Development of Electronic Students's Worksheets with Problem Based Learning Models to Increase Students Chemistry Learning Outcomes in Class XI Senior High School Even Semester

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Abstract Research objective is to know the increasing students's chemistry learning outcomes in class XI senior high school even semester after using electronic student worksheets with problem based learning models developed. Research type is research and development with ADDIE design. Data analysis technique is qualitative and quantitative descriptive. Analysis step showed that students need this product as learning sources. In design, product was designed using web. In development, product was validated by material and IT experts. It showed that product was feasible to be used in learning process. In implementation, product was used by students in buffer solution material. In evaluation, it showed that students's n-gain in experimental class were better than control class. Right side t-test calculation showed that t_{count} (5.919) > t_{table} (1.668). It showed that there was effect of using electronic student worksheets with problem based learning model to increase students's learning outcomes in buffer solution material.

Keywords : electronic student worksheets, students's chemistry learning outcomes, problem based learning models

1 Introduction

The education development in Indonesia today demands an increase in quality of scientific and technological achievements. The way to improve output quality is by making various improvements during the learning process [1]. One of government's efforts is to implement and develop the 2013 curriculum which requires students to be more active in learning process [2]. Students play an active role during the learning process while the teacher acts as a facilitator [3].

Based on the before research results, during the learning process, teacher still used conventional learning interspersed with student discussion activities. The learning tools used

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also did not support learning activities that lead to creative thinking skills because the learning media used were only whiteboards and textbooks. As a result, student learning outcomes were low and also with their creative thinking abilities [4]. Other research also showed that chemistry learning activities still used conventional methods and occasionally only used simple power point media obtained from the internet. As a result, teachers often dominate the class in teaching and learning process [5]. In addition, students consider chemistry as a difficult subject so students are less interested in learning it [6].

Other research also showed that one of causes the large number of students at SMA Negeri 1 Secanggang who did not pass the minimal score was the lack of innovative and interactive teaching materials and media. Students only had textbooks, so innovative and interactive teaching materials and additional media were needed and able accessed using a computer, smartphone or notebook [7]. The results of other research observations also showed that out of 70 students in class X MIPA at SMA Negeri 14 Medan, only 10 students had handbooks as learning resources and teachers also did not use teaching materials according to the 2013 curriculum [8]. Teaching materials are one of the factors that can strengthen students's motivation to learn [9].

The existence of technology has become increasingly important since the era of industrial revolution 4.0 applied in learning process. Educators are required to be able to develop digital based teaching materials so that students can use them anytime and anywhere [10]. One of the digital based teaching materials that is most needed by teachers and students in learning process is electronic student worksheets [11]. Students worksheets are a collection of sheets containing students’s activities that allow students to carry out real activities with the objects and issues being studied [12], the learning process is student centered and provides opportunities for students to develop knowledge and skills [13].

An electronic student worksheets can also be integrated with learning models in it [14]. One of them is problem based learning (PBL) model. Problem based learning model is a learning model that uses students's thinking skills individually and in groups as well as the real environment to solve problems so that they are meaningful, relevant and contextual [15]. In addition, students are trained to be able to discover, learn concepts independently and relate the concepts they learn to everyday life [16]. The interesting about this learning model is the involvement of students in learning, they are given various problems by the teacher then students are expected to analyze problems, diagnose problems, formulate alternative/problem solving strategies, determine and implement problem solving strategies then evaluate these problems [17], while the teacher only guides and assists students in learning process [18].

Some research results showed that the development of student worksheets with problem based learning model improves student learning outcomes in experimental and control class [19]. The learning outcomes of students who were taught using chemistry teaching materials with problem based learning model were higher than learning outcomes of students who used teaching materials from schools [20]. Teaching materials in the form of electronic student worksheets with problem based learning models assisted by live worksheets could increase students's mental activity with an increase in learning mental activity from an average of 71.91% to 86.27% [21].

Because of some problems stated above, researcher wants to carry the research about the development of electronic student worksheets with problem based learning models to increase student's chemistry learning outcomes in class XI senior high school in even semester.

