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Development of Electronic Worksheet Based on Project Based Learning using Liveworksheet to Improve Critical Thinking Skills

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Abstract. The purpose of this research is to determine the feasibility of developing Electronic worksheet based on Project Based Learning using Liveworksheet and to determine the improvement of students Critical Thinking skills after the implementation of Electronic worksheet based on Project Based Learning using Liveworksheet. The research method used is research and development (R&D) with a development model using the ADDIE model which consists of 5 phases (Analyze, Design, Development, Implementation and Evaluation). The results of the research data were obtained from needs analysis, interview results, observations, validation results of media experts and materials. Based on the results of media validation, it shows that Electronic worksheet based on Project-Based Learning using Liveworksheet gets a percentage of 90.62% with a very feasible category. In the field trial, the N-gain result is 0.62 which is included in the moderate category. Based on the results of the analysis, it can be concluded that the Electronic worksheet based on Project Based Learning using Liveworksheet is very feasible to use.

Keywords: electronic worksheet, liveworksheet, critical thinking skills

1. Introduction

In today's era of education, both teachers and students have used advanced technology in the learning process. Technology has made the learning process in the classroom easier. Learner activities in the classroom can be more varied with the application of technology, so that students do not feel bored in the teaching and learning process [1]. The rapid advancement of information technology in the current era of globalization inevitably has an impact on the world of education. Global demands require the world of education to always adjust technological developments in an effort to improve the quality of education, especially the adjustment of the use of information and communication technology for the world of education, especially in the learning process [2].

Physics is a science that describes and analyzes the structure of natural events accompanied by experiments and measurements and presented in a structured manner. One of the materials in physics is Renewable Energy material. Renewable Energy is energy produced from natural sources that can be renewed and are widely available in nature. Renewable Energy material is one of the subjects that relates a lot of material to events, phenomena or problems in real life, so that students' knowledge about the use and future of energy is an important study, because the right use of energy can help daily life problems and even reduce the impact of climate change. However, in the current era, physics is a subject that is considered difficult by students and requires extra thinking to be able to understand and learn it, this is what results in some students in schools who experience learning difficulties [3].

Students experience difficulties in learning material because teachers still use conventional learning tools and students are less faced with concrete problems, problems given are monotonous, not complex and less varied [4]. One of the learning efforts to overcome this is by implementing the Project Based

Learning (PjBL) learning model. Project-based learning is a learning approach that encourages active learning processes within boundaries set by the teacher [5]. Learning that emphasizes on projects can maximize student activities in learning, can increase student creativity, improve critical thinking skills and scientific performance, thus helping students to develop long-term learning skills. Project-based learning emphasizes contextual problems experienced by students directly, so project-based learning makes students think critically and be able to develop their creativity [6].

Education in the current era needs to train students' critical thinking skills to face the challenges and demands of everyday life. Critical thinking is a reflective thinking process that focuses on deciding what to believe or do [7]. Critical thinking is one of the higher level thinking skills needed in development 21st century skills [8]. Critical thinking skills can be trained for students in the learning process in the classroom Students' critical thinking skills can be practiced by utilizing student worksheets [9].

Worksheets is a form of learning media, while learning media is one of the learning tools, where the function of worksheets is still not optimal so that it is still not able to help students in finding concepts and stimulating critical thinking skills. Along with the times, worksheets can experience innovations in terms of presentation, one of which is integrated with electronic media or technology known as electronic worksheet [10]. Electronic worksheet stands for Electronic Student Worksheet, which is an interactive teaching material designed to be used in online learning [11]. The advantage of electronic worksheet is that it can make it easier and narrow the space and time so that learning will be more effective.

Liveworksheets is a platform in the form of a website that offers accommodation to educators so that they can take advantage of the electronic worksheet that has been provided or compile their own interactive electronic worksheet online. The use of liveworksheets in making electronic worksheet is also very beneficial, because the electronic worksheet is arranged interactively and can be easily used by students. Students can work directly and accept completed assignments as a result. Liveworksheet can be accessed by learners using Google Chrome, so they don't need to download or sign up first [12]. Educators can utilize this software to transform static internet activity into dynamic, engaging and interactive worksheets.

