Development of Chemistry Electronic Student Worksheets Problem Based Learning Model to Improve Student's Learning Outcome in Grade X Senior High School on Stoichiometry Topic

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Abstract. This study aims to improve student learning outcomes of class X high school after using the Chemistry electronic student worksheets Problem Based Learning Model's which was developed with website. This is a research and development that uses the ADDIE Model. The data analysis technique used is quantitative and qualitative descriptive. Analysis stage obtained students need interactive teaching materials. In design, electronic student worksheets was designed using web. In development, product was validated by material and media experts. The result showed that product was feasible to be used in chemistry learning. In implementation, students used product in Stoichiometry topic. In evaluation, students had post-test. With One Sample T-Test was obtained learning outcomes of students were higher than the minimum completeness criteria where the sig. 0.000 < 0.05 and tcount > ttable (10.289 > 1.690). it can be concluded that the use of electronic student worksheets problem based learning model can improve student learning outcomes on Stoichiometry topic.

Keywords: electronic sudent worksheets, problem based learning

1 Introduction

Choosing the right learning resources and media for students is a reference that needs to be considered in preparing fun chemistry lessons where the characteristics of chemistry are attitudes, processes and products [1]. The selection of learning media that is not in accordance with the characteristics of the material and students causes learning to be ineffective and unable to invite students to be actively involved in learning which causes students to not understand the material presented. Teachers must be able to design learning strategies that can activate all students in the learning process [2]. Efforts that can be made by educators to overcome this is to maximize the adjustment of material with learning facilities and media

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available in schools. According to the demands of the 2013 curriculum, currently educators must be able to integrate learning models into teaching materials or learning media [3]. One of the teaching materials that is very often used by teachers and students in learning is Student Worksheets.

The availability of teaching materials that are in accordance with the curriculum, characteristics and needs of students is very important for educators to pay attention to. The development of teaching materials according to the needs and characteristics of students needs to be continuously carried out to create a learning process that attracts students' learning interest [4]. One of the teaching materials that can be developed by teachers in schools is Student Worksheets. Student Worksheets is a teaching material that is most often used by students in learning [5]. So far, Student Worksheets is only interpreted as sheets of paper which contain questions that must be answered by students according to learning indicators, even though Student Worksheets is a tool or media that can be used as a learning resource that can make students active in the learning process, helping students' understanding of the material in which there is integration between the concept of the material and the questions [6]. Supported by the availability of Student Worksheets in learning, students are invited to be actively involved in the learning process. Student Worksheets is prepared according to competency achievement indicators so that it really helps achieve learning goals [7]. Student Worksheets can also help students to be skilled and active in the learning process so as to strengthen their understanding of the concept of the material [8].

From the results of observations and interviews that have been conducted by researchers at SMA N 11 Medan it is known that teachers still use teaching materials in the form of print media only. This is of course still less interactive and has not maximized current technological developments. In the current digital era, technology and information are developing very fast and have entered the world of education [9]. A good education can adapt and apply technological developments in the learning process. The learning model has been applied in learning but has not been optimized to increase students' motivation and understanding of learning so that learning is still teacher centered. Based on the results of interviews with chemistry teachers, information was also obtained that the material which was quite difficult for students to understand was Stoichiometry. This is supported by data on the results of daily tests that achieve the learning completeness criteria of 75, only 40% of the students. The teacher revealed that this happened due to the low learning motivation of the students which was also caused by the low numeracy skills of the students and there were still many students who thought that chemistry lessons were difficult so they were reluctant to be actively involved in the learning process. So a learning model is needed that can stimulate students to be active in learning as well as train learning independence and collaboration between students [10].

In today's technological era, the use of Student Worksheets can be further maximized with the help of technology. The display of images, videos and animations will certainly help today's learning be more enjoyable, printed worksheets can be converted into electronic worksheets with the help of a website system. The website will change the questions in the electronic Student Worksheets into interactive questions where students can immediately type their answers in the column provided and can immediately find out the score of the answers obtained when they finish working on the quiz. The development of electronic worksheets is expected to help students better understand the concept of subject matter and train independent

learning and collaboration between students. To get even more optimal student learning outcomes, the use of electronic Student Worksheets must also be integrated with the application of learning models that are in accordance with the 2013 curriculum [11].