2 Method

The type of research conducted is research and development with ADDIE design. The development model has 5 steps, namely analysis, design, development, implementation and evaluation step. The resulting product is an electronic student worksheets with problem based learning model for chemistry subject matter in class XI senior high school in even semester.

The first step is analysis. At this step, researcher conducted an initial analysis and students's needs analysis. Initial analysis was carried out to find out information related to the use of teaching materials, learning models, learning outcomes and student motivation during learning activities. The data obtained in initial analysis was carried out by conducting interviews with chemistry teachers at SMA Negeri 1 Sunggal. Analysis of students's needs was carried out by giving questionnaires to students in class XI SMA Negeri 1 Sunggal so that information could be obtained regarding students's preferences in chemistry lessons, learning methods, difficulties encountered, teaching materials owned and introduction to electronic student worksheets so that teaching materials developed according to students's needs.

The second step is design. At this step, researcher designed the product of electronic student worksheets with problem based learning models. The steps taken were selecting supporting applications for manufacture, compiling the initial format, collecting references related to chemistry subject matter in class XI senior high school in even semester and compiling the design and features of electronic student worksheets with problem based learning models.

The third step is development. At this step, researcher developed the product according to the results of design step. Developed electronic student worksheets with problem based learning model are then validated by expert validator. The assessment of experts was carried out by three chemistry education lecturers at Unimed and three chemistry teachers at SMA Negeri 1 Sunggal as material experts and one educational technology lecturer at Unimed as an IT expert using the developed National Education Standards Agency (BSNP) instruments. Suggestions and comments given by validator were used as improvement or revision of initial product so that final product is deemed feasible to be implemented in learning process.

The fourth step is implementation. This step was using electronic student worksheets with problem based learning model by students in classroom so that it could be seen how electronic student worksheets with problem based learning model increase students's chemistry learning outcomes in buffer solution material. The first step was giving the pretest to find out the prior knowledge of each students in buffer solution material. Then the implementation of learning process where in experimental class, students used electronic student worksheets with problem based learning model while in control class, students used problem based learning models and textbooks from school. After that students were given posttest questions to find out which students have understood the subject matter that has been given.

The fifth step is evaluation. At this step, researcher evaluated the increasing students's chemistry learning outcomes after using electronic student worksheets with problem based

learning model in learning process. In addition, researchers also evaluated the electronic student worksheets with problem based learning model that have been developed based on all the activities that have been carried out. The research steps can be seen in Figure 1 below.

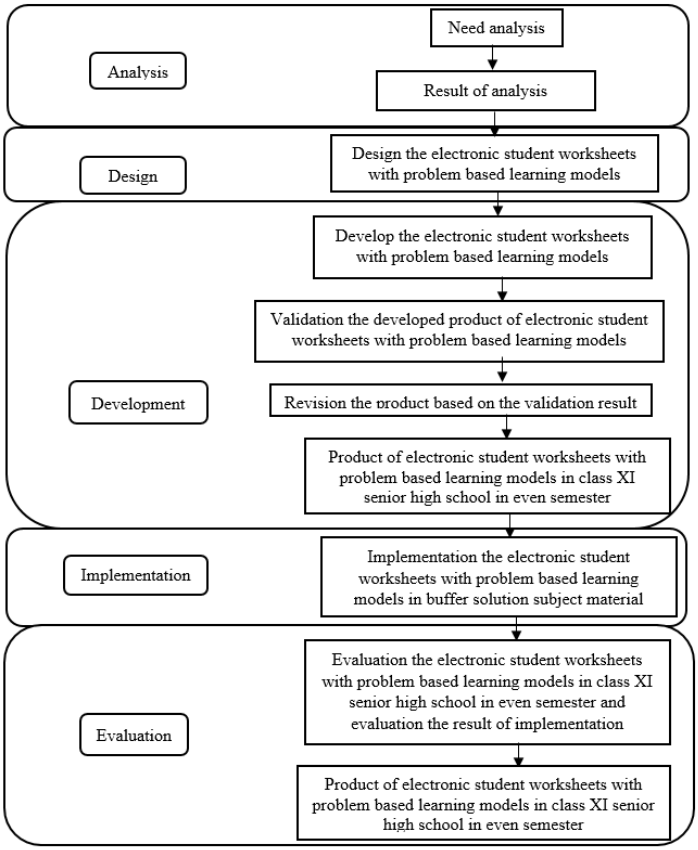

Fig. 1. The research steps.

