23 (3), 2022, 1038-1046

Jurnal Pendidikan MIPA

e-ISSN: 2550-1313 | p-ISSN: 2087-9849

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Development of Guided Discovery-Based e-Module on Colligative Properties to Improve Higher Order Thinking Skills of High School Students

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Abstract: The current condition of the Covid-19 pandemic is very influential on the learning process in schools so that a teaching material is needed that can increase the activity of students. This study aims to develop an e-module of colligative properties of solutions based on Guided Discovery Learning to improve Higher Order Thinking Skills (HOTS), as well as determine the level of validity, practicality and effectiveness of the developed e-module. This research and development uses the Plomp model which consists of 3 stages. The assessment instruments used are observation sheets, questionnaires, and learning outcomes tests. The e-Module was validated by six expert validators and tested on six students and 36 students at SMAN 14 Padang. The validity results of the e-module obtained an average value of Aiken's V of 0.84 with a very valid category. The results of e-module practicality by teachers and students obtained an average score of 0.90 and 0.88 with a very practical category. The results of the e-module learning effectiveness test obtained an average N-gain value of 0.691 with a moderate category

Keywords: e-module, guided discovery learning, higher order thinking skills, Plomp development model, colligative properties of solutions.

Abstrak: *Kondisi pandemi covid-19 saat ini sangat berpengaruh pada proses pembelajaran di sekolah sehingga dibutuhkan suatu bahan ajar yang dapat meningkatkan keaktifan peserta didik. Penelitian ini bertujuan untuk mengembangkan e-modul sifat koligatif larutan berbasis Guided Discovery Learning untuk meningkatkan Higher Order Thinking Skills (HOTS), serta menentukan tingkat kevalidan, kepraktisan dan keefektifan e-modul yang dikembangkan. Penelitian dan pengembangan ini menggunakan model Plomp yang terdiri dari 3 tahap. Instrumen penilaian yang digunakan yaitu lembar observasi, angket, dan tes hasil belajar. e-Modul divalidasi oleh enam orang validator ahli dan diujicobakan kepada enam orang peserta didik serta 36 orang peserta didik di SMAN 14 Padang. Hasil validitas e-modul diperoleh nilai rata-rata Aiken's V sebesar 0.84 dengan kategori sangat valid. Hasil Praktikalitas e-modul oleh guru dan peserta didik diperoleh nilai rata-rata sebesar 0.90 dan 0,88 dengan kategori sangat praktis. Hasil uji efektifitas hasil belajar e-modul diperoleh nilai rata-rata N-gain sebesar 0,691 dengan kategori sedang.*

Kata kunci: *e-modul, guided discovery learning, higher order thinking skills, model pengembangan Plomp, sifat koligatif larutan.*

▪ INTRODUCTION

Education aims to develop the potential of students to become human beings with noble character, knowledge, competence, creative and responsible. One of the elaborations of the objectives of national education in chemistry subjects is to understand the concepts, principles, laws and theories of chemistry and their interrelationships and their application to solve problems in everyday life. In the current 2013 curriculum, students are required to be able to think critically and analyze the material studied. Thus, students must have skills in higher order thinking in the learning process. These higher order thinking skills (HOTS) include the ability to analyze,

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DOI: http://dx.doi.org/10.23960/jpmipa/v23i3.pp1038-1046
Received: 10 August 2022
Accepted: 11 September 2022
Published: 14 September 2022

evaluate, and create in bloom taxonomy which is in the cognitive realm of C4 to C6 (Anderson & Krathwohl, 2001). In order to form an understanding of the concept, arousing the motivation and activeness of good students, a learning model from the teacher is needed in presenting the subject matter. One of the 2013 curriculum learning models that can increase understanding of concepts, arouse motivation and activeness of students so as to improve cognitive outcomes is the guided discovery learning learning model (Smitha, 2012; Janssen, et al., 2013; Maulidar, 2016).

