presenting food

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coloring material, it is necessary to present the material in pictures, videos, sounds, and writings that can make students interested in learning it more deeply, especially when presented in the form of e-modules.

The development of digital-based science and technology invites educators to design innovative teaching materials to support learner-centered learning. The digital era is an era of disruption where technological and communication advances occur very rapidly. Along with the rapid development of technology towards the digital era, the implementation of learning today needs to be supported by the modernization of learning in schools. The use of digital media to create teaching materials can foster student interest, motivation and independence to study additive chemistry courses (Manurung & Simaremare, 2022).

Some studies explain that low learning outcomes in several chemistry concepts are influenced by several factors, including: (1) Students have difficulty in determining the hydrolysis reaction of various types of salts in terms of the type of reaction and making the hydrolysis reaction with 38.00% of students' conceptual understanding (Nusi et al., 2021), (2) Students' mastery of concepts in stoichiometry material to evaluate and create is still low with a percentage of 7.50% and 2.50% respectively (Manurung, 2021), (3) Only 12.00% of students comprehend the idea of motion kinematics, while 29.00% have misconceptions about it and 59.00% don't understand it at all. This demonstrates that the approaches, methods, or learning strategies employed by lecturers are still ineffective at improving conceptual understanding and decreasing misconceptions among students (Busyairi et al., 2021). The treatment shows that the chemistry module can improve student learning outcomes. The chemical materials discussed in the study include the concepts of Chemical Bonding, Acid-Base Solutions, Elemental Chemistry, Chemical Equilibrium, Colloidal Systems, Buffer Solutions, and Solution Stoichiometry (Suswati, 2021).

The results of research conducted by Haryani, (2021) on modules containing character values worthy of use in learning chemistry on the subject matter of redox reactions and compound names through the development stage, obtained that the score of student learning outcomes was 85.29% with N-gain of 0.63 for the medium category. Based on the results of student satisfaction surveys related to the implementation of learning using electronic modules (e-modules) preferred by students compared to using slide handouts. Giving slide handouts to students during lectures makes learning passive and does not involve students. Meanwhile, the provision of e-modules makes students better master the concept of the material provided so as to encourage students to be actively involved in feedback activities. The faculty claims that the application of concept mastery into the chemistry education curriculum will have advantages in terms of: student learning. These include supporting revision, increased student understanding, increased interest/engagement, and perspective and forward thinking (Jackson & Hurst, 2021).

According to Sunarsih et al. (2020) the steps of discovery learning include : 1) stimulation; 2) problem statement; 3) data collection; 4) data processing; 5) verification; and 6) generalization. Discovery learning requires students to find new things that require creativity, so that the syntax in it can improve students' creative thinking (Asrul et al., 2018). Thus students can learn to discover new things actively and independently so that the use of discovery learning can change passive learning conditions to be active and creative (Subekti & Prahmana, 2021).

Based on a literature study conducted by Chusni (2020), it was found that the hypothesis generation phase of the discovery learning model, which aims to provide a rational argument from the real phenomenon orientation phase, is followed by the process of interpreting, analyzing, evaluating, and drawing conclusions from experimental data through the hypothesis testing stage until the correct conclusions are drawn from the results trial. Based on the description that has been described, the researchers are interested in researching the implementation of additive chemistry e-modules using the discovery learning model on student learning outcomes on food coloring materials.

Method

This research uses a pseudo experiment with 2 variables, namely: (1) Free Variable, additive chemistry e-modules using discovery learning model and additive chemistry e-modules without discovery learning model and (2) Dependent Variable, student learning outcomes. sampling in this study using random sampling technique. this research design uses factorial 2x2, namely the number of classes determined as many as 2 classes and the treatment given with a total of 2 treatments in the form of additive chemistry e-modules using discovery learning model and additive chemistry e-modules without discovery learning model. This research was conducted at HKBP Nommensen University Pematangsiantar in the chemistry education study program whose population was 240 students and the sample was 70 students consisting of 2 classes, namely the experimental class taught with additive chemistry e-modules using the discovery learning model and the control class taught with additive chemistry e-modules without using the discovery learning model. The research instrument used by researchers is a test. The test used is an objective test, namely: a multiple choice test of 20 questions out of 30 questions after validating the items used to measure student learning outcomes. Each question has four alternative answers. For questions that are answered correctly with a score of 1 and answer incorrectly with a score of 0. The maximum score is 20. The time given in doing the 20 questions is 60 minutes. The data collection techniques carried out are: item validity, test reliability, item difficulty level, test item differentiability. While the data analysis techniques carried out are normality test, homogeneity test, and research hypothesis test.

