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VALIDITY OF DISCOVERY LEARNING-BASED E-LKPD TO TRAIN STUDENTS' METACOGNITIVE SKILLS ON COLLOID MATERIAL

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Abstract

The aims of this research are the validity of e-worksheets based on Discovery Learning designed to train students' metacognitive skills on colloid material. The research utilized the 4D development model, which includes four main stages: Define, Design, Develop, and Disseminate. However, the study was limited to the third stage, namely Develop. The subjects of this study were 30 students of Class XI IPA 1 at MAN 2 Gresik. The research instrument included a validation sheet. The validation results showed that e-LKPD 1, 2, and 3 on the content criteria obtained a mode of 4 with percentages of 83.33%, 83.3%, and 100%, respectively. On the construct criteria, e-LKPD 1, 2, and 3 obtained a mode of 4 with a percentage of 66.67%. All three e-LKPDs obtained a mode ≥ 3 and the percentage obtained ≥ 61%, which states that the developed e-LKPD is valid. This e-LKPD is expected to be used as a learning medium in learning colloid material through discovery learning.
Keywords : validity, e-worksheets, discovery learning, metacognitive skills, colloids

INTRODUCTION

The Indonesian education system continues to undergo various reforms aimed at improving the quality of human resources through education. Along with the rapid development of technology, education plays a crucial role in developing qualified, competent individuals with the ability to contribute to the nation's progress in various fields. To achieve this improvement in the quality of learning, a graduate qualification profile is required, outlined in graduate competency standards. In Ministerial Regulation of Education and Culture Number 20 of 2016 concerning Graduate Competency Standards for Elementary and Secondary Education, Article 1, "Graduate Competency Standards for Elementary and Secondary Education," is used as the primary reference for developing content standards, process standards, educational assessment standards, standards for educators and education personnel, standards for facilities and infrastructure, management standards, and financing standards [1].

The government's implementation of the 2013 curriculum aims to develop students' abilities to be more active in the learning process. Through this curriculum, students are encouraged to observe, ask questions, connect various pieces of information, conduct experiments, and communicate their understanding after studying a subject. Chemistry is a branch of science that develops through experiments and research to answer various questions about what, how, and why phenomena occur. Therefore, chemical concepts are not only understood theoretically but can also be demonstrated through practical laboratory activities [2].

In classroom learning, students' worksheets (LKS) or textbooks are often used as reference or guideline for learning, with few practical exercises due to limited materials and laboratory staff, as well as the fact that the science laboratory is still connected. To help overcome students' difficulties in understanding the material, electronic student worksheets (e-LKPD) are used as learning media.

In solving a problem, it is necessary to monitor the effectiveness of the solution and modify the chosen strategy to solve the problem and find a solution. Through metacognition, students are able to identify information they have

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understood and areas they have not yet mastered. The term metacognition is often referred to as "thinking about thinking," or thinking about the thinking process itself [3].

Based on a preliminary study conducted through interviews with a chemistry teacher at a high school, it was revealed that the learning model frequently used in schools is the conventional or lecture model, with cooperative and discussion models sometimes also being used. Therefore, efforts are needed to support the development of metacognitive skills, one of which is through the implementation of the discovery learning model. The discovery learning model is considered suitable for implementation because it can develop various cognitive skills in students, particularly in discovering concepts and solving problems independently [4]. Through this model, students are encouraged to be more active in the learning process by exploring and constructing their own knowledge, thereby reducing dependence on the help of others.

One of the topics studied in chemistry is colloidal systems. This topic has the potential to develop students' metacognitive skills because it requires a deep understanding of concepts and the ability to connect theory to phenomena occurring in everyday life. In developing this e-LKPD, validation must be carried out to ensure the accuracy of its content and construction. Therefore, it is important to determine the validity of the developed e-LKPD. This e-LKPD is expected to be used as a learning medium for colloids to practice metacognitive skills through discovery learning.