The current condition of the Covid-19 pandemic is very influential on the field of education, especially the learning process in schools. The government decided that the implementation of learning in schools was transferred to online learning. Online learning is defined as the experience of knowledge transfer using video, audio, images, text communication, software (Basilaia & Kvavadze, 2020). Realizing some of these things, it is very necessary to develop a teaching material in the form of an e-module that can increase students' understanding of concepts, can attract students to learn, can make students active or can increase student involvement in the learning process, especially in learning on solution colligative properties material so that students' understanding of solution colligative properties material will increase. The colligative nature of the solution is material that must be studied by students in class XII SMA / MA. The material colligative properties of this solution have basic competence (KD) at the level of analyzing (C4) according to the level of bloom taxonomy.

Based on the results of the questionnaire that researchers have carried out regarding the chemistry learning process in class XII, data was obtained that there were several problems faced when learning the colligative nature of the solution. The first problem is that in the learning process teachers still often use textbooks as the main reference material in teaching. In addition, students get knowledge only from the explanation of the teacher who is still guided by the textbook so that the learning process still tends to be teacher-centered (teacher center). Therefore learners become passive and lack the motivation to develop higher thinking.

The second problem is based on the questionnaire given, namely, as many as 70% of students stated that the material of the colligative nature of the solution is material that is still considered difficult by students because the material is calculating, so that students have difficulty in determining the formula that will be used in solving the learning problem of the colligative nature of the solution. In addition to the two problems above, insufficient time in the learning process is the third problem based on the questionnaire given. Based on the above problems, to support guided discovery learning-based learning, especially in the material of the colligative nature of solutions in the current pandemic conditions, it is necessary to have teaching materials that can improve the high-level thinking ability of students such as e-modules.

This study aims to develop an e-Module of colligative properties of solutions based on guided discovery learning to improve the ability to think at a high level of students, as well as to determine the validity and practicality of the e-Module developed. Therefore, the researcher proposed an idea in this study with the title of the study, namely "Development of e-Module Colligative Properties of Solutions Based on Guided Discovery Learning to Improve Higher Order Thinking Skills of Class XII SMA / MA Students"

▪ METHOD

This type of research is educational design research. The development model used is the Plomp development model as developed by Tjeerd Plomp. This model consists of 3 stages, namely the preliminary research stage, the development or prototyping phase and the assessment stage (Plomp, 2007). In this study, the expected product is the teaching material e-Module colligative properties of solutions based on guided discovery learning to improve the thinking ability of high-level students. The purpose of creating this e-Module is to meet the criteria of valid, practical and effective.

The Plomp model is the implementation guideline in this study with stages: preliminary research, prototyping and assessment stage. At the preliminary research stage, needs analysis, context analysis, literature study, and framework development are carried out. Furthermore, at the prototyping stage, researchers design products, learning devices, instruments, and validations. The e-Module is designed in Microsoft Word and flip PDF Professional application. At the assessment stage, researchers conducted trials of e-module product development to measure the effectiveness and practicality of learning. The E-Module is used in learning during four meetings. When learning using the e-module, students bring their own smartphones and laptops in learning, then the e-module will be distributed to students in the form of a link shared on the class group whatsapp social media.

Then students read the material in the e-module and do practice questions for each learning activity by applying the Guided Discovery Learning learning steps in the e-Module. The research samples at the assessment stage are two classes at SMA Negeri 14 Padang, namely class XII IPA 2 as an experimental class and class XII MIPA 3 as a control class, each of which consists of 36 students with random sampling techniques. This research was carried out from October 2021 to December 2022.

The instrument used to measure the practicality of the e-Module is a practicality questionnaire. Aspects of the assessment include ease of use, time efficiency and benefits. Researchers learn the colligative nature of the solution using the e-Module, then the observer will assess the implementation of the learning by filling out a practicality sheet. Observers are six students of class XII IPA 5 at SMAN 14 Padang who have studied this material before and two chemistry teachers of SMA N 14 Padang. The assessment technique in the questionnaire uses the Likert scale with a score range of 1-4 and is calculated using the practicality formula. If the practicality results of 41%-60% of the practicality are considered less practical, 61%-80% of the practicality is. considered practical and 81%-100% of the practicality is considered very practical (Ariani et al., 2021). The scores obtained from the learning implementation sheet will be calculated as the percentage and average of the eight observers.