Result and Discussion

E-modules are electronic versions of printed modules that can be read on a computer and designed with the required software. E-modules are a means or learning tool that contains material, methods, limits, and ways of evaluation that are systematically designed and attractive to achieve the expected competencies according to the level of complexity electronically (Mufida et al., 2022). The display of additive chemistry e-modules is designed as interesting as possible so that students can gain knowledge easily besides that, additive chemistry e-modules can encourage student independence to learn optimally (Prabasari, 2021).

Figure 1. Additive Chemistry E-module Design

Additive chemistry e-modules using the discovery learning model in this study are specific to the material of additives in food which are designed to consist of components: cover, table of contents, mind map, graduate learning outcomes, introduction, brief description of the material, YouTube link material, instructions for using e-modules, research links, material summary, glossary and self-assignment. The form of additive chemistry e-modules using the discovery learning model that has been designed is as follows.

Results of Research Data Collection

Testing the validity of the items obtained that the valid questions were 20.00 questions using the Pearson product moment correlation formula. Testing the reliability of the test using Kuder-Richardson 20.00 (KR-20), obtained the test reliability coefficient r11 = 0.80 while the product moment rtable value = 0.35 with a significance level of 5.00% (α = 0.05) can conclude that the test is reliable. The level of difficulty of the questions obtained was 1 question in the difficult category and 19.00 questions in the moderate category. Furthermore, the differentiating power of the question obtained that 12.00 questions in the sufficient category and 8 questions in the good category.

Results of Research Data Analysis

Statistical data of the two classes, namely: experimental class taught with additive chemistry e-modules using discovery learning model and control class taught with additive chemistry e-modules without using discovery learning model obtained the following data:

Table. 1 Statistical Calculation of Research Data

Type of Statistics	Experiment Class	Control Class
N	35.00	35.00
Average	14.44	11.94
Variance	5.62	5.19
Standard Deviation	2.37	2.27
Highest Score	18.00	16.00
Lowest Score	9.00	6.00

Based on the data in Table 1, the lowest score in the experimental class was 9.00 and the control class was 6.00. These results show that the lowest score is in the control class. When compared to the highest score that the experimental class amounted to 18.00 and the control class amounted to 16.00. This also shows that the highest score is owned by the experimental class. While the average student learning outcomes of the experimental class and control class were 14.44 and 11.94 respectively. The highest student learning outcomes data is owned by the experimental class.

Normality Test

Based on the calculation of the price $L_0 = 0.09$ while $L_{tabel} = 0.16$ for n = 35.00 and a significance level of 5.00%. It turns out that $L_0 < L_{tabel}$, thus it is concluded that the data in the experimental group comes from a normally distributed population. Meanwhile, from the calculation of the control group, the data obtained is $L_0 = 0.10$ while $L_{tabel} = 0.16$ for n = 35.00 and a significance level of 5.00%. It turns out that $L_0 < L_{tabel}$, thus it is concluded that the data in the experimental group comes from a normally distributed population.

Homogeneity Test

Based on the calculation results, the value of $F_{count} = 1.08$ was obtained. When compared with F_{table} for α = 0.05 and $V_1 = 35.00$ and $V_2 = 35.00$, then by using a one-party test, the critical point is obtained $F_{0.05;(35.00,35.00)} = 1.84$, where the critical area is $F_{count} > F_{table}$, it turns out that 1.08> 1.84 is obtained, Fhit is not in the critical area, thus it can be concluded that the two samples come from a homogeneous varied population.

