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Development of Student E-Worksheet Based on PBL (Problem Based Learning) to Practice Metacognitive Abilities of High School Student on Reaction Rate Material

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ABSTRACT: Developments in the 21st century is so rapid that innovation in various fields is required one of which is education. Through the implementation of the 2013 curriculum, the metacognitive abilities needed in the 21st century were train. The Problem Based Learning (PBL) model can support students to develop their metacognitive abilities. The rate of reaction as one of the subjects that are difficult to understand can be taught through the PBL learning model. The aim of this study is to develop a Student E-Worksheet based on Problem Based Learning to train students metacognitive abilities on reaction rate material. The Student E-Worksheet development model in this study uses a 4D model. The development of Student E-Worksheet was declared feasible to train student metacognitive abilities. The results of content validity of 94.81% and construct validity of 96.97%. Then the results of practical of observing student activities and questionnaire with a value of 96.37%. The effectiveness of the Student E-Worksheet is seen from the pretest and posttest values which were analyzed using the SPSS Paired Sample t-Test test, a significance value of 0.000 was obtained.

KEYWORDS: Chemistry, Metacognitive, Problem Based Learning (PBL), Rate Reaction, Student E-Worksheet.

INTRODUCTION

Changes in the 21st century occur very quickly, both in terms of society, the environment, and everyday life [1]. Increasing human resources is very much needed to deal with the various demands of massive developments that have occurred. One form of preparation carried out by the government in the realm of education is curriculum improvement. The 2013 curriculum is now a reference for educational institutions in Indonesia in planning, preparing, and implementing learning [2].

The metacognitive ability has become a demand in the world of education along with the implementation of the 2013 curriculum. One of the innovative skills in 21st-century learning is metacognitive, where the process of high-level cognition or thinking about what students think includes thinking about knowledge, and how to acquire it during learning [3]. Metacognitive abalities as one of the life skills that need to develop, so that students' can improve their understanding of concepts, improve quality, and can survive life[4]. Through practicing metacognitive abilities, students can use these abilities to direct their thinking in solving problems [5].

Chemistry is a branch of natural science (IPA) that has a parallel role with other science branches, such as physics, biology, geology, and astronomy [4]. Experts in science education view that science does not only consist of facts, concepts, and theories that can be memorized but also consists of active activities or processes using scientific thoughts and attitudes in studying unexplained natural phenomena [6]. Chemistry has 3 aspects, namely microscopic aspects, macroscopic aspects, and symbolic aspects. This part of the microscopic aspect is usually difficult for students to understand. Therefore, students consider chemistry a difficult subject to understand. The difficulty of chemistry is due to its abstract characteristics [7].

The material for reaction rates in Permendikbud Number 37 of 2018 is in class XI which is in the realm of knowledge at KD 3.6 which explains the factors that affect reaction rates using collision theory, while in the realm of skills in KD 4.7, namely designing, doing, and concluding and presenting the experimental results of the factors that affect the rate of reaction and the order of the reaction. The results of the pre-research conducted at SMA Al-Islam Krian as many as 93.3% of students thought that the material factors that affect the reaction rate were difficult chemical materials.

Now the learning process in the 21st century is through the application of material examples, and experiences in the real world, both at school and outside school [8]. Changes in learning to be more creative and innovative are needed [9]. Student-centered learning or

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from teaching to learning is one of the learning models in the 2013 Curriculum [10]. Learning models that follow the conditions of students are needed during the learning process [11]. One model of learning that can use is Problem Based Learning (PBL). In the implementation of the 2013 Curriculum, PBL model is the recommended learning [9]. Chances for Learning using the PBL model supports students to play an active role in finding and processing information, developing their knowledge and building meaning based on their experiences[12].

In addition to appropriate learning models, appropriate media and teaching materials are also needed for the learning process [11]. The learning process, which begins to focus on students, needs to be supported by various learning resources. One of the learning media that used in the education process is Student Worksheet. Along with the development of technology, the Student Worksheet has begun to be converted into a digital form that can be run using a computer or even a smartphone. By simplifying and narrowing space and time, teaching materials in the form of Student E-Worksheet can make learning more effective [13]. Through the Student E-Worksheet provided, students can find out the information that has been obtained reflect on and evaluate the results of their thoughts on the problems given in the Student E-Worksheet [14].

The background described above, research will be conducted with the title "Development of Student E-Worksheets based on PBL (Problem Based Learning) to Practice Practice Metacognitive Abilities of High School Students on Reaction Rate Material."

METHOD

The method used in this research is Research and Development (R and D). Development of Student E-Worksheet using the Four D (4D) model consists of 4 stages, namely Define, Design, Develop, and Disseminate, which was limited trials to develop stage. As many as 30 students of class XI Al Islam Senior High School Krian will be involved in a limited trial.