Problem Based Learning is a learning model that provides real, contextual problems for students to solve. Problem Based Learning does not only focus on students' ability to solve problems, but can also train students' independent learning to dig up information from various sources to solve given problems [12]. Furthermore, students can put forward their initial hypotheses and then proceed with data collection using the Problem Based Learning model. Furthermore, students can present the results of their findings and solutions to problem solving given by presenting them in front of the class [13].

Because of the problems above, a solution is needed to help improve student learning outcomes, namely by developing the Chemistry electronic student worksheets Model Problem Based Learning. The advantage of PBL-based student worksheets is that it can develop students' critical thinking skills and independent learning. This will certainly bring students more creative, skilled in solving problems and able to communicate the ideas they have [14]. The results obtained were that the PBL-MR-based electronic Student Worksheets using the flip builder application was very suitable for use in the chemistry learning process [15]. Similar research has also been carried out by [16] with the result that electronic Student Worksheets based on Problem Based Learning on Redox Material that has been developed is feasible and can be used as a chemistry learning resource. The development of the PBL-based Student Worksheets was useful in the learning process and received a very good response from the chemistry teacher [14]. The Problem Based Learning model helps students to be actively involved in learning [17] and The use of worksheets in learning really helps teachers in delivering material and guides students to actively discuss, ask questions answer and investigate [18]. Another study showed that the problem-based electronic student worksheets developed is very appropriate to use as a learning resource in the learning process because it can help students understand the concept of Redox [19]

Based on the results of observations, interviews and the problems described above, it is necessary to develop an electronic student worksheets Chemistry Problem Based Learning Model which can help improve student learning outcomes in Stoichiometry Material. The electronic student worksheets, which is supported by a website system, was chosen by researchers for the novelty of previous studies.

2 Method

This research is a Research and Development which is a development research method used to produce certain products and test the effectiveness of these products [20]. The procedure carried out in this study is to use the ADDIE model stages. The procedure consists of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The result product from this research is a chemistry electronic student worksheets Problem based learning model for students class X senior high school in even semester. This research was conducted in SMA Negeri 11 Medan.

The first stage in this research is analysis. The analysis phase is the initial or preparatory stage for development. The purpose of this analysis phase is to collect data with existing conditions as a comparison or basic material for the product to be developed. In this stage interviews and observations were carried out with chemistry teachers at SMA N 11 Medan, curriculum analysis was in the form of syllabus analysis used at school according to the curriculum used at school then analysis of teaching materials was carried out in the form of printed worksheets used in the learning process in class as the basic material for developing chemistry electronic student worksheets Problem Based Learning model. Analysis of teaching materials was carried out using a modified BSNP questionnaire instrument. Analysis was carried out to find out the existing learning problems and then collect information for the development of chemistry electronic student worksheets so as to produce chemistry electronic student worksheets that meets quality standards.

The second stage was designed chemistry electronic student worksheet Problem based learning model which is used for one semester. Electronic student worksheet designed in accordance with the syllabus, basic competencies, and stage-oriented Problem based learning on chemistry material for class X even semester. At this stage the researcher begins to collect and compile learning materials according to learning indicators from various sources, collect learning videos that are relevant to the material, and select supporting applications assisted by a website system to convert printed student worksheet into electronic student worksheet.

The third stage is development. At this stage, researcher developed the products which was designed in previous stage. At this stage, the electronic student worksheet being developed is a Problem Based Learning model for all material in class X even semester. Several processes or stages in the activities after developing the electronic student worksheet on chemistry material for class X IPA Even Semester include the stages of expert assessment and revision of the initial draft of the electronic student worksheet that has been produced. The assessment of the experts was carried out by three chemistry education lecturers as material experts, one educational technology lecturer as a media expert, and 3 chemistry teachers using instruments according to the modified developed National Education Standards Agency (BSNP) .

The fourth stage is implementation. In the implementation phase, the revised product that is chemistry electronic student worksheet Problem based learning model was implemented for students in class X-7 Science. Students are taught using the chemistry electronic student worksheet model Problem Based Learning and at the end of the lesson was given a post-test as an evaluation of student learning outcomes after using electronic student worksheet was developed. Researchers was collect the data on how students respond to the developed electronic student worksheet product through the questionnaire provided, at this stage students are also given a learning motivation questionnaire and a student response questionnaire to the electronic student worksheet that developed.