The instrument used to measure the effectiveness of the e-module is a student competency sheet in order to obtain the data needed in determining students' higher order thinking skills (HOTS) after participating in learning activities, through written tests in the form of multiple choices in pretest and postest. Before the test questions are used, several tests are first carried out to determine the feasibility of the questions that will later be used to determine the higher order thinking skills (HOTS) of students. The pretest and post-test results will be analyzed using N-Gain. The effectiveness of the e-module is obtained by looking at the difference in the learning outcomes of students who use Guided Discovery Learning-based e-Modules (for experimental classes) with those who do not use Guided Discovery Learning-based e-Modules (control classes)

from pre-test and posttest results. If the n-gain result < 0.30, the effectiveness of the e-Module is low. If the n-gain result < 0.30, the effectiveness of the e-Module is low. If the n-gain result is 0.30 g < 0.70, the effectiveness of the e-Module is medium, and if the n-gain result is≥ 0.70, the effectiveness of the e-Module belongs to the high category (Hake, 1999).

▪ RESULT AND DISSCUSSION

Preliminary Research

In this preliminary research stage, several stages are carried out, namely needs analysis, curriculum analysis, concept analysis and student analysis. The results of each stage carried out in the preliminary research are as follows.

At the curriculum analysis stage, it was obtained that the 2013 revised 2018 curriculum requires students to actively seek, process and construct knowledge in the learning process and be skilled in using media, technology, information, and communication. This can be achieved by applying contextual-based learning and using teaching materials in the form of electronic modules when carrying out learning. As well as at the stage of concept analysis, the identification of the hatching of important concepts studied on the material of the colligative properties of the solution is carried out. Then the details of concepts related to the material are carried out in accordance with the existing sourcebook.

At the student analysis stage, the data obtained in the field, namely data from the questionnaires of several students at SMAN 1 Padang, SMAN 5 Padang, and SMAN 14 Padang, showed that students had difficulty in understanding the material of the colligative nature of the solution because this material was abstract, and the learning media used by teachers in the learning process were inadequate.

Prototype Stage

The second stage in the Plomp development model is the prototyping stage. At this stage, it is carried out to develop an e-module of colligative properties of solutions based on Guided Discovery Learning-based learning to improve students' Higher Order Thinking Skills. This stage produces four prototypes where each prototype is evaluated formatively. This research is only limited to the product validation stage and is practical. The first stage is prototype I, which is a prototype produced in the form of an e-module containing a cover, foreword, table of

contents, table of tables, list of images, list of videos, learning instructions, core competencies, basic competencies, GPA, learning objectives, learning activities, evaluation questions and bibliography. The shape of the cover display e-module can be seen in Figure 1.

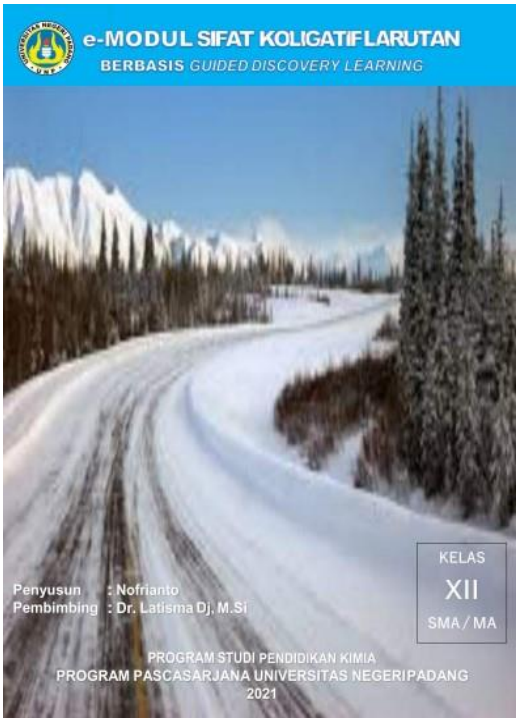

Figure 1. Electronic module cover design

Guided Discovery Learning has 5 stages of learning, namely the Motivation and Problem Presentation Stage, Data Collection, Data Processing, Verification, and Closure. An example of the appearance of the e-module in the Motivation and Problem Presentation stage can be seen in Figure 2