METHOD

The research method used is research and development. The model used in this study is the 4D model (Four D Model) which is a learning device development model developed by S. Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel (1974) which consists of 4 main stages, namely: Define, Design, Develop, and Disseminate. However, in this study it is limited to the third stage, namely develop. The validation sheet is used to obtain data regarding expert assessments of the developed e-LKPD. The validated criteria are content and construct criteria. The e-LKPD validators are 2 Chemistry lecturers from Surabaya State University and 1 chemistry teacher from MAN 2 Gresik. The e-LKPD validation is based on score calculations using the Likert scale assessment criteria presented in the following Table 1.

Table 1. Likert Scale Assessment

Score	Criteria
0	Very Poor
1	Poor
2	Sufficient
3	Good
4	Very Good

[5]

The percentage calculation in determining the validity criteria for the developed e-LKPD can be calculated using the following formula:

$$Persentase(\%) = \frac{total\ score\ obtained}{criteria\ score}\ x\ 100\%$$

The criteria score is obtained from the maximum value scale x number of criteria assessed x number of students. The resulting percentage can be interpreted through the assessment criteria in the following Table 2.

Table 2. Interpretation of Validity Criteria

Percentage (%)	Criteria
0-20	Very weak
21-40	Weak
41-60	Fair
61-80	Strong
81-100	Very strong

[5]

E-LKPD is declared valid if the percentage obtained is ≥ 61% [5].

RESULT AND DISCUSSION

The results and discussion will be described as follows.

Define Stage

The define stage is the initial stage in development research, which aims to identify learning needs as the basis for developing e-LKPD (learning materials) based on Discovery Learning. This stage analyzes learning conditions, student characteristics, learning materials, and learning objectives.

Based on observations and interviews with chemistry teachers at MAN 2 Gresik, it was

discovered that chemistry learning for colloids is still dominated by simple lecture and discussion methods, using textbooks and printed LKPD. The use of these teaching materials has not fully encouraged students to discover concepts independently or practice metacognitive skills during the learning process. Students tend to receive information from teachers without engaging in in-depth thinking to plan, monitor, and evaluate their learning process.

The student analysis results indicate that 11th-grade students have mastered the ability to use digital devices, such as smartphones and laptops, enabling the use of e-LKPD in the learning process. Furthermore, students are at the formal operational development stage and are capable of logical reasoning and problem-solving when provided with appropriate learning activities.

Next, task and concept analysis were conducted based on the 2013 Curriculum on the colloid material. The analysis revealed that the colloid material comprises the concepts of colloid systems, types of colloids, properties of colloids, colloid preparation, colloid purification, and the application of colloids in everyday life. These concepts were systematically organized into a concept map as the basis for compiling the e-LKPD content.

Based on the analysis, learning objectives were formulated that not only focus on conceptual mastery but also aim to develop students' metacognitive skills through the application of Discovery Learning syntax, enabling students to plan, monitor, and evaluate their learning process independently.

Design Stage

The design stage aims to produce an initial design for the Discovery Learning-based e-LKPD that aligns with the needs analysis results from the previous stage. The first step was to develop research instruments, including validation sheets, pretest and posttest questions, student response questionnaires, Metacognitive Awareness Inventory (MAI) questionnaires, and teacher interview guidelines.

Next, e-LKPD was selected as the medium because it was deemed more appropriate for the characteristics of students who are accustomed to using digital devices. The use of e-LKPD also allows for a more engaging presentation of material through the integration of images, illustrations, videos, and interactive learning activities.

The next stage was selecting the e-LKPD format. The product developed consisted of a :

1) Cover

The e-LKPD cover is designed to reflect the content and characteristics of the material being studied. The cover contains several components, namely the Surabaya State University (UNESA) logo, the 2013 Curriculum logo, the e-LKPD title, the author's identity, a column for student or group identification, information about the grade XI SMA/MA, and illustrations appropriate to the colloid material. The cover design is as shown in the following image in Figure 1.