The fifth stage is evaluation. At this stage the researcher evaluates the Chemistry electronic student worksheet Problem Based Learning model that has been developed based on all the activities that have been carried out so that a teaching material product is produced in the form of a Chemistry electronic student worksheet Problem Based Learning model that is suitable for use in schools. In brief, the flowchart of research procedures for developing the chemistry electronic student worksheet Problem Based Learning model that have been carried out. The research procedure presented in Figure 1.

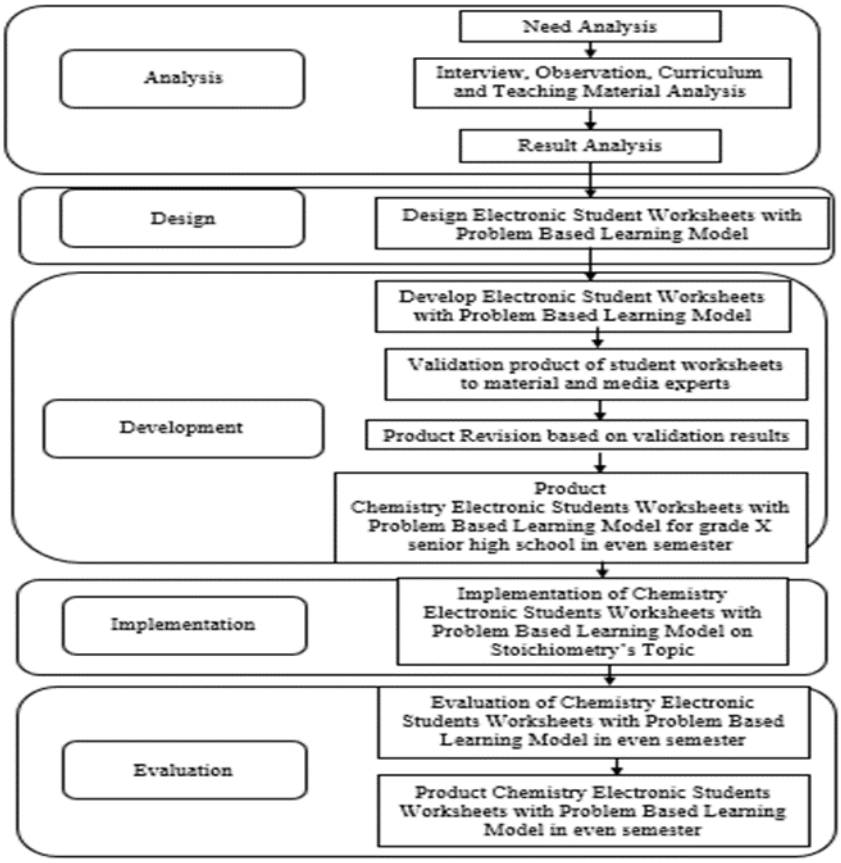

Fig. 1. Research Procedure of Electronic Student worksheets

There are two instruments used in this research consisted of test and non-test instruments. The test instrument used was multiple choice questions aimed at measuring students' chemistry learning outcomes. Non-test instruments in the form of interview sheets, observation sheets, learning motivation questionnaires, Chemistry electronic student worksheets Model Problem Based Learning feasibility test questionnaires based on National Education Standards Agency (BSNP) and student response questionnaires to the products developed.

3 Results and Discussion

3.1. Analyze

At this stage the researcher first conducted an initial needs analysis related to chemistry learning at school by conducting interviews and observing teaching and learning activities in class with two chemistry teachers at SMA N 11 Medan. From the results of the interviews, information was obtained that the teaching materials used by teachers and students in the learning process were still in the form of printed books from publishers and printed worksheets. There are not yet available teaching materials, either books or student worksheets,

in electronic and interactive forms that are integrated with technology. The use of less attractive teaching materials can be the cause of low learning motivation. In line with research conducted by Sariati et al which states that the low motivation to learn students is caused by the difficulties experienced by students in understanding chemical concepts in the learning process [21]. From the results of observations, researchers found that teaching and learning activities in class were still ongoing in one direction or teacher-centered. In the classroom, many students are sleepy and bored in chemistry learning activities. The low level of learning motivation can be caused because learning chemistry in schools has not been adapted to the needs of students. The use of teaching materials that are less attractive can be a cause of low learning motivation.