3 Result and Discussion

3.1 Analysis

In analysis step, an initial analysis and students's needs analysis were carried out. Based on the results of initial analysis by interviewing three chemistry teachers at SMA Negeri 1 Sunggal, it was found that teachers and students only used textbooks as teaching materials during learning process. The chemistry learning process is still teacher-centered, whereas the learning model used is still conventional, such as lecture and discussion methods. Students's chemistry learning outcomes are also still relatively low, where the average student who passed the minimum completeness criteria is only about 60%. Learning resources were still very limited, not able to train students's thinking skills in finding their concepts, monotonous and less attractive for students are some reasons for low students's learning outcome.

Based on the results of students's needs analysis, 83.6% of students said that they studied chemistry only when there were assignments, only 4.9% of students said that they very often did the questions in the book, even as many as 21% of participants students said that they had never done the questions in the book. From the data obtained, it can be concluded that more than 50% of students were still reluctant to do the questions in the book. It shows that students's motivation to learn chemistry is still low.

Learning method most often used by teachers during chemistry lessons is the lecture. As many as 50.8% of students often experience difficulties in learning chemistry, even 18% said that it was very often. As many as 70.5% of students said that the most difficult chemistry lesson was calculation. As many as 50.8% of students stated that they would better understand chemistry lessons by watching videos. The lack of teaching materials used was also one of the causes low students's chemistry learning outcomes. It was accordance with the results of questionnaire, it can be seen that the teaching materials most used by teachers and students during the learning process were textbooks. As many as 65.6% of students have never seen electronic student worksheets and 60.7% of students have never used electronic student worksheets in learning process.

Based on the data above, it can be concluded that based on students's needs analysis, it is necessary to develop the electronic students's worksheets with problem based learning model. This is also in accordance with the results of the initial needs analysis of teachers, so that the development of electronic students's worksheets with problem based learning model can increase students's chemistry learning outcomes. The use of electronic students's worksheets with problem based learning model will cause students to be able to find their concepts which require student-centered learning. In learning process, there are also some video links to make it easier for students to understand the learning material provided. If students still do not understand the learning material, students can repeat the material until students can understand it well. In addition, at the end of the lesson, there are multiple choice quiz questions. After students have finished working on it, the value obtained will immediately appear, so that students can easily find out the extent of their understanding the learning material that has been studied.

3.2 Design

Application used to make this teaching material is web-based. Link to access the electronic students's worksheets with problem based learning model is http://lkpd-kimia.com/. This link can be accessed by using laptops, smartphones and notebooks so that it can be done anywhere and anytime without limited space and time. The format or initial design of electronic students's worksheets with problem based learning model is presented in a flowchart shown in Figure 2 below.

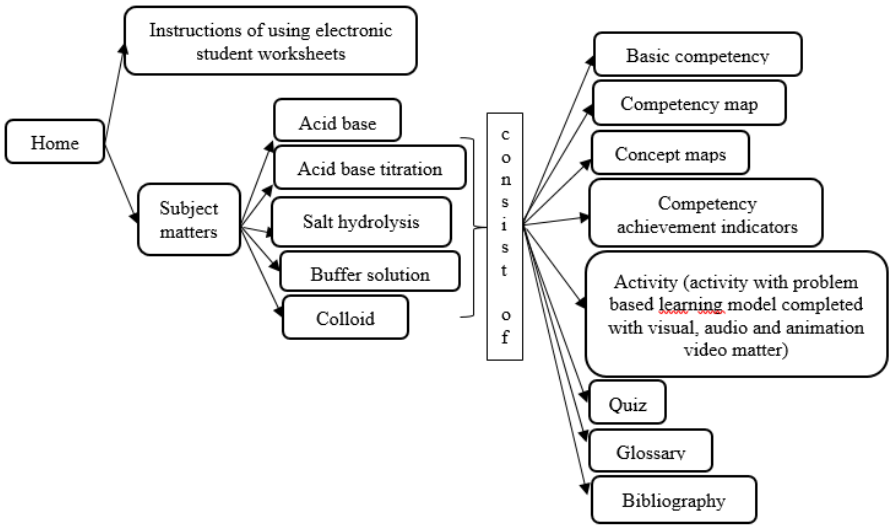

Fig. 2. Flowchart about initial design of electronic students's worksheets with problem based learning model.

