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PROBLEM-BASED CHEMISTRY E-MODULE FOR DISTANT LEARNING: DEVELOPMENT, VALIDITY AND EFFECTIVENESS

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Abstract
Distanttraining demands innovative, digital-based curriculum and learning models. This study aims to develop PBL-based electronic module in hydrocarbon for promoting the learning outcomes of distant learning training teachers. The module was developed using the ADDIE method which uses the stages ofAnalyze, Design, Development, Implementation, and Evaluation. The results of analyses showed that a valid and effective e-module had been successfully developed. According to the Indonesian Standard of Education, this passed the content feasibility, presentation feasibility, language feasibility, and graphic feasibility standard.It means that the e-module was very feasible and did not need revisions. The results of the data analysis showed that the use of the e-module had been effective (p-value< .05) .N-gain values for Experiment and Control Classof teachers' score in the experimental group(mean=0,81) high categoriesand the control group(mean=0.65) include in medium categories.

Keywords: E-module, PBL, Distance Training, Chemistry Teachers

1. Introduction

The implementation of distance learning is an emergency policy taken by the government, in order to maintain the continuity of the learning process during the covid 19 pandemic. Current conditions are urgent for innovation and adaptation related to the use of available technology to support the learning process [1]. This also causes various educational institutions to have to choose the right application to use in supporting the implementation of distance learning. The practice requires widyaiswara and trainees to interact and transfer knowledge online. Although there are many alternative applications that can be used in the implementation of distance learning, the widyaiswara must determine the right type of application for the training participants so that each trainee can be accessed and utilized optimally [2,3].

Distance Training (PJJ) is held on a scheduled basis, where participants can ask questions directly about various things to Widyaiswara (WI) or to other participants through chat features or forums. In this PJJ, WI does not teach like teaching and learning activities in regular classes in general. WI will provide training materials, modules, presentation materials, practice questions and exam questions in accordance with the training courses held. The trainees can organize their own learning activities.

Digital-age in education, especially at the Education and Training Center (BDK), has consequences in the form of learning design by utilizing digital media as a means to increase the knowledge of training participants. Digital media can present learning materials contextually, audio and visually in an interesting and interactive way [4,5]. Online learning can take advantage of platforms in the form of applications, websites, social networks and learning management systems. These various platforms can be used to support the transfer of knowledge supported by various discussion techniques and others [6]. E-learning is an open source learning system, a learning system that uses web applications that can be run and accessed with a web browser [7].

Problem based learning (PBL) is a learning model that is able to meet the goals of 21st century education. In the learning scenario, PBL involves the 4C principles, namely critical thinking, communication, collaboration, and creativity. Problem-based learning in a long time, is able to improve learning outcomes and higher order thinking skills [8,9].

The implementation of the PBL model can train several thinking skills such as critical thinking, analyzing and solving complex problems, collaboratively, as well as verbally and written communicatively [10,11]. Learning science, especially chemistry, is closely related to technology, critical thinking [12,13]. Critical thinking is a skill in sorting out what is valuable or making judgments from a decision to analyze arguments and generate insight into each meaning and interpretation, develop cohesive and logical reasoning patterns, understand the assumptions and

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biases that underlie each position [14]. Critical thinking finally provides a reliable, concise and convincing presentation model [15,16].

Assessment can be done by HOTS (Higher Order Thinking Skill), on the process and learning outcomes. HOTS is an ability at the top level of Bloom's cognitive taxonomy. The purpose of learning based on Bloom's cognitive taxonomy is to build the trainee's way of thinking to be able to apply knowledge and skills to new contexts [17]. HOTS is a thinking skill that not only requires memory skills, but requires other higher skills. Another factor could be the unavailability of HOTS assessment instruments used as learning outcomes instruments and the lack of HOTS assessment instruments designed to measure critical thinking skills and creative thinking skills of trainees [18,19]. This study aims to develop a hydrocarbon E-module in chemistry training courses using the PBL model with e-MBLD to improve the learning outcomes of the Chemistry Teacher Distance Training participants.

2. Methodology

This study uses the ADDIE method which uses 5 stages, namely Analyze, Design, Development, Implementation, and Evaluation [20].