At this stage the researcher conducted an analysis of the printed student worksheets which was often used during teaching and learning activities in schools on Stoichiometry before the development of the electronic student worksheets was carried out. This is done with the aim of knowing the feasibility of the printed student worksheets used and knowing what things need to be developed in a teaching material in the form of student worksheets so that it can be used in teaching and learning activities in accordance with the characteristics of the 2013 curriculum. Based on the analysis results of printed Chemistry student worksheets conducted by researchers concluded that the student worksheets used in schools is good enough and meets the eligibility according to BSNP standards, but there are several things that need to be developed such as adding learning videos, questions and interactive quizzes. The following presents the results of the feasibility analysis percentage of printed worksheets used by students.

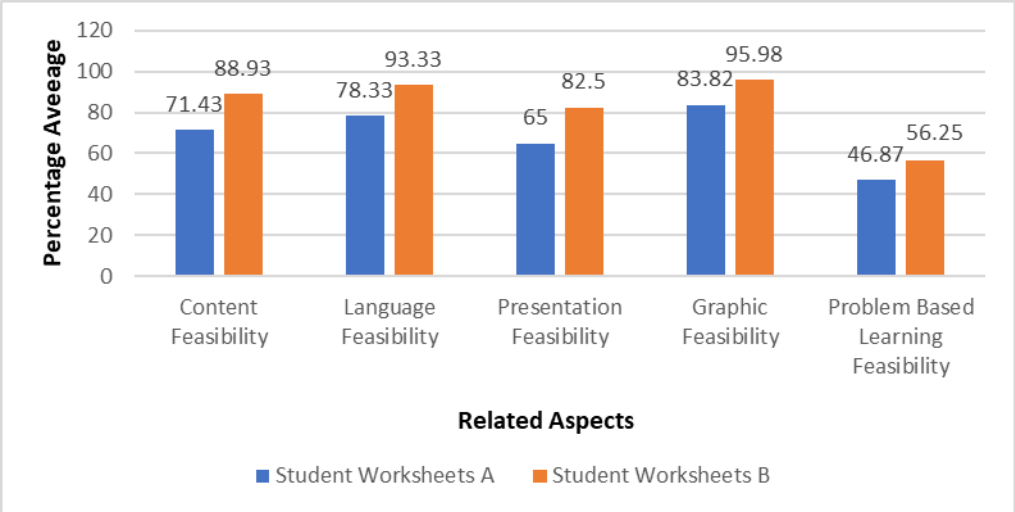

Fig. 2. Results of the Feasibility Analysis of Two Chemistry Print Students Worksheets

The researcher also conducted a curriculum analysis with the aim of loading material on the chemistry electronic student worksheets Problem Based Learning model which was developed according to the curriculum used in schools. The curriculum used in schools is the 2013 revised 2017 curriculum. The materials contained in the chemistry electronic student worksheets Problem Based Learning model in accordance with the 2013 curriculum are

Electrolyte Solutions and Non Electrolyte Solutions, Oxidation Reduction (Redox) Reactions, Nomenclature of Chemical Compounds, Basic Laws of Chemistry, and Stoichiometry.

3.2. Design

At this stage, the researcher began to design a chemistry electronic student worksheets Problem Based Learning model which would be developed based on the results of the 2013 curriculum syllabus analysis, initial needs and the results of the analysis of printed chemistry student worksheets for senior high school grade 10th even semester.

The developed chemistry electronic student worksheets is arranged using the syntax of the Problem Based Learning learning model where in the early stages of learning problems related to the daily lives of students are presented in accordance with the characteristics of the material. The chemistry electronic student worksheets Problem Based Learning model is designed with the help of a website system using the 000webhost.com domain. Furthermore, the domain address that was developed was changed to the link https://e-lkpdkimia classxmodelpbl.000webhostapp.com. This link can be accessed later when the chemistry learning process takes place.

All document components are first compiled in PDF form. All material is collected from various sources and arranged according to the stages of the Problem Based Learning model. The chemistry electronic student worksheets display is also designed to be interactive by including pictures, learning videos, and evaluation questions related to the material. After all documents are complete, all document files will be converted into interactive documents using HTML (Hyper Text Markup Language) to the page https://elkpdkimiakelasxmodelpbl.000webhostapp.com. After student worksheets document in PDF format is converted into an interactive electronic student worksheets, the questions listed on the electronic student worksheets turn into interactive questions meaning that students can type the answers directly to the questions contained in the electronic student worksheets and for evaluation questions at the end of the electronic student worksheets, when students have finished working on their evaluation questions, they can press the "finished quiz" button and the scores they get from the quiz they can immediately find out the results. The Chemistry electronic student worksheets with the Problem Based Learning model is also equipped with storage media to store data on the answers of all students in each electronic student worksheets.