The next step is to collect the references related to chemistry subject matter in class XI senior high school in even semester as content in developed electronic students's worksheets with problem based learning model. The chemistry material for class XI in even semester is in accordance with chemistry syllabus of 2013 curriculum, namely acid-base solutions, acid-base titrations, salt hydrolysis, buffer solutions and colloid. Next, compile the design and features of electronic students's worksheets with problem based learning model. The preparation of designs and features is adjusted to the characteristics of good electronic worksheet that fulfills 3 requirements, namely didactic, constructive and technical requirements.

3.3 Development

At this step, researcher developed the product based on design step. After electronic students's worksheets with problem based learning model has been developed, next step is validity test by expert validators. Electronic students's worksheets with problem based learning model was validated by material experts including aspects of content feasibility, language feasibility, presentation feasibility and graphic feasibility. The results of validation by material experts can be seen in Figure 3 below.

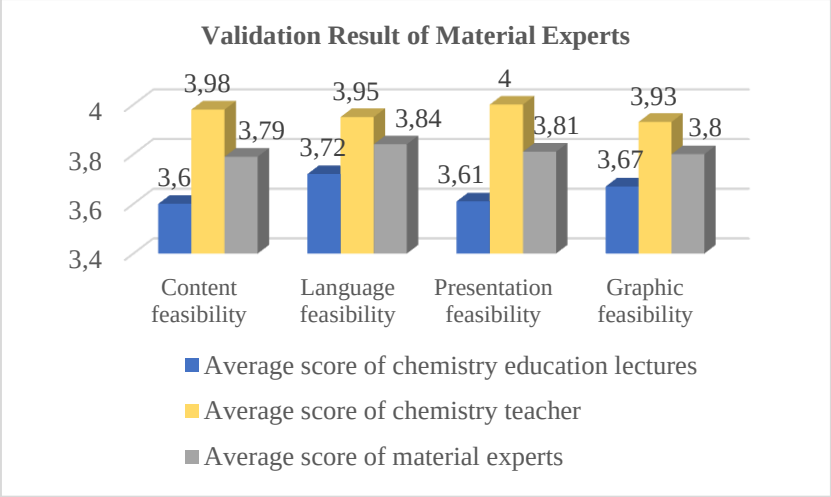

Fig. 3 Validation result of matter experts.

Based on the results of validation by material experts both chemistry education lecturers and chemistry teachers, the average value was 3.81 (95.25%). It can be concluded that the developed electronic students's worksheets with problem based learning model is feasible and can be used for further research step.

Validation was held by IT expert covering the aspects of guidance and information, program performance, systematics, aesthetics and design principles. The validation results by IT experts can be seen in Figure 4 below.

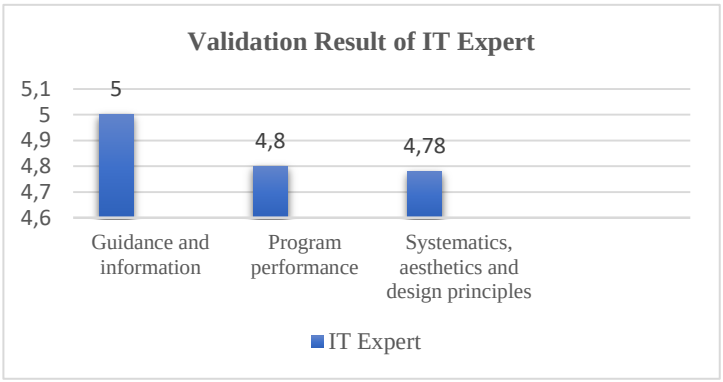

Fig. 4 Validation result of IT expert.