The validation sheets are one of the research instruments used to determine the validity of student e-worksheet. The practicality is measured with student activity observation sheets and student response questionnaires by observing activities during learning and respond students after learning with student e-worksheet. Then the learning outcomes test sheet is to measure the effectiveness of the Student E-Worksheet through the students' initial and final abilities.

This study uses a "*One Group Pretest-Post-test*" design, with a pretest before and post-test after treatment. The assessment validation data was analyzed using a Likert scale score. Then for the student response questionnaire, the Guttman scale score was used.

The criteria for decision appointment are shown in table 1. Then for practical interpretation based on result observations and questionnaires to table 2. Categorization of metacognitive awareness according to table 3. And for analysis of learning outcomes tests using SPSS, analyzed by the Shapiro-Wilk normality test, the value is considered normally distributed when the significance level is > 0.005. Then the Paired Sample t-Test test, Student E-Worksheet is declared effective if the significance level is <0.05.

Table 1. Category Validity

Percentage	Category
0% - 20%	Very less valid
21% - 40%	Less valid
41% - 60%	Fairly valid
61% - 80%	Valid
81% - 100%	Very valid

Table 2. Percentage of Practicality

Percentage	Category
0% - 20%	Very less practical
21% - 40%	Less practical
41% - 60%	Fairly practical
61% - 80%	Practical
81% - 100%	Very practical

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Table 3. Categorization Range of Metacognition Awareness

Range of Values (%)	Categorization
0- 19.99	Poor
20-39.99	Less
40-59.99	Enough
60-79.99	Good
80-100	Good

RESULT AND DISCUSSION

Research has carried out according to the 4D development model stage, which was limited to the Develop stage.All paragraphs must be indented as well as justified, i.e. both left-justified and right-justified.

A. Define

First define, is carried out to determine and explain learning based on the analysis of competencies, objectives, limitations, and problems in chemical learning of the reaction rate material. The stages contain an analysis of curriculum, studentss, concept, tasks, and formulation of learning objectives.

The 2013 curriculum is a curriculum that demands independence, responsibility, and character from students. Almost all learning models in the 2013 curriculum are centered on students as the main actors in education[11]. The 2013 curriculum directs students to be involved in the learning process because in this curriculum learning focuses on students (student-centered). The teacher acts as a facilitator or mediator as well as a learning designer so that students are active and creative in seeking new knowledge[7].

The analysis of students includes the ability, motivation, attitude, and interest in learning about the reaction rate material. Concept analysis is carried out to identify concepts related to the material to be developed to help students achieve the competencies set out in the curriculum. The basic competencies for the reaction rate material are contained in Basic Competencies 3.6 and 4.7. The formulating of learning objectives are arrange by the results of student analysis, concepts, and tasks using operational verbs.

B. Design

At the design stage, the instrument and learning media are designed based on the learning objectives that have been made. At this stage, the media in the form of Student E-Worksheet based PBL is designed with the hope of training students' metacognitive abilities of the reaction rate concept, especially on the material factors that affect the reaction rate. Then the draft I Student E-Worksheet is produced which will be developed at a later stage.

C. Development

The development stage aims to determine the feasibility of learning media, namely Student E-Worksheet draft I based on suggestions and comments from experts. The procedures carried out are review, revision, validation, limited trial, and data analysis. The initial design of the Student E-Worksheet that was made was reviewed by an expert lecturer in the field of chemistry using a study sheet instrument. Then revisions were made and draft II of the Student E-Worksheet was produced. Furthermore, validation was carried out by two chemistry lecturers and one high school teacher who was an expert in chemistry. Then the draft III Student E-Worksheet was produced which was revised based on the validation results so that it was feasible to be tested. The resulting Student E-Worksheet is then included in the e-liveworksheet website as shown in Figure 1. The Student E-Worksheet was developed by regulatory metacognitive components, namely Planning, Information Management Strategies, Monitoring, Debugging Strategies, and Evaluation.