Based on the results from observations and interviews conducted at SMAN 3 Bengkulu Tengah, it was found that the learning resources used by students to learn were printed books and other simple teaching materials. The results of the interview with the physics teacher of SMAN 3 Bengkulu Tengah were informed that learning in the classroom is currently using worksheets, but the worksheets used is still not based on the sequence of lessons and is directly directed to questions so that the ability to analyze problems is not optimal. The Student Worksheets used by teachers are still not interactive and varied in the learning process, this is what makes students less fond of physics learning. Information from the results of the interview was also obtained that the critical thinking ability of students was still relatively low and the lack of evenness of students' abilities in one class, in one class only half of the students were able to analyze, sensitize, solve problems, conclude, and evaluate.

Based on data obtained through the distribution of the needs analysis questionnaire, which was distributed by 129 respondents, it showed that students agreed that the learning process often uses package books, in addition to that, as many as 69.6% of students stated that they were more interested in non-printed teaching materials and 85.89% stated that they needed teaching materials that were equipped with Figures, animations and could be accessed through handphone and anywhere. Some of the students stated that they were not active enough in the learning process. This makes 87.44% of students need teaching materials that make them more active in the learning process, for example the development of electronic teaching materials that can improve students' critical thinking skills. This is based on the response of 82.01% of students who need teaching materials that can train them in improving critical thinking skills and 78.13% of students in the category agree that the development of electronic worksheet teaching materials that link materials with daily life is needed. So that an electronic teaching material and a learning model that is able to improve the critical thinking skills experienced by students in real life in a learning process, with good internet facilities at SMAN 3 Bengkulu Tengah can be used by teachers as an interactive and varied learning resource in the learning process.

Based on the background description, the researcher is interested in developing of Electronic Worksheet Based on Project Based Learning using Liveworksheet to Improve Critical Thinking Skills

in physics material, namely Renewable Energy. The development of Electronic Worksheet Based on Project Based Learning using Liveworksheet is an interesting combination to improve students' critical thinking skills. This research aims to define the feasibility and improvement of students' critical thinking skills towards developing the development of Electronic Worksheet Based on Project Based Learning using Liveworksheet.

2. Method

This research is a type of research and development using the Research and Development research method. Research and Development (R&D) is the process or steps to develop new product or improve an existing product. Development research is a type of research that can act as a breaker or link between basic research and advanced research [13]. This research was carried out at SMA Negeri 3 Bengkulu Tengah in the odd semester of the 2024/2025 school year. The sample of this study is students of SMA Negeri 3 Bengkulu Tengah.

In this study, the ADDIE development model is used. The ADDIE development model is an instructional process consisting of five phases, namely analysis, design, development, implementation and dynamic evaluation [14].The schematic of the ADDIE development model is as shown in Figure 1.

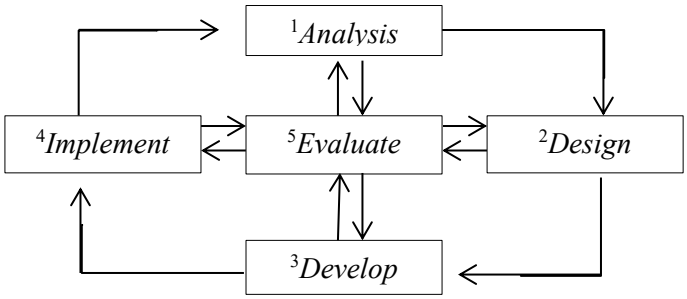

Figure 1. ADDIE development model schematic [15].

In this research, data collection techniques used include literature studies, observations, interviews, questionnaires, pretests and posttests. The pretest and posttest sheets are created based on a series of critical thinking ability indicators. According to Ennis, critical thinking skills are grouped into five indicators, namely giving elementary clarification, basic support, inferences, advanced clarification, and Strategies and tactics [16].

At this stage of data analysis techniques, it is carried out to group information from data collection techniques using qualitative, quantitative and descriptive data analysis techniques. In the needs analysis using interview and observation techniques, it can be concluded in a qualitative descriptive manner. Meanwhile, quantitative descriptive data analysis was carried out to calculate the percentage of media and material validation scores and calculate the results of the posttest pretest. The measuring scale used in the questionnaire uses a Likert scale with an interval of 1-5. The media feasibility test in this study uses the Likert scale in the form of categories, which can be seen in Table 1.

Table 1. Categories assessment.

Criteria	Score
5	Strongly agree
4	Agree
3	Quite agree
2	Disagree
1	Strongly disagree

The percentage results of the validation data obtained are calculated using equation 1 as follows:

$$Validasi\ (v)\ = \frac{\Sigma\, skor\ yang\ diperoleh}{\Sigma\, skor\ maksimal} x100\% \quad (1)$$

The percentage obtained from the validation data is then converted into an assessment statement according to the table to determine the feasibility of the media developed. The interpretation of the eligibility assessment percentage can be seen in Table 2.