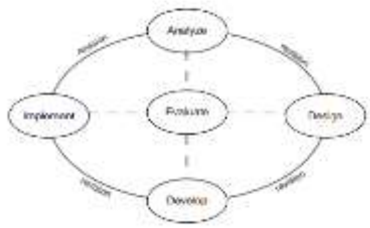

Figure 1. ADDIE approach [20]

3. Results and Discussion

Analysis of Circulating MA Chemistry Textbooks

In the early stages of this study, an analysis of the feasibility of chemistry textbooks circulated in MA schools in North Sumatra was carried out. This feasibility test uses the eligibility standards of the National Education Standards Agency (BSNP). The analysis was carried out with a total of 26 respondents consisting of 3 Chemistry lecturers at the State University of Medan (UNIMED) and 23 MA Chemistry participants. The test criteria are assessed based on four eligibility standards according to BSNP, namely content feasibility, presentation feasibility, language feasibility and E-module graphic feasibility. MA chemistry teaching materials were analyzed by giving responses in the form of a checklist with an assessment of 1 = not feasible; 2 = less feasible; 3 = fairlydecent; 4= Eligible.

The results show that the average values for teaching materials include: 1) the feasibility of the content is 2.76 (fairlydecent), but needs improvement; 2) the feasibility of the presentation of 2.83 (fairlydecent), but needs improvement; 3) the feasibility of the language is 2.93 (fairlydecent), but needs improvement; and 4) the graphic feasibility of the e-module is 1.92 (not feasible).

Development of Innovative Hydrocarbon E-Modules

Based on the results of the feasibility test analysis, the researchers developed an innovative E-Module [21]. The material presented in this module is divided into three learning activities, namely: 1) Describing the specifics of the carbon atom and writing the structure of carbon compounds; 2) Describe the material of Hydrocarbon Compounds, Alkanes, Alkenes, Alkynes and Hydrocarbon Combustion; 3) Describe the material of Petroleum Processing, Multilevel Distillation, Conversion Process, Mixing Fractions, Uses of Petroleum, Octane Number and Type of Gasoline.

The components that make up learning activities in the developed module [22] include: 1) Competency Objectives, explaining the objectives to be achieved after studying the module; 2) Material Description, containing the essential material of hydrocarbons and petroleum to be studied; 3) Formative tests, containing multiple choice questions and essay tests after studying the material; 4) Assignments, containing description questions that can be done after studying the material; 5) Summary.

Innovative Hydrocarbon E-Module Analysis

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The results of the analysis of MA chemistry teaching materials that have been modified and developed based on the BSNP questionnaire include the feasibility of the contents of the average value of 3.81 which means it is valid and does not need to be revised so that it is feasible to use, the feasibility of presenting an average value of 3.85 (Eligible),the feasibility of the language shows that the average value of 3.85 (Eligible), and the feasibility of the graphic e-module has an average value of 3.85 (Eligible).

HOTS Instrument Validation Analysis

The next researcher validated the HOTS instrument. At this stage, the questions developed were validated by 3 Chemistry lecturers at the Medan State University (UNIMED). The questions were analyzed by giving responses in the form of a checklist with an assessment of 1 = very poor; 2 = less ; 3 = good; 4= very good.

The results of the HOTS instrument validation analysis based on the modified assessment aspect have a valid average value and do not need to be revised and are suitable for use. There are three aspects of the assessment, namely 1) The material aspect has an average value of 3.88 which means very good; 2) The construction aspect has an average value of 3.87 which means very good; 3) The language aspect has an average value of 4 which means it is very good and does not need revision.

Analysis of Learning Results

The validity of the test instrument is calculated using the biserial correlation formula with the provision that if rcount > rtable at = 0.05 with n = 50, then the question is said to be valid and vice versa if rcount < rtable then the question is said to be invalid. Based on the validity table, it shows that of the 50 questions tested, there are 35 valid questions. The summary of the validation test can be seen in Table 1.

Table 1. Summary of Test Instrument Validation Test

Criteria	**Question number**	**Total**	**Percentage**
Valid	1, 2, 3, 4, 5, 5, 7, 8, 9, 10, 11, 18, 19, 20, 21, 22,23, 24, 25, 26, 27,28, 29, 30, 31, 33, 34, 35, 36, 38, 40, 42, 43, 44, 48, 49	35	70 %
Invalid	12, 13, 14, 15, 16, 17, 27, 32, 37, 39, 41, 45, 46, 47, 50	15	30 %
Total		**50**	**100%**

Reliability Test

Reliability test is used to determine the consistency of the measuring instrument, whether the measuring instrument used is reliable and remains consistent if the measurement is repeated. The reliability test was determined using the KR-20 formula. Based on the overall test reliability test data, the test reliability (rcount) is 0.88 with a very high category.

