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DEVELOPMENT OF LEARNING-BASED CHEMISTRY DEVICES GUIDED DISCOVERY TO IMPROVE CRITICAL THINKING SKILLS

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Abstract: Learning tools have been developed through lesson plans, worksheets based on learning-guided discovery, and assessment instruments to improve critical thinking skills on the sub-subject factors that affect the reaction rate. The stages carried out in the production process of the two types of learning devices are defining, planning, and development, which are the three stages of the four stages of the 4D model. Two lecturers and one teacher validate the quality of the developed learning tools. Based on the results of data analysis, the lesson plan as a whole has good quality, the student worksheet is in the very good category, and the instrument for assessing students' chemical critical thinking skills has a high category of validity. Based on the integration of learning model guided discovery, the lesson plan and student worksheet have very good quality, and the integration of critical thinking skills in the assessment instrument is very good.

Keywords: *Chemistry Learning Devices, Learning Guided Discovery, Critical Thinking Skills*

INTRODUCTION

Critical thinking ability is a reflective and logical way of thinking focused on making decisions to solve problems [1]. Thus, the ability to think critically is a competency that students need to have to solve the problems faced in student life.

Critical thinking skills can be developed in students through continuous practice [2]. Learning methods or models that provide opportunities for students to be active in solving problems, analyzing and applying concepts and principles so that they become more meaningful in learning can develop students' critical thinking skills [3]. Besides that, critical thinking skills can also be developed through group learning because, in this learning, there are discussions, clarification of ideas, and evaluation of other people's ideas [4].

Learning model guided discovery is a learning model that can be implemented through discussion and can optimize physical and mental student learning activities.

In learning to direct the process according to the learning scenario to achieve the goals that have been set, learning tools are needed. In addition to support from learning tools, the teacher's ability to implement learning tools that have been compiled is also an important variable that determines the achievement of learning objectives.

Critical thinking skills correlate with student learning outcomes [5]. Therefore, critical thinking skills can be predicted from learning outcomes. Based on the results of observations at SMA Negeri 6 Mataram, it was found that the average value of chemistry at the end of the semester for class X MIPA was 73.5. The data provides an overview of students' critical thinking skills, which still need to be improved by improving the quality of the learning process.

In the learning process, the teacher uses the learning model of guided discovery, which is one of the learning models that can develop students' critical thinking skills [6-8]. Still, not all stages of learning are applied according to the syntax of the learning model guided discovery. In addition, the teacher must assess students' critical thinking skills in evaluating learning outcomes. These problems are due to the difficulty teachers prepare based on learning tools guided discovery, which is oriented towards improving critical thinking skills [9-10].

Following the problems above, one of the efforts to assist teachers in preparing learning tools that meet quality standards is to conduct research and development with the objectives (1) Producing lesson plans for lesson plans, worksheets, and learning-based assessment instruments guided discovery, which is oriented towards improving students' critical thinking skills in chemistry with a minimum good quality category. (2) Knowing the quality of integrating learning model guided discovery on lesson plan and student worksheet resulting from research and development, (3) Knowing the quality of integrating critical thinking skills on the items in the instrument for assessing students' critical thinking skills based on the degree of suitability between the contents of the items and the assessment indicators.

RESEARCH METHODS

This research is research and development or research and Development (R&D). R&D-type research is research that is used to produce specific products and test the effectiveness of these products [6]. In this study, the products produced were lesson plans, worksheets, and critical thinking skills assessment instruments. The learning materials developed by the learning tools are chemistry

learning materials, sub-subject to the factors that affect the reaction rate, studied in class XI SMA.

In developing learning devices in this study, 4D Models. 4D Models consist of four main stages, namely the definition stage (define), planning level (design), development stage (develop), and the level of diffusion (disseminate) [11]. Of the four stages according to the 4D model in this study, only three stages were carried out, namely the stages of defining, designing, and developing.

At the defining stage, an analysis of the curriculum, the characteristics of students, the models or methods used by teachers in learning, and the problems that arise in learning are carried out.

At the design stage, the device is prepared, including a lesson plan, student worksheet, instrument assessment of critical thinking skills, and an instrument for validating all learning devices that will be compiled. The preparation of learning tools refers to the principles that have been set. At this stage, a learning device is produced as a draft.

Learning device products arranged at the design stage are tested for eligibility at the development stage. The feasibility of the learning device is based on an assessment carried out by a validator who meets competence.