Table 2. Interpretation of Assessment Scores [17].

Criteria	Score
0% - 20%	Highly Worthy
21% - 40%	Proper
41% - 60%	Quite Decent
61% - 80%	Not Eligible
81% - 100%	Very Unworthy

The analysis of the level of students' critical thinking ability can be seen from a cognitive point of view using a critical thinking ability test. The improved critical thinking skills in the Electronic worksheet based on Project Based Learning using Liveworksheet developed can be seen in the pretest and posttest. The pretest and posttest scores are calculated and analyzed to further become the basis for drawing conclusions from the N-Gain calculation. The results of the improvement analysis are calculated using the N-gain score to see the improvement in test results [18], which is calculated using equation 2

$$N - gain = \frac{skor\ posttest - skor\ pretes}{skor\ ideal - skor\ pretest} \quad (2)$$

After the N-gain results are obtained, then proceed by calculating the percentage of student scores in the N-gain category in Table 3.

Table 3. Criteria for improving critical thinking skills.

Value N-gain	Interpretation
$0.70 \leq g < 1.00$	Tall
$0.30 \leq g < 0.70$	Keep
$0.0 < g < 0.30$	Low
$g = 0.00$	There was no decrease
$-1.00 \leq 0.00$	There is a decline

3. Results and Discussion

Liveworksheet is one of the platforms that can help teachers in creating e-worksheets or student worksheets, with Liveworksheet teachers can present materials such as videos, audio, other interesting images and symbols that can attract students' attention [19]. Liveworksheet is very easy to access without having to install and register the application first, can display videos on worksheets and make the worksheet look more attractive. Liveworksheet is also a media that turns students' worksheets into interactive, interesting, and of course presented online. Liveworksheet can be used by students online and can be accessed anywhere on the Liveworksheet link or platform provided by the teacher, students also get feedback from the teacher after working on it. This Liveworksheet is also very interesting, besides that the use of this Liveworksheet is very easy to use for both teachers and students. Although electronic worksheet using liveworksheet has many advantages, it also has disadvantages such as students and teachers must have a supporting device (such as a computer, tablet, or smartphone) and a stable internet connection. Next is the Liveworksheet menu shown in Figure 2.

The development of Electronic Worksheet Based on Project Based Learning using Liveworksheet through several stages of the ADDIE model in the form of analysis, Design, Development, Implementation, and Evaluation. The process of each of these stages is as follows.

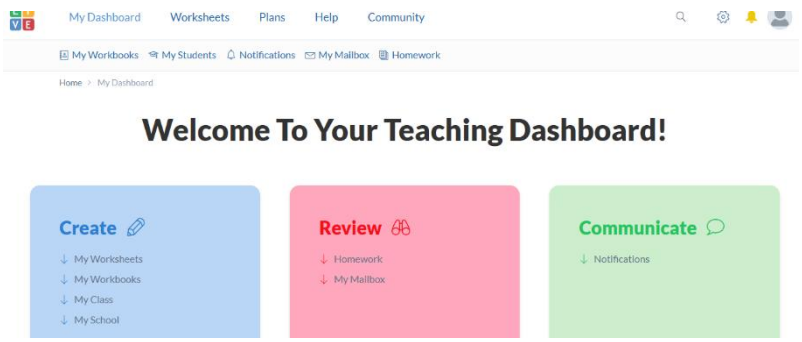

Figure 2. Liveworksheet dashboard view.

3.1. *Analysis stage*

At the analysis stage, the activities carried out are a preliminary analysis. The activities carried out were observation, interviews and dissemination of questionnaires on the needs of students carried out at SMA Negeri 3 Bengkulu Tengah. From the interview results, it was found that the student worksheets (LKPD) used by teachers were still less varied and interactive in the learning process, and students' critical thinking skills were still quite low. Based on data obtained through the dissemination of a needs analysis questionnaire, which was distributed by 129 respondents, it was shown that students agreed that the learning process often uses package books, besides that students stated that they were more interested in non-printed teaching materials and that students needed teaching materials that were equipped with Figures, animations and could be accessed via handphone and anywhere. Some of the students stated that they were not active enough in the learning process. This makes students need teaching materials that make them more active in the learning process, for example, the development of electronic teaching materials that can improve students' critical thinking skills.