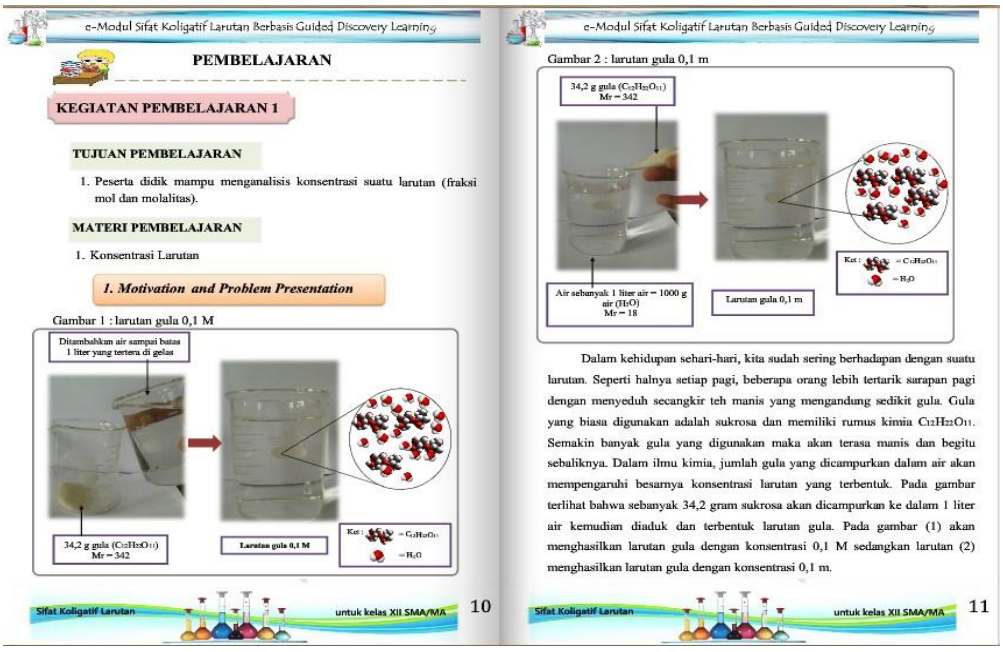

Figure 2. Motivation and problem presentation stage

Furthermore, at the Data Collection stage, students are asked to dig and collect information in various ways, namely observing objects / events, images, videos, tables and reading other sources to prove hypotheses. An example of the appearance of the e-module at the Data Collection stage.

The next stage is the Data Processing stage where students are asked to be able to provide simple explanations, mention examples, make definition content, ability to give reasons in answering questions and solving problems. An example of how the e-module looks at the Data Processing stage. The fourth stage is Verification where students are asked to prove whether the hypotheses that have been put forward before are true /not after students have collected and processed data, so that students can draw conclusions. In the last stage, namely the Closure stage, students are asked to write down the conclusions of the material on the colligative nature of the solution that students get based on facts or observations during the learning process in accordance with the learning objectives. An example of the appearance of the e-module in the Verification and Closure stage. The design of prototype I in the form of an e-module of colligative properties of solutions based on guided discovery learning was made using pro flipbook maker software. The e-Module that has been developed can be presented using a laptop or smartphone. Prototype II was produced after conducting a formality assessment in the form of self-evaluation Prototype I. Prototype II which is the result of self-evaluation was subsequently validated by 6 experts who were referred to as validators, consisting of UNP chemistry lecturers and high school chemistry teachers.