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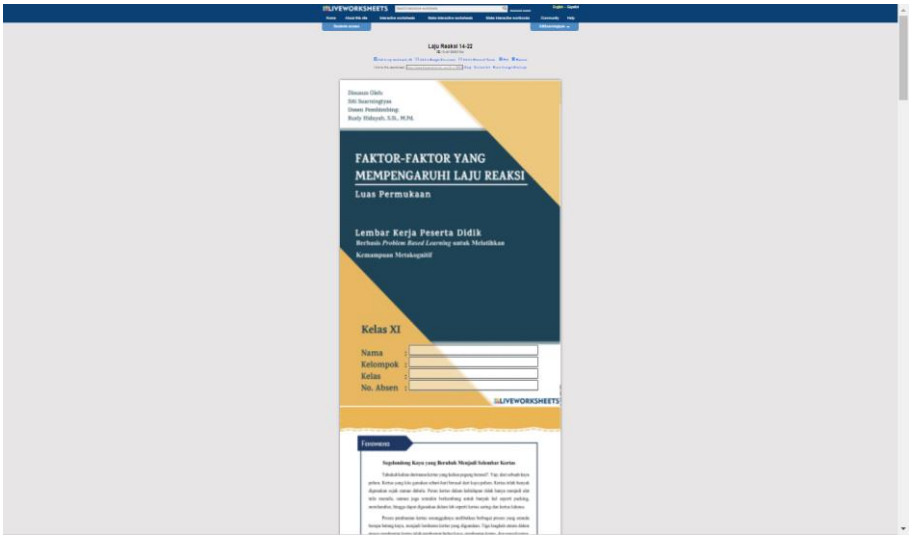

Figure 1. Cover Display on the E-Liveworksheet Website.

D. Validity

Validity of the Student E-Worksheet is obtained from the validation results by experts through content and construct with validation instrument. The validator provides suggestions and input on the developed Student E-Worksheet. The validator gives an assessment of the Student E-Worksheet in the form of a score of 1-5. The validity of the developed Student E-Worksheet was reviewed based on construct and content validity. Student E-Worksheet is declared valid if it reaches 61%.

Construct validity is seen from several aspects, namely presentation criteria, linguistic criteria, and graphic criteria. Based on the assessment of experts, the results of the validation of the developed Student E-Worksheet construct obtained an average percentage of 94.81% with very valid criteria. Content validity is viewed from the aspect of conformity with the 2013 curriculum, conformity with KI and KD, conformity with PBL syntax, and conformity with metacognitive ability criteria. The results of content validity were obtained, namely very valid criteria with an average percentage of 96.97%.

E. Practically

Then, practicality can be achived from the results of student activity observations and questionnaires after using Student E-Worksheet in the learning process. Student activity will be observed throughout the learning process using student observation worksheets. The observation process was carried out for four meetings. Observation of student activities includes metacognitive abilities that are trained during the problem-solving process contained in the Student E-Worksheet. At the beginning of the learning process, students read, observe, and discuss phenomena in the early stages of learning presented in the Student E-Worksheet as shown in Figure 2.

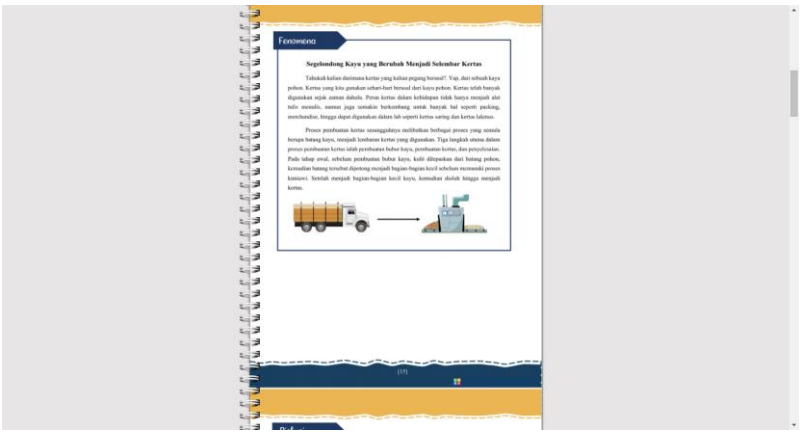

Figure 2. Phenomena in the Student E-Worksheet

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By linking the material with a phenomenon around students, students can practice their thinking skills in solving problems in life [10]. Then students read, and discuss solving problems presented in the Student E-Worksheet. The phenomenon of the given problem occurs in the environment and everyday life regarding the rate of reaction so that students can more easily practice their metacognitive abilities by going through a problem-solving process. Giving the phenomenon of problems in everyday life also aims to make students more motivated in problem-solving activities [15]. Metacognitive abilities can help students in the planning process of problem-solving and effective strategies to solve them [16].

Then the metacognitive ability trained in "*planning*", at this stage students are given a problem to observe and set goals, strategies, and learning resources [17] as shown in Figure 3. Furthermore, the ability to "*manage information strategies*", based on the problems presented in Figure 3, students are given a question as a (stimulus) to manage the information that has been obtained efficiently[17] including problem identification, problem formulation, literature study, and formulation of hypotheses.