Figure 1. Cover

2) Foreword

The foreword contains an expression of gratitude, the purpose of the compilation, the author's hopes, and a brief explanation of the e-LKPD that has been developed, as seen in the following image in Figure 2.

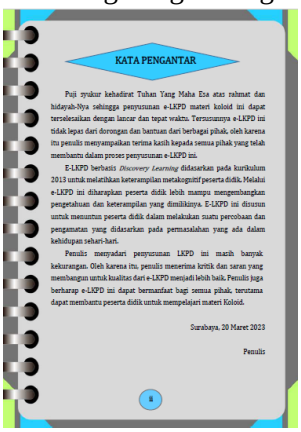

Figure 2. Foreword

3) List of Contents

The table of contents is an important component of e-LKPD, serving as a guide for users to find materials, activities, and specific sections more quickly and systematically. As seen in the following image in Figure 3.

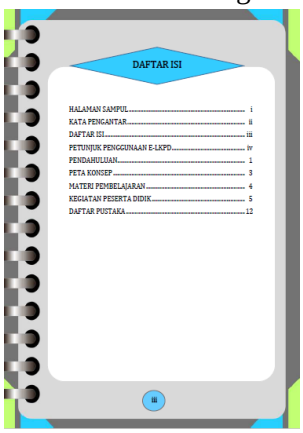

Figure 3. List of Content

4) Instructions for use

The e-LKPD User Guide is a section containing information on how to use the e-LKPD through the Liveworksheets platform. This section explains the steps students need to take to access, operate, and complete the learning activities contained in the e-LKPD, as shown in the following image in Figure 4.

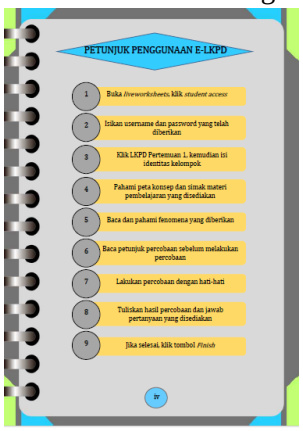

Figure 4. Instruction for Use

5) Introduction

The e-LKPD introduction contains general information that provides an overview of the content and scope of the learning to be covered. This information includes subject identity, learning materials, class, semester, time allocation, learning outcomes, learning objectives, and other components relevant to the learning activities. As seen in the following image in Figure 5.

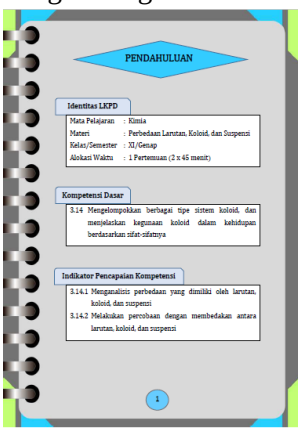

Figure 5. Introduction

6) Concept Maps

Concept maps are presented to help students understand the colloid material comprehensively and systematically before studying each subtopic in more depth. In this e-LKPD, the concept map illustrates the relationships between the main topics of colloids, including colloid systems, colloid properties, and colloid preparation. The concept map can be seen in the following image in Figure 6.

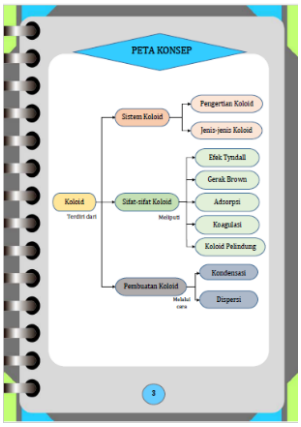

Figure 6. Concept Maps

7) Learning Material

The learning materials contained in e-LKPD are used as learning resources to help students understand concepts related to the topics being studied and to support the completion of assigned tasks and problems. The learning materials are as shown in the following image in Figure 7.