The electronic teaching materials that can be used during learning activities or outside learning are interactive E-LKPD. The use of teaching materials makes the role of teachers not authoritarian and does not dominate a learning [22]. Interactive E-LKPD is a student worksheet presented in electronic form with animations, videos, and images that make students learn interactively [23].

3.3. Development

At this development stage, the product was made according to the design that was designed at the previous stage using problem based learning syntax. By using the Problem Based Learning model, learning will become more meaningful because students are faced with contextual

problems that are close to their environment so that students more easily understand the content of the lesson [24]. After the chemistry electronic student worksheets Problem Based Learning model for class X even semester has been developed, the next step is to conduct a feasibility test for the chemistry electronic student worksheets Problem Based Learning model to material experts and media experts as well as chemistry teachers with the aim of knowing whether the chemistry electronic student worksheets Problem Based Learning model developed is feasible or not used as chemistry teaching material in class X even semester and to find out one aspect of product development quality, namely the aspect of validity using validation instruments based on eligibility standards according to National Education Standards Agency (BSNP).

The chemistry electronic student worksheets developed was validated by six material experts consisting of three chemistry lecturers in Univesitas Negeri Medan and three chemistry teachers using the BSNP questionnaire. The results of the average percentage of the chemistry electronic student worksheets feasibility test for the Problem Based Learning model by the material expert validator can be seen in Figure 3.

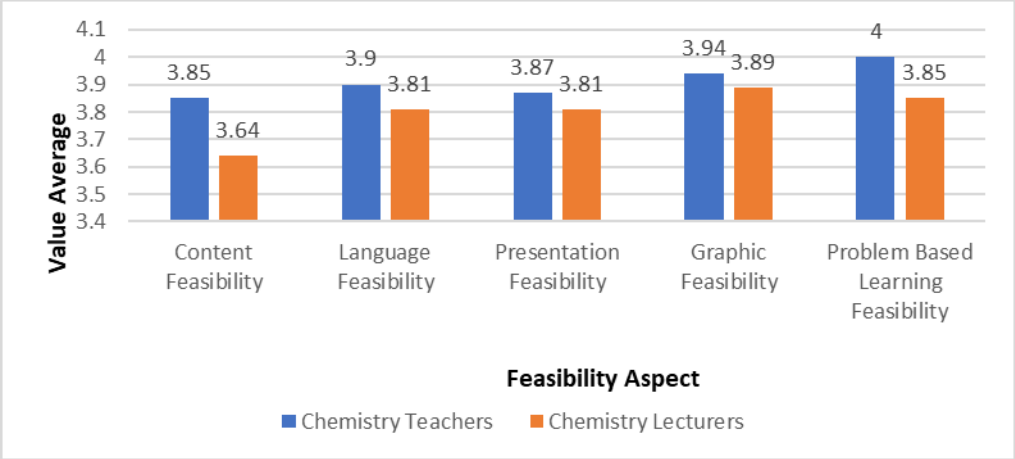

Fig. 3. Results of the Feasibility Analysis by Material Experts

Based on Figure 3 it can be seen that the feasibility score of the chemistry electronic student worksheets obtained was 3.80 with an average percentage of 95% by three chemistry lecturers and 3.91 with an average percentage of 97.8% by three chemistry teachers. Based on an average percentage value of 96.4% obtained from chemistry lecturers and teachers, it can be stated that the chemistry chemistry electronic student worksheets Problem Based Learning model that was developed meets valid criteria (very suitable for use).

Then the feasibility test of chemistry electronic student worksheets Problem Based Learning model by media experts was carried out to determine the feasibility of the developed electronic student worksheets. Assessment by media experts focused on aspects of guidance and information, aspects of program performance, and aspects of systematics, aesthetics and design principles. The chemistry electronic student worksheets developed was validated by a Education Technology lecturer in Universitas Negeri Medan. The average results of the

chemistry electronic student worksheets due diligence by media experts can be seen in Figure 4.