3.2. *Design Stage*

This design stage designs a conceptual framework for the development of an electronic worksheet based on the results of the analysis. The initial design of the product is closely related to the selection of media, meaning to design or design learning content. Electronic Worksheet Based on Project Based Learning using Liveworksheet that will be developed is designed using the Canva application (font selection, coloring, layout, and so on). Then the results of the canva application will be saved in the form of a file and converted into an innovative Electronic Worksheet on the Liveworksheet platform.The initial design of the Electronic Worksheet Based on Project Based Learning using Liveworksheet can be seen in Figure 3.

In this basic research, Wati [20] with the title Development of Interactive electronic worksheet Newton's Law Based on Mobile Learning using Liveworksheet in High School, there are main components of the Worksheet including a cover containing the title of the electronic worksheet, student identity, usage instructions, objectives, theoretical basis, work procedures, questions, conclusions, and collection instructions. This reset research also uses mobile learning as the learning model used. This research aims to improve students' motivation and learning outcomes. The electronic worksheet developed is based on the design described in Figure 3 which consists of a cover/title, an introduction containing learning outcomes, learning objectives, a summary of the material, learning instructions and preliminary tasks, project activities containing steps or syntax of the Project Based Learning learning model and indicators of critical thinking skills. In the project activities, students can analyze various information, analyze, synthesize, solve problems, evaluate and create. Based on the results of research findings and discussions conducted by Musi'in [6] it can be concluded that after using the Project Based Learning (PjBL) model in the learning process, there was an increase in the ability of students to reason critically.

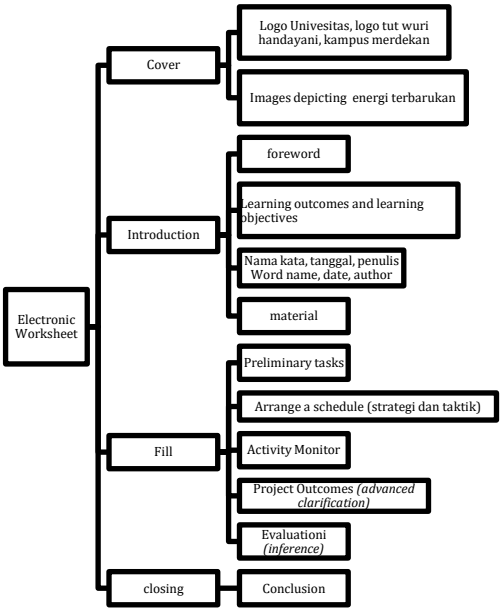

Figure 3. Initial design of Electronic Worksheet Based on PjBL using Liveworksheet.

3.3. *Development Stage*

This stage contains the realization activities of the product design. The framework that is still conceptual is realized into a product that is ready to be implemented. At the editing stage, the content and design of the media made are checked. Corrections are made if the product is made has shortcomings that need to be corrected. The results of the development of Electronic Worksheet Based on Project Based Learning using Liveworksheet can be seen in Figure 4.

Figure 4. Cover Electronic Worksheet.

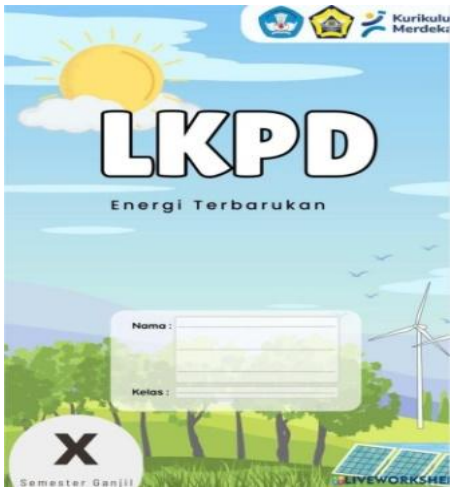

Figure 5. Revised Electronic Worksheet cover.

In Figure 4 is the cover of electronic worksheet that has not been revised, there is an improvement in the color quality of the image that is lacking and the animation of the cornering related to the material to make it more attractive. In Figure 5 is a revised cover that contains the title of electronic worksheet, student identity, university logo, tut wuri handayani logo, and independent campus. There are material titles and images that describe the material, namely renewable energy. In the identity column, students can be interactive where students can fill in the fields by pressing on the identity section.

Figure 6. Introduction to electronic worksheet.

The introduction of Figure 6 contains a preface along with the author's identity, there are learning outcomes and learning objectives are aligned with the curriculum. There is a summary of material from renewable energy that can be used as reading material for students.