Hypothesis Test

From the calculation results obtained the price of tit = 4.54 for α = 0.05 and V = 70.00, based on the statistical table of the t distribution curve obtained the value of t table = 1.98 and the critical area is $t_{count} > t_{table}$. So it can be concluded that there is an effect of the implementation of additive chemistry e-modules using the discovery learning model on student learning outcomes on food coloring materials.

Discussion

An electronic module is one of the teaching tools that makes use of technological advancement. An electronic module is a method of presenting independent learning materials that are systematically organized into the smallest learning unit to achieve learning objectives. These materials are presented in an electronic format with navigation, animation, and audio to make learning more engaging (Kurniawan, 2020). Additive chemistry is an elective course in the chemistry education study programme that examines chemical additives in food and chemical additives in industry. In presenting additive course material using e-modules because there are many concepts in the material so that the appearance of material in pictures, videos, sound, and writing can make students interested in learning it more deeply, especially when presented in the form of e-modules. Student learning outcomes after analysis have been homogeneous through the test of equality of variance and equality of means based on students' daily test scores. The test results show that the variance and average of students' mathematics learning outcomes from both classes are homogeneous where $F_{count} = 1.78 < F_{0.05:7.25} = 2.73$. The classes taken in this study were the experimental class of 35.00 students and the control class of 35 students. The experimental class was taught with additive chemistry e-modules using the discovery learning model and the control class was taught with additive chemistry e-modules without using the discovery learning model. Instrument used in the form of student learning outcomes test with multiple choice forms conducted instrument validity test. item validity obtained those valid questions as many as 20.00 questions using the Pearson product moment correlation formula. Testing the reliability of the test using Kuder-Richardson 20.00 (KR-20), obtained the test reliability coefficient r11 = 0.80 while the product moment r_{table} value = 0.35 with a significance level of 5.00% (α = 0.05) can conclude that the test is reliable. The level of difficulty of the questions obtained was 1 question in the difficult category and 19.00 questions in the moderate category. Furthermore, the differentiating power of the question obtained that 12.00 questions in the sufficient category and 8 questions in the good category.

From the results of the research data obtained the results of the normality test using the Liliefors test found that the data results of the two groups were normally distributed. From the results of the homogeneity test the class has a homogeneous variance using the F test. homogeneity test $F_{count} = 1.08 < F_{tabel} = 1.84$ and from the results of data analysis obtained class average value = 14.44; variance = 5.61; and standard deviation = 2.37 for the experimental class, while the class average value = 11.94; variance = 5.15; and standard deviation = 2.27 for the control class.

The steps of the Discovery learning model using a cognitive conflict method are 1) Beginning (stimulation), 2) Cognitive Conflict (issue identification), and 3) Solution (data collection, data processing, verification, and generalization) (Gunawan, 2021). Based on the results of student satisfaction surveys related to the implementation of learning using electronic modules (e-modules) preferred by students compared to using slide handouts. Giving slide handouts to students during lectures makes learning passive and does not involve students. Meanwhile, the provision of e-modules makes students better master the concepts of the material provided so as to encourage students to be actively involved in feedback activities. The faculty claims that the implementation of concept mastery into the chemistry education curriculum will have advantages in terms of: student learning. These include supporting revision, increased student understanding, increased interest/engagement, and perspective and forward thinking (Jackson & Hurst, 2021).

This research uses e-modules, discovery learning models, and additive chemistry courses while the previous research, namely: (1) The course is evaluation and chemistry learning outcomes (Sugiharti, 2020), (2) The treatment carried out in chemistry learning uses instructional methods (Zendler, 2020) and (3) Chemistry learning uses e-learning-based collaborative learning with course review horay (Maria, 2020). The chemistry learning outcomes obtained by students have increased significantly. So it was concluded that there is a significant effect of student learning outcomes with additive chemistry e-modules using the discovery learning model.

Conclusion

There is a significant effect of the implementation of additive chemistry e-modules using the discovery learning model on student learning outcomes on food coloring materials. The percentage difference in student learning outcomes with additive chemistry e-modules using the discovery learning model is 17.31%.

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