Table2. Learning Outcomes of Chemistry Teacher Participants

	Class	**Mean**	**Max**	**Min**
Pretest	Experiment	58,90	72	48
	Control	41,71	50	40
Postest	Experiment	92,45	98	90
	Control	79,42	90	76

Table 2 shows that the average posttest score for the experimental class, namely students who were taught using the MA chemistry e-module with the PBL learning model, was higher than the control class taught using MA chemistry textbooks circulating in the field, with an average posttest experiment. is 92.45 and the control class posttest is 79.42

Normalized Gain Data

The level of understanding of the chemistry teacher participants about hydrocarbons can be seen by calculating the normalized gain (N-gain).

Table 3. N-gain Values for Experiment and Control Class

Class	Mean	Max	Min
Experiment	0,81	0,92	0,68
Control	0,65	0,80	0,61

Table 3. shows that the N-gain (level of understanding) of the chemistry teacher participants on the subject of hydrocarbons for the experimental class, the average N-gain is 0.81 (the average is high) with the highest score of 0.92 and the lowest score. 0.68. Meanwhile, for the control class, the average N-gain was 0.65 (medium classified as average) with the highest value of 0.80 and the lowest value of 0.61.

Normality Test

Normality testing was conducted to determine whether the data were normally distributed. The normality of the data was tested using the Kolmogorov-Smirnov Test technique. The data is declared normal if the probability value or sig > 0.05.

Table 4. Normality Test Results for Experimental Class and Control Class

Class	Data	Sig	A	Result
Experiment	*Pretest*	0,112	0,05	Normal distributed data
	Posttest	0,067	0,05	Normal distributed data
	N-gain	0,200	0,05	Normal distributed data
Control	*Pretest*	0,052	0,05	Normal distributed data
	Posttest	0,069	0,05	Normal distributed data
	N-gain	0,069	0,05	Normal distributed data

Table 4 shows that the pretest, posttest and N-gain data for the experimental class and the control class have a probability value of > 0.05. Thus it can be concluded that the pretest, posttest and N-gain data are normally distributed.

Homogeneity Test

Homogeneity test was carried out using the Levene's Test technique using SPSS 23.0 on the pretest, posttest and gain data of the two sample groups. The data is declared homogeneous if the value of sig. > 0.05.

Table 5. Homogeneity Test for Experiment Class and Control Class

Data	Sig	A	Result
Pretest	0,081	0,05	Homogeneous
Posttest	0,059	0,05	Homogeneous
N-gain	0,942	0,05	Homogeneous

Table 5 shows that from the pretest, posttest and gain data, the probability value value is > 0.05. Thus, it can be concluded that the pretest, posttest and N-gain data are homogeneous.

Hypothesis test

Hypothesisis a relationship between achievement motivation and increased learning outcomes, the Linear Regression Test is used in the SPSS 23.0 program.

Table 6. Hypothesis Test Results

Hasil	Sig	α
Coefficients	0,004	0,05

The criteria that apply in testing the data using SPSS 23.0 for windows is if Sig. < (α = 0.05), then Ha is accepted, but if Sig. > , Ha rejected. From the test results obtained Sig. < (0.004 < 0.05). This means that there is a relationship between achievement motivation and increasing learning outcomes taught with the MA chemistry module so that the hypothesis is accepted.The magnitude of the correlation value or the relationship of achievement motivation to improving learning outcomes is used by the Linear Regression test in the SPSS 23.0 for windows program. After analyzing the relationship between learning outcomes and achievement motivation, R squared 0.28 is obtained, which means that there is a relationship between learning motivation and increasing learning outcomes by 28%.

4. Conclusion

The results of the data analysis of the use of media on the learning outcomes of chemistry showed that the data were normally distributed and homogeneous with = 0.05teacher distance training participants. The average value of the experimental class is 92.45 and the control class is 79.42, indicating that the use of a hydrocarbon E-module with an e-MBLD based on the PBL model can significantly improve the learning outcomes of the Chemistry Teacher Distance Training participants.

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