The type of data collected in this study is data on the value of learning devices as a basis for determining their feasibility to be applied in learning. The data that was also collected in this study was trial data of learning devices. The data exists in 2 forms, namely qualitative data and quantitative data. Qualitative data is in the form of comments or input from validators who are experts and practitioners in chemistry education. Quantitative data obtained from the validation results of experts and practitioners are in the form of assessment scores with a scale of 1 to 5.

The instrument used in this study was a Likert scale questionnaire to assess the validity or quality of learning tools. The indicators used as a reference in the lesson plan assessment are the formulation of indicators, learning objectives, learning materials, learning methods and models, learning steps, learning resources/media, and assessment. The student worksheet assessment uses didactic, construction, and technical indicators. Indicators as a measure of feasibility in the assessment instrument include material, structure, and language.

The data analysis technique used in this research is qualitative and quantitative analysis techniques. The following is an explanation for each analysis technique.

Qualitative analysis, namely an analysis based on suggestions from experts or practitioners on the products developed by researchers, is the lesson plan, student worksheet, and instrument assessment of students' critical thinking skills in chemistry.

Analysis Quantitative is an analysis obtained from expert or practitioner validation of data in the form of scores from a questionnaire filled out by the validator.

The quality of lesson plans and worksheets is reviewed from the assessment of expert validators and practitioner validators based on the score data of the learning device validation sheet. The feasibility assessment analysis is carried out in the following way.

1) Count rating average score
2) $\bar{X}\frac{\Sigma X}{n}$
   X = average value
   ΣX = total score of all validators
   n = number of validators
3) Calculating the ideal maximum score = number of items x maximum score
4) Counting scores minimal ideal = number of items x minimum score
5) Calculating the average ideal score (X_i) = ½ (shoes maximum ideal + shoes minimum ideal)
6) Calculating the ideal standard deviation (SB_i) = 1/6 (shoes maximum ideal + shoes minimum ideal)
7) Determine the assessment criteria according to Table 1

Table 1 Criteria for the Quality of Learning Devices

No	Interval Shoes	Quality Category
1	$X > Xi + 1.8\ SBi$	Very good
2	$Xi + 0.6\ SBi < X \leq Xi + 1.8\ SBi$	Good
3	$Xi - 0.6\ SBi < X \leq Xi + 0.6\ SBi$	Pretty good
4	$Xi - 1.8\ SBi < X \leq Xi - 0.6\ SBi$	Not good
5	$X \leq Xi - 1.8\ SBi$	Not very good

[12-13]

RESULTS AND DISCUSSION

Learning tools have been produced from the research and development activities that have been carried out in the form of lesson plans, lesson-based worksheets, discovery learning, and critical thinking assessment instruments. All learning device products are presented in the appendix. The learning device has been revised based on the suggestions for improvement the validator gave during the due diligence.

Results of Quality Analysis of RPP

The lesson plan and student worksheet were analyzed for quality through validation carried out by three validators who are competent experts and practitioners in chemistry education. As for experts who validate the device learning, The results consisted of 2 lecturers from the Chemistry Education Study Program, FKIP University of Mataram, and one chemistry teacher at SMA Negeri 6 Mataram.

The quality of the lesson plans, both as a whole and per aspect, is based on the results analysis presented in Table 2.

Table 2. Quality of Lesson Plan

No	Assessment Aspects	X	Interval	Category
1	Formulation of indicators	14.0	X > 12.6	Very good
2	Formulation of learning objectives	13.7	X > 12.6	Very good
3	Learning materials	4.7	X > 4.4	Very good
4	Learning methods and models	9.7	X > 8.3	Very good
5	Learning steps	36.3	X > 33.5	Very good
6	Learning Resources/media	13.0	X > 12,6	Very good
7	Assessment	8.0	X > 8.3	Good
	Lesson plan as a whole	91.2	74.8 < X ≤ 92.5	Good

Based on the table. In general, lesson plan research and development results have good quality. If viewed per aspect of the lesson plan whose quality is assessed, 6 out of 7 aspects (85.7%) are in the very good category.

From the analysis that has also been carried out to determine the quality of integrating the learning model into lesson plans, it is known that the quality is in a very high category (X = 4.7 with intervals > 4.4). One of the descriptors assessed in this aspect is learning steps integrated with learning syntax-guided discovery (orientation, formulating problems, collecting data, data analysis, and concluding). By applying the steps according to the learning syntax-guided discovery, students' critical thinking skills are expected to increase [14-16].