Formative evaluation is carried out in the form of personal assessment and expert review. Expert reviews are carried out by content experts and construct experts, by assessing and reviewing products carried out either with or without the presence of a researcher (Tessmer, 1993). Validation is carried out by 4 lecturers and 2 teachers. Validator aspects are measured using the formula V aiken. The construct validation questionnaire contains four aspects consisting of aspects of assessing the content component, the linguistic component, the presentation component, and the graphic component (Muljono, 2007). The results of data processing of the validity of the e-module construct of the colligative properties of the solution can be seen in Table 1.

Table 1. The result of the validity of the construct e-module colligative properties of the solution by the validator

No	Category	V	validity categories
1	Eligibility of Contents	0.84	Valid
2	Construction Feasibility (Serving Component)	0.88	Valid
3	Linguistic Components	0.78	Valid
4	Graphic Components	0.84	Valid
	Average	0.84	Valid

Description V = Index V Aiken

Based on the validation results it can be seen from Table 1 that the e-module shows a valid category. This result is in line with the opinion of Akbar (2013) that e-modules can be implemented in chemistry learning if the validity value is above 70% -

100%. The e-module has been well structured in terms of content validity and construct validity. A development research product is said to be feasible if the product is adequate in terms of the content and validity of the construct (Nieveen, 1999). The validity of the contents means that the e-module has a state of being up-to-date. The validity of the construct means that all the components of the e-module are arranged consistently and interconnected. This revised e-module will later be used in field trials to measure effectiveness and practicality.

Assessment Stage

The next stage is a small group trial. The small group saw the changes made to 6 students of SMAN 14 Padang. The results of the practicality questionnaire test is average practicality score of students is 93.51%. This is in line with Adriyani (2018) that the implementation of learning when the practicality value is more than 61%, it can be said that e-modules are very practical to be applied and used by students in chemistry learning. The next assessment is to see whether the resulting product can be used in practice in the field. This assessment step is carried out using testing on high school students to see the practicality (field trials) and effectiveness of the e-module developed. Practicality assessment is carried out by filling out the e-module practicality instrument by two teachers and 36 students.

Average practicality scores of teachers and students are 92.10% and 81.70% respectively with very practical categories, this proves that this guided discovery learning-based e-module makes it easier for students to understand the material's colligative properties of solutions. This ease of use relates to the language and material in the e-module being clear and easy to understand because the e-Module should provide text that is easy for students to understand (Laili, 2019). From the results of field tests, in general, Guided Discovery Learning-based e-Modules are practical and able to guide students in finding material concepts according to learning objectives so as to improve the Higher Order Thinking Skills of students. After testing the practicality of this e-Module, the next stage is to test the effectiveness of the e-Module using N-Gain analysis. The effectiveness of the e-Module is seen from the comparison of student learning outcomes through posttest scores from experimental classes that use e-Modules with control classes that do not use e-Modules.

The results of the N-gain analysis in the experimental class were 0.60 and according to Hake (1998) this result belonged to the moderate category. So it can be said that there is an increase in student HOTS with learning using e-modules, with the increase referred to being in the moderate category. These results are in line with Astalini et al. (2019) that the use of e-modules in learning can train students' abilities and skills effectively. Based on the results of the N-gain analysis, the e-module developed is quite effective in improving student learning outcomes. The results of the development research show that the e-Module belongs to the category of valid, practical, and effective. e-Modules can be used in chemistry learning, especially in the material of the colligative properties of solutions to improve the learning outcomes of class XII SMA / MA students. This follows Nieveen's (1999) statement that product development can be successful when the resulting product meets valid, practical, and effective criteria

▪ CONCLUSION

Based on the results of research and product studies e-Module colligative properties of solutions based on Guided Discovery Learning to improve Higher Order Thinking Skills Students of class XII SMA / MA it can be concluded that the results of the expert assessment of the e-Module colligative properties of this solution obtained valid and very practical criteria judging from the responses of students and teachers to the e-Module which was developed and effectively used in the chemistry learning process, especially in the nature material colligative solution. Based on research, the use of e-modules can improve Student Higher Order Thinking.

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