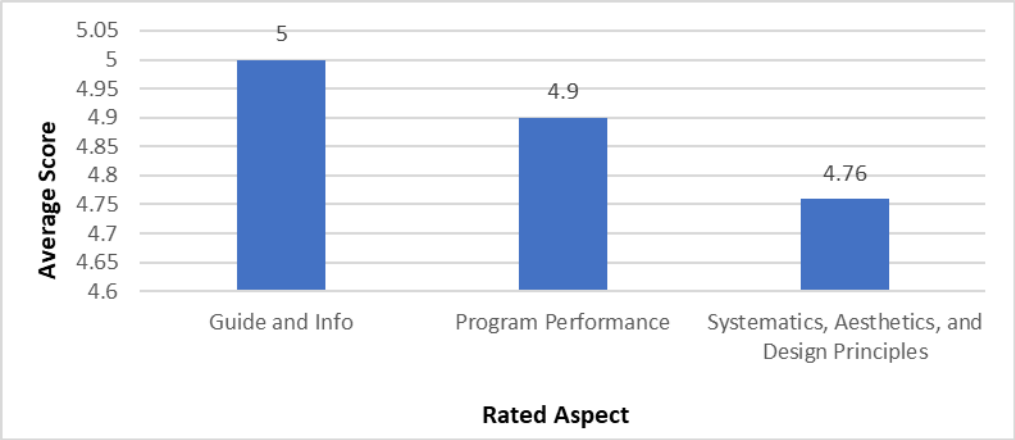

Fig. 4. Results of the Feasibility Analysis by Media Experts

Based on Figure 4 it is known that the average value of the percentage of media feasibility tests by media expert lecturers for all components obtained a value of 4.88. Based on that average value, it can be stated that chemistry electronic student worksheets Problem Based Learning model that has been developed meets valid criteria (very suitable for use).

Based on data from the feasibility test results for materials and media obtained from the validator, it can be concluded that the chemistry electronic student worksheets Problem Based Learning model developed is very suitable for use in chemistry learning. there are also several suggestions for improvement from the validator on the developed electronic student worksheets such as (1) correcting typos; (2) correcting the incorrect writing of symbols and indexes of chemical compounds; (3) adjust the color of the text with the background; and (4) adjusting the font size so that it can be read by students clearly, where all of these suggestions have been included as a revision into the Problem Based Learning model chemistry electronic student worksheets product that was developed. The following in Figure 5 are displays of electronic student worksheets Problem Based Learning model resulting from the development assisted by the website system.

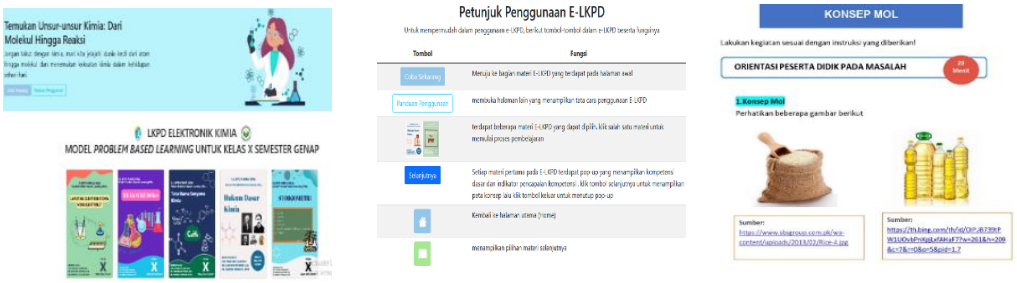

Fig. 5. Design of Chemistry Electronic Student Worksheets Problem Based Learning Model

3.4 Implementation

At this stage, the chemistry electronic student worksheets Problem Based Learning model that has been developed, revised and suitable for use is then implemented in chemistry learning in schools. The implementation of the electronic student worksheets was carried out in 4 face-to-face meetings from 17 May 2023 to 03 June 2023 at SMA Negeri 11 Medan. The research subjects were class X IPA 7 consisting of 36 students. The application of the Chemistry electronic student worksheets Problem Based Learning model in class begins with distributing the link that has been developed to all students in class X IPA 7 via the whatsapp group which students can then access via their respective smartphones. The application of the Chemistry electronic student worksheets Problem Based Learning model in the chemistry learning process in class aims to improve student learning outcomes by achieving the minimum completeness criteria score set by the school, which is 75. At this implementation stage, the material taught by researchers in class is Stoichiometry material.