Based on validation results by IT expert, the average value obtained was 4.86 (97.20%) with a very feasible interpretation. Therefore it can be concluded that the developed electronic students's worksheets with problem based learning model is very feasible and can be used for further research step.

Developed electronic student worksheets with problem based learning model were declared feasible to be used based on validation results from both material and IT experts. Figure 5

shows several displays of developed electronic students's worksheets with problem based learning model.

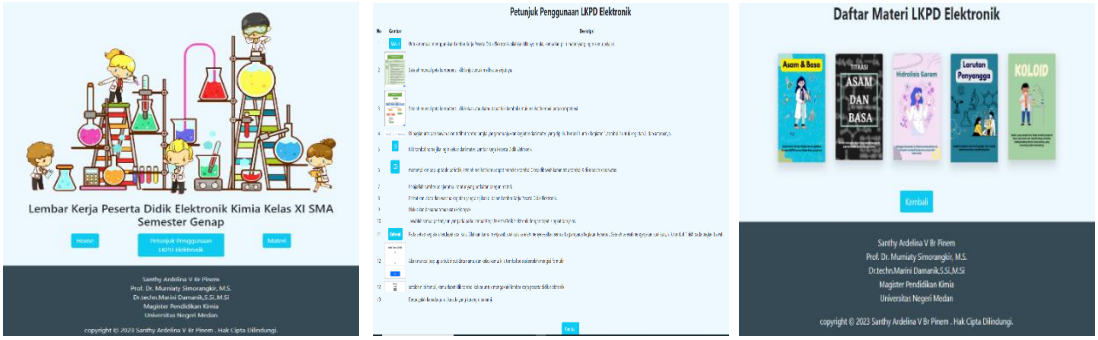

Fig. 5. Several displays of developed electronic students's worksheets with problem based learning model

3.4 Implementation

At this step researcher did the learning process. The first step was giving the pretest to find out the prior knowledge of each students in buffer solution material. Then the implementation of learning process where in experimental class, students used electronic student worksheets with problem based learning model while in control class, students used problem based learning models and textbooks from school. In learning process, it could be seen that students in experimental class were more active than students in control class. Every activity and assignment was done well by students in experimental class, meanwhile there were some students not active in control class. After that students were given posttest questions to find out which students understood the subject matter given and see the students's chemistry learning outcomes.

3.5 Evaluation

In evaluation step, researcher evaluated the implementation results of electronic student worksheets with problem based learning model based on all the activities that have been carried out so that conclusion can be obtained whether the product of electronic student worksheets with problem based learning model is feasible to be used and can improve students's chemistry learning outcomes in class XI in even semester or not. The increasing students's learning outcomes can be seen from the n-gain value. The results of average pretest, posttest and n-gain score can be seen in Table 1 below.

Table. 1. The results of average pretest, posttest and n-gain score.

Class	Number of students	Average score			
		Pretest	Posttest	n-gain	Category
Control	34	27.50	77.35	0.68	Middle
Experimental	34	21.76	85.15	0.81	High

From the data obtained based on Table 1, it can be seen that there was increasing students's learning outcomes both in control and experimental class. However, the increasing students's learning outcomes in experimental class was higher than in control class. The increasing students's learning outcomes in control class were in medium category, while in experimental class was in high category.

Increasing students's learning outcomes data were analyzed statistically using the right-hand side t-test. However, before t-test was carried out, normality test and data homogeneity test were first carried out as a prerequisite test for t-test.

The normality test used in this study was Kolmogorov-Smirnov test in SPSS 26.0 program to data increasing students's learning outcomes (n-gain). The decision-making criterion based on P-Value or Significance (sig) is if Sig < 0.05 then Ha is rejected or the data is not normally distributed whereas if Sig > 0.05 then Ha is accepted or the data is normally distributed. Output data from normality test of increasing students's learning outcomes is presented in Table 2 below.

Table 2. Normality Test of Increasing Students's Learning Outcomes.