In the lesson plan feasibility test, there are suggestions for improvement from the validator, name related to the lesson plan format so that it is adjusted to Permendikbud no 22 of 2016, which no longer lists Core Competencies (KI) in the lesson plan. Based on this suggestion, revisions have been made by removing the KI formulation from the lesson plan.

Student Worksheet Quality Analysis Results

The results of data analysis from three validators are according to Table 3.

Table 3. Student Worksheet Feasibility

No	Assessment Aspects	X	Interval	Category
1	Didactic	10	X > 8.3	Very good/very decent
2	The construction	40	X > 37.8	Very good/very decent
3	Technical	30.7	X > 29.5	Very good/very decent
	Student worksheet by hole	88.3	X > 75.6	Very good/very worth it

Based on the results of the quality analysis of student worksheets according to Table 4, overall and per aspect are all in the very good category. The quality of integrating learning model-guided discovery in student worksheets is also very good based on the analysis results (X = 5 with intervals > 4.4).

Even though, in general and per aspect, the assessment has been categorized as very good, there are still aspects of the student worksheets that need to be improved according to the suggestions for improvement from the validator. The aspect that needs to be improved is the learning resources in the student worksheets, especially the student worksheets for learning activity four about the catalytic factors that affect the reaction rate, the types, and how to access them have yet to be written clearly [17-20]. According to this suggestion, improvements have been made by writing down learning resources, including the Chemistry book for SMA/MA compiled by Unggul Sudarmo and Nanik Mitayani on pages 88-89 and the internet on page https://sites.google.com/view/wonderfulchemistrybyandira /reaction-rate/factors-affecting-rate-of-reaction.

Results of the Analysis of the Validity of the Critical Thinking Ability Assessment Instrument

Two validators validated the assessment instrument, and the results of the data analysis are presented in Table 4.

Table 4. The Validity of Critical Thinking Ability Assessment Instrument

No.	Assessment Aspects	CV	Category
1	Material	1	Height
2	Construction	0.75	Currently
3	Language	1	Height
	Overall	0.9	Height

According to the analysis results in Table 4, the critical thinking ability assessment instrument has shown overall high validity**.** The data analysis also found that the quality of integrating critical thinking skills in the items on the assessment instrument for assessing students' chemical critical thinking was in the very good category (X = 5 with intervals > 4.4.

Of the three aspects that were assessed for validity, one aspect was classified as moderate invalidity; namely, the item descriptors did not depend on the answers to the previous items. The question that needs to meet this requirement is question number 13. Based on the data you obtained in question number 5, if the observation results are recorded 20 seconds after the CaCO stone$_3$ and HCl are mixed, present the data with a graph showing the relationship between the concentration of HCl and the reaction rate based on the volume of CO gas$_2$ formed/length of time (ml/second). Besides this question, the answers depend on the answers to the previous questions. It is also possible that students cannot answer because they need help understanding how to determine the reaction rate. Based on these suggestions, the Indi question was corrected by providing data on reaction rates and reagent concentrations with examples of other reactions that were not related to the previous questions. The problem after revision becomes: In the reaction of Mg metal with HCl, it produces H gas$_2$ as a product of the reaction. In measuring the reaction rate by reacting Mg metal with HCl, four experiments were carried out with the mass and size of the Mg metal being fixed but the concentration of HCl being varied. If experiment I used 1 M HCl, the reaction rate for the formation of H gas$_2$ was 5 ml/sec; in experiment II using 2 M HCl gas, formation occurred at a rate of 10 ml/sec, and in experiment III using 3M HCl gas formation occurred at a rate of 15 ml/sec. Present the data relationship between the concentration of HCl and the reaction rate in graphical form!

CONCLUSIONS

From research and data analysis**,** It can be concluded that learning tools in the form of lesson plans, worksheets, and instruments for assessing students' critical thinking skills have been arranged through stages according to the 4D model, which is limited to 3 stages, namely definition (define), planning level (design), and development stage (develop). Research and development learning tools for lesson plan generally have good quality student worksheets in a very good category based on validity assessment by experts and practitioners of chemistry learning as validators. The quality of integrating learning model-guided discovery in lesson plans and student worksheets resulting from research and development is in a very good category. The quality of integrating critical thinking skills based on the suitability of the items' contents with indicators of students' chemical critical thinking abilities on the assessment instrument is in a very good category. In connection with the research results, it is necessary to carry out further tests on the learning tools that have been produced both to determine their effectiveness and for further improvement.

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