3.5 Evaluation

In evaluation stage was carried out to obtain data on student learning outcomes after using the Chemistry electronic student worksheets Problem Based learning model. Student learning outcomes were obtained from posttest results data which was carried out after using the chemistry electronic student worksheets Problem Based learning model in the learning process. to find out the learning outcomes of students were measured using a test instrument in the form of multiple choice questions of 20 questions and the highest posttest score was 100 and the lowest score was 75. Furthermore, after obtaining posttest data from students, a prerequisite test was carried out, namely the normality test. After obtaining normal data, a hypothesis test can be carried out using the one sample t-test. 1. Normality Test The experimental class posttest data are normally distributed or cannot be known if a normality test is carried out. Processing the normality test of learning outcomes data using IBM SPSS – 26 software for windows. The normality test results are presented in Table 1.

Table 1. Results of the Normality Test of Learning Outcomes

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Hasil Belajar	.150	36	.040	.943	36	.065

a. Lilliefors Significance Correction

Based on Table 1 The results of the normality test used are the results of the Shapiro-Wilk significance because the number of samples is less than 50 students. The decision making requirement is if the significance value is > the value of α (0.05) then the data is normally distributed [25]. Based on the results of the Shapiro-Wilk normality test using SPSS 26 for windows, the sig. 0.065 > 0.05, it can be concluded that the data on student learning outcomes is normally distributed. 2. Hypothesis Test After the data is normally distributed, it can be continued with hypothesis testing using the one sample t-test using SPSS 26 for windows. The output results of the one sample t-test using SPSS 26 for windows are presented in Table 2 and Table 3.

Table 2. One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Hasil belajar	36	87.08	6.695	1.116

Based on Table 2, the average score of 36 students taught using the chemistry electronic student worksheets problem based learning model was higher than the teaching completeness criteria score that had been set at school, which was 87.08.

Table 3. Results of the One Sample T-Test

	Test Value = 75					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Hasil Belajar	10.829	35	.000	12.083	9.82	14.35

Based on the output data from the One Sample T-Test results presented in Table 3, the sig. 0.000 < 0.05 and $t_{count} > t_{table}$ (10.289 > 1.690) then Ha is accepted, so it can be concluded that student learning outcomes after using the electronic student worksheets chemistry Problem based learning model developed are higher than the Minimum Completeness Criteria scores that have been the school set is 75.

The results obtained in this study are also in line with previous studies that have been conducted the results obtained that the Problem Based Learning-based electronic student worksheets which was developed was effective in improving student learning outcomes in the era of independent learning [26]. In line with research it was found that the use of interactive electronic student worksheets improves student learning outcomes and motivation [27]. Other Research also states that the development of the electronic student worksheets Acid-Base Solution produced is feasible and practical to use to increase high school students' chemistry learning motivation. Research [28] also states that the development of the electronic student worksheets Acid-Base Solution produced is feasible and practical to use to increase high school students' chemistry learning motivation. In research [29] the results obtained in the experimental class experienced an increase in critical thinking with a gain score with moderate criteria after students were taught using the Android-based electronic student worksheets with the Problem Based Learning learning model. From the results of the study [30] it is known that Problem Based Learning-based E electronic student worksheets can be developed as a learning medium that can improve students' science process skills in junior high school.

Conclusion

Based on the result of data analysis, it can be concluded that this research produced a product that is chemistry electronic student worksheets Problem Based Learning Model. Based on validation results was obtained the average value from material experts is 3.85 with the average percentage 96.4% and from media expert was obtained the average value is 4.88 with average percentage 97.6%. Based on that results, the product is feasible and very suitable for using in chemistry learning process. Based on using one sample t-test from the research carried out, it can be concluded that students' chemistry learning outcomes were higher than the teaching completeness criteria using the one sample t-test where the sig. 0.000 < 0.05 and tcount (10.289) > ttable (1.690) in the learning process using the electronic student worksheets Chemistry Problem Based Learning Model. It means that electronic student worksheets Chemistry Problem Based Learning Model is feasible to be applied as a media or teaching source in teaching the Stoichiometry material for high school students.

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