Figure 3. Section Student E-Worksheet Metacognitive Ability Planning and Information Management Strategies

The next metacognitive ability is "*monitoring*", students begin to analyze problem-solving based on the information that has been obtained and discusses it, during the process students connect the new knowledge they have with what they have previously studied [17]. Then students present the results of each group's discussion to be discussed together. Next is the metacognitive ability of "*debugging strategies*", at this stage the whole group will discuss the problem-solving process that is less precise. During the discussion process, students were active in expressing their opinions both in class and group discussions, this shows that PBL-based learning makes students more interested in the learning process [18]. Furthermore, the last is the ability to "*evaluate*", students are asked to make conclusions about the material that has been discussed together.

Figure 4. Learning Process when Presenting the Discussion Results

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According to the results of observation of student activities in four meetings, student activities have increased. Observational data can be seen in Table 4. The average percentage of student activity is included in the very practical criteria, which is 96.37%.

Table 4. The Results of Observation of Student Activities

Meetings	Percentage
1	95.00%
2	96.20%
3	97.10%
4	97.18%
Average	96.37%

Then the practicality of Student E-Worksheet apart from observing student activities can be seen from the student response questionnaire after using Student E-Worksheet developed in the learning process. Depending on outcome of the questionnaire, 85% of students considered the Student E-Worksheet used during the learning facilitate learning material on reaction rate, as well as make learning fun and interesting, then 92.67% stated that metacognitive abilities could be trained using Student E-Worksheet.

F. Effectiveness

Then the effectiveness Student E-Worksheet based from the results pretest and post-test. The pre-test was carried out before the use of the Student E-Worksheet which was developed into the learning process, while the post-test was carried out after learning using the developed Student E-Worksheet. The pretest is carried out to determine the initial ability, posttest is carried out to determine the final ability of students. The test is in the form of essay questions which are arranged based on the metacognitive abilities being trained. The data from the pretest and post-test results can see in Figure.

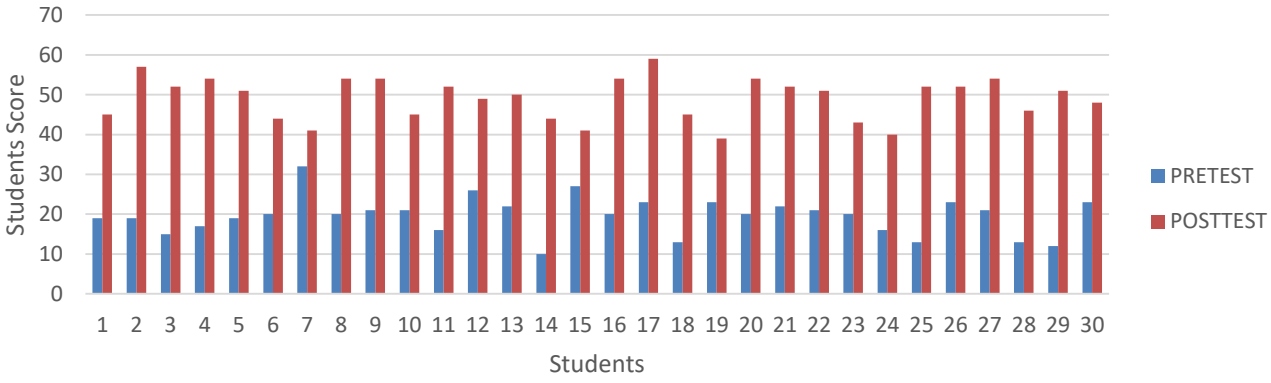

Figure 5. Pretest and Posttest Value Data

Based on Figure 5, the value of students has increased after using Student E-Worksheet. Learners can construct their knowledge through the application of concepts in everyday life with the knowledge they have previously [15]. PBL can help students understand abstract concepts [19] and enable them to solve real-life problems solving [20].

The value obtained by the analysis of the normality test, then the test results show a significant value above 0.005 which indicates the pretest and post-test values normal distributed. Then continued with the Paired sample t-Test, then a significance value of 0.000, which showed that the Student E-Worksheet developed effective because the significance value obtained was <0.005.

CONCLUSION

Based on the results of this study, it can conclude that Student E-Worksheet based on Problem Based Learning to train metacognitive abilities of student on the reaction rate material is feasible to use based on validity, practicality, and effectiveness. The validity is seen from the construct and content with the percentage of 94.81% and 96.97% respectively with very valid criteria. Then the practicality in terms of observing student activities and response questionnaires is in very practic al criteria with a value of 96.37%.

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The effectiveness is seen from the increase in metacognitive abilities and analyzed with the help of the Paired sample t-test obtained a significance value of 0.000.

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