Figure 7. Learning Materials

8) Learning Activities

The learning activities in e-LKPD are designed to encourage students to discover concepts independently through a series of structured activities. The learning activities are structured according to the stages of the Discovery Learning model and integrate students' metacognitive skills, which include the stimulation and problem statement stages using the planning skills component; the data collection, data processing, and verification stages using the monitoring skills component; and the generalization stage using the evaluating skills component in metacognitive skills. As seen in the following Figure 8.

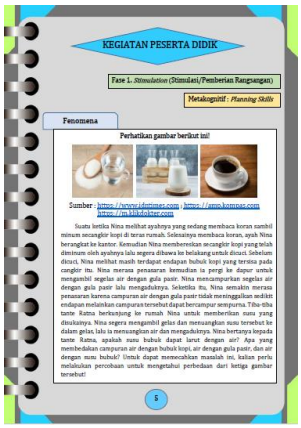

Figure 8. Learning Activities

9) References

The references is a section containing various reference sources used in compiling the e-LKPD. These sources can include books, scientific journals, articles, or other references relevant to the learning materials being developed. As seen in the following Figure 9.

Figure 9. References

The final result of the design stage was an initial draft (Draft I) of the e-LKPD, which was then submitted to the validator for input before the trial.

Development Stage

The development stage aims to produce a feasible, practical, and effective e-LKPD through expert validation and student trials.

The first activity in this stage is expert appraisal. Draft I of the e-LKPD was validated by two Chemistry Education lecturers from Surabaya State University and one Chemistry teacher from MAN 2 Gresik. Validation was conducted on aspects of content suitability, presentation, language, appropriateness of Discovery Learning syntax, and appropriateness of metacognitive skill indicators. In addition to providing assessment scores, the validators also provided suggestions and input as a basis for product improvements. Based on the validation results, revisions were made to several sections of the e-LKPD to produce Draft II, which better aligns with learning needs.

The validity of the Discovery Learning-based e-LKPD was assessed by three validators, consisting of two Chemistry Education lecturers from Surabaya State University and one Chemistry teacher from MAN 2 Gresik. The assessment was conducted using a validation instrument with a Likert scale covering five aspects: content suitability, presentation, language, suitability of the Discovery Learning model, and suitability of metacognitive skill indicators. The assessment results from each validator were then calculated as a percentage to determine the level of validity of the developed e-LKPD.

1) Material Expert Validation

The purpose of the material expert validation was to determine the suitability of the e-LKPD content to the curriculum, the appropriateness of the colloid material concepts, the systematic presentation of the material, the use of language, and the integration of Discovery Learning syntax in training students' metacognitive skills. The validation was conducted by a Chemistry Education lecturer with expertise in developing teaching materials. Aspects assessed included the appropriateness of the content, presentation, language, suitability of the Discovery Learning model, and the suitability of metacognitive skill indicators. The validation results showed that all aspects were categorized as valid to very valid, thus the e-LKPD was deemed to meet the requirements as a suitable teaching material for use in learning. Input provided by the material validator included refinement of several concepts in the colloid material, the addition of examples of colloid phenomena in everyday life, and improvements to the wording of several sentences to make them more easily understood by students. All of these suggestions were used as the basis for revisions to improve the quality of the e-LKPD content.

2) Media Expert Validation

Media expert validation aimed to determine the suitability of the e-LKPD display as a digital learning medium. The assessment included aspects of display design, layout, color combinations, font type and size selection, image quality, ease of navigation, and the presentation of Discovery Learning-based learning activities. The validation results indicated that the e-LKPD display met the criteria for good learning media. The layout of each page was deemed systematic, the choice of colors and illustrations enhanced student engagement, and the navigation within the e-LKPD was easy to use. Furthermore, the integration of images, illustrations, and learning activities was deemed effective in helping students understand the concepts in the colloid material. The media validator also provided several suggestions for improvements, such as increasing the font size in some sections, improving the color consistency of icons, and adding user instructions to the home page of the e-LKPD. All of these suggestions were addressed through a revision process before the e-LKPD was piloted with students.mampu membantu peserta didik memahami konsep-konsep pada materi koloid. Validator media juga memberikan beberapa saran perbaikan, seperti memperbesar ukuran huruf pada beberapa bagian, memperbaiki konsistensi warna ikon, dan menambahkan petunjuk penggunaan pada halaman awal e-LKPD. Seluruh saran tersebut telah diakomodasi melalui proses revisi sebelum e-LKPD diujicobakan kepada peserta didik.