Variable	Class	Sig.	Distribution
n-gain	Control	0.200	Normal
	Experimental	0.104	Normal

From data in Table 2, it can be seen that significance value of both classes were greater than 0.05. For control class, the significance value was 0.200 while for the experimental class, it was 0.104, so it can be concluded that the n-gains in the control and experimental classes were normally distributed.

The homogeneity test used in this study was Levene test in SPSS 26.0 program. The decision-making criteria based on P-Value or Significance (sig) is if Sig < 0.05 then Ha is rejected or the data is not homogeneous whereas if Sig > 0.05 then Ha is accepted or the data is homogeneous. Output data from homogeneity test of increasing students's learning outcomes is presented in Table 3 below.

Table 3. Homogenity Test of Increasing Students's Learning Outcomes.

Variable	Sig.	Distribution
n-gain	0.229	Homogenous

From the data, it can be seen that the significance value is 0.229. The significance value is greater than 0.05 so it can be concluded that the n-gain data in the control and experimental classes are homogeneous.

After data were declared to be normally distributed and homogeneous, t-test can be performed. Based on the results of right side t-test calculation, the value of t_{count} was 5.919. To find out whether the hypothesis is accepted or rejected, t_{count} value is compared to t_{table} value, where if $t_{count} > t_{table}$, then H_0 is rejected and H_a is accepted. Based on the t table data, the t_{table} value was 1.668. If t_{count} was compared with t_{table}, then t_{count} (5.919) > t_{table} (1.668) was obtained. Therefore it can be concluded that H_0 is rejected and H_a is accepted, so there is an effect of using electronic student worksheets with problem based learning model to increase students's learning outcomes in buffer solution material.

Increasing students's learning outcomes in experimental class was higher than in control class. The use of teaching materials in the form of electronic student worksheets with problem based learning model causes students to be more active in learning. This is because the electronic student worksheets with problem based learning model developed by researchers is diactivated, which means that the use of electronic student worksheets with problem based learning model can invite students to be active in learning because the use of electronic student worksheets with problem based learning model is very easy, can be accessed anytime and anywhere using a computer, smartphone or notebook.

In addition, this electronic student worksheets is also constructive where it was presented using problem based learning model so that it can improve students's thinking skills in applying concepts to new/real problems, integrating higher order thinking concepts, desiring to learn, directing self-learning and student skills. This is appropriate with government's program to improve 2013 curriculum, including content standards that enriched with students's need to think critically and analytically based on international standards, while assessment standards provide space for assessment instruments development that measure higher-order thinking. Assessment of learning outcomes is expected to help students improve their higher-order thinking skills because higher-order thinking can encourage students to think broadly and deeply about subject matter. Each learning activity consists of 5 syntaxes, namely student orientation to problems, organizing students to learn, guiding individual and group investigations, developing and presenting work and analyzing and evaluating problem solving processes.

Technically, this electronic student worksheets with problem based learning model emphasizes the presentation, such as writing, pictures and appearance that attracts attention and can motivate students to learn. Presented display on the electronic student worksheets is in the form of visual, audio, video animation and interactive quiz questions. With an attractive appearance, students are motivated to learn every part of this electronic students worksheet. In studying this electronic students worksheet, communication occurs in two directions (interactive), where when students answer quiz questions, the electronic students worksheet will display the student's grades or scores. So that students can find out the extent of their understanding learning material being studied. When students do not understand the learning material, students can play it back according to the wishes of students and it can increase students's learning outcomes.

4 Conclusion

Based on the research results, it can be concluded that this research and development produced a product of electronic student worksheets with problem based learning model. Based on validation result, average value of material expert was 3.81 (95.25%), meanwhile average value of IT expert was 4.86 (95.25%). The product was feasible and can be used in learning process. Based on the results of right side t-test calculation, t_{count} was 5.919. If t_{count} was compared with t_{table}, it can be seen that t_{count} (5.919) > t_{table} (1.668). Therefore it can be concluded that there is an effect of using electronic student worksheets with problem based learning model to increase students's learning outcomes in buffer solution material.

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