3) Chemistry Teacher Validation

Validation by the Chemistry teacher aimed to determine the suitability of the e-LKPD for the learning conditions at the school. The assessment focused on the material's suitability to the curriculum, ease of use, the implementation of Discovery Learning syntax, the clarity of activity instructions, and the e-LKPD's ability to develop students' metacognitive skills.

Based on the Chemistry teacher's assessment, the e-LKPD was deemed appropriate for the characteristics of 11th-grade students and could be used as an alternative teaching material for colloids. The teacher assessed that the step-by-steplearning activities encouraged students to actively explore concepts, discuss topics, and reflect on their learning process. The teacher also provided several suggestions, including increasing the time allocated for each learning activity and refining several instructions for clarity. After revisions based on the validator's suggestions, the e-LKPD was declared suitable for use in the pilot phase with students.

4) Validity of e-LKPD based on Discovery Learning to train students' metacognitive skills on colloid material

The e-LKPD validity aims to determine the product's suitability before use in learning. The assessment was conducted by two Chemistry Education lecturers from Surabaya

State University and one Chemistry teacher from MAN 2 Gresik, assessing the appropriateness of content, presentation, language, suitability of the Discovery Learning model, and suitability of metacognitive skill indicators.

Validation results showed that the e-LKPD received valid to very valid ratings across all assessed aspects. This indicates that the material presented aligns with the curriculum, learning indicators, and the characteristics of 11th-grade students. The presentation of the material was also deemed systematic, making it easier for students to follow each stage of the learning process.

From a linguistic aspect, the language used is considered communicative and easy to understand. Furthermore, the Discovery Learning stages have been implemented sequentially to guide students in discovering concepts independently. The questions formulated in each activity have also accommodated indicators of metacognitive skills, starting from the planning stage, monitoring, and evaluation of the learning process. Several inputs from the validators, such as improvements to sentence wording, improvements to the display, and the addition of examples to the material, were used as revision material before the e-LKPD was trialed. These revisions were made so that the developed product would have better quality and be in accordance with the needs of students. Based on the results of the e-LKPD validation conducted by three validators, it was found that all three e-LKPDs obtained a mode of 4 on the content and construct criteria, resulting in the mode percentages for e-LKPDs 1, 2, and 3 being 83.33%, 83.33%, and 100%, respectively, while for the construct criteria obtained a percentage of 66.67% for e-LKPD 1, 2, and 3. Therefore, it can be stated that e-LKPD 1, 2, and 3 are valid for use because the percentage results obtained are ≥ 61% [5]. This is in line with research conducted by Pratama et al. (2021) [6] which proved that the development of discovery learning-based e-LKPD on the main topic of acids and bases was declared very valid and suitable for use in the learning process. This is also supported by research by Mitasari and Hidayah (2022) [7] which proved that the development of e-LKPD on Stoichiometry material can improve students' metacognitive abilities.

CONCLUSION

Based on the data and analysis conducted, it was concluded that the Discovery Learning-based e-LKPD developed on the e-LKPD content criteria 1, 2, and 3 obtained a mode of 4 with percentages of 83.33%, 83.3%, and 100%, respectively, while on the e-LKPD construct criteria 1, 2, and 3 obtained a mode of 4 with a percentage of 66.67%. All three e-LKPDs obtained a mode of ≥ 3 and the percentage obtained was ≥ 61%, which states that the developed e-LKPD is valid for use in chemistry learning on colloid material so that students' metacognitive skills can be trained well.

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