Figure 7. Content of electronic worksheet Liveworksheet based on Project Based Learning.

which aim to make it easier for students to understand and reduce errors in filling in the work.. In the content of electronic worksheet, there is a syntax of Project Based Learning, namely basic questions, planning, compiling schedules, making projects and monitors, evaluation results, and there is a syntax of critical thinking skills. Learning videos are also available on the electronic worksheet to make it easier for students to work on questions and projects. Students can analyze through the available teaching videos, the videos can be watched directly on electronic worksheet. In the results section, students are asked to collect a video presentation about the project at the link that has been linked in electronic worksheet. learning objectives are aligned with the curriculum.

Figure 8. Conclusion

Figure 8 is the conclusion of electronic worksheet where students can give conclusions after learning and this is the syntax of the ability to think critically inference. After the product is designed, the next activity is to carry out the validity of the Electronic Worksheet Based on Project Based Learning using Liveworksheet which is validated by 3 media and material validators, namely 2 lecturers who are experts in media and materials and 1 high school teacher. In line with julianti's research [21] which uses 3 experts in validating The results of the validation data analysis carried out by several experts can be seen in Table 4.

Table 4. Expert validation results

No	Aspects	Percentage	Eligibility Category
1	Eligibility	84.44%	Very worthy
2	Linguistics	93.33%	Very worthy
3	Serving	92%	Very worthy
4	Graphics	96.66%	Very worthy
5	Aspects of Critical Thinking Skills	86.66%	Very worthy
	Total score obtained	90.62%	Very worthy

From the Table 4, there are 5 aspects, namely the feasibility of content, language, presentation, graphics, and aspects of critical thinking skills. In terms of eligibility, ISI received a percentage score of 84.44% with the eligibility category very feasible. In the language asepek which received a percentage of 93.33% with a very decent category, then in the aspect of presentation it received a percentage of 92% with a very decent category. The graphic aspect received a percentage of 96.66% with a very decent category, and the last aspect was the critical thinking ability aspect with a score percentage of 86.66% with a very decent category. It was concluded that these five aspects received a percentage with a very feasible category, with a total overall percentage of validation of 90.62% which shows that Electronic Worksheet Based on Project Based Learning using Liveworksheet is declared very feasible. This is supported by research conducted by Hardhani [22] that the Electronic Worksheet assisted by the Liveworksheets application was declared valid and practical for use by teachers and students. This is also supported based on the results of the feasibility assessment on the Tunga research [23] that the Electronic Worksheet Physics with the Project Based Learning model on the material of direct current circuits shows that the average percentage of the overall score obtained and according to the category of descriptive statistical analysis the percentage of student scores, is included in the category of "Very Good" Based on the percentage category, it is known that this electronic worksheet can be said to be feasible and meet the criteria so that it can be used as one of the physics teaching materials.

3.4. *Implementation*

At this stage, the implementation of the developed product is carried out in real conditions, namely in the classroom. To find out that the media designed can improve the critical thinking skills of class X students at SMAN 3 in Central Bengkulu, then at the initial stage of implementation, there is a pretest that will be given to students, after that then the electronic worksheet media is implemented to students. After the media has been implemented, the next is to provide posttest questions to find out the improvement of students' critical thinking skills by using Electronic Worksheet Based on Project Based Learning using Liveworksheet on energy terbarukan materials. The pretest-posttest questions given include aspects of critical thinking indicators. The improvement in students' pretest and posttest results can be seen in Figure 9.

Based on Figure 9, the pretest and posttest graphs show that there was an increase in each indicator of critical thinking ability, the indicator of giving simple explanations increased by 0.54%, the indicator of building basic skills by 0.60%, the indicator of giving more advanced explanations by 0.77%, the indicator of concluding by 0.58% and setting strategies and tactics by 0.62%. The highest increase in indicators through pretest and posttest data on renewable energy materials is in the indicator providing a basic explanation of 0.77% with the high category. This is in line with Masruroh's research [18] which states that Electronic Worksheet is able to improve students' critical thinking skills. The increase in students' scores ranging from moderate to high occurs due to the influence of students' learning style factors. Each student has their own learning style, whether kinesthetic, visual, or auditory learning style

so that students who are more suited to certain teaching methods will experience a greater increase in scores because the material taught can be delivered in line with their learning style [18]. In the study, project-based learning (PjBL) was used to overcome the difficulties faced during learning and was proven to improve students' critical thinking. Previous studies have shown that students with low critical thinking skills can improve after using the PjBL learning model [24]. Critical thinking skills of students who get an increase in pretest and posttest formative results are obtained from the results of the N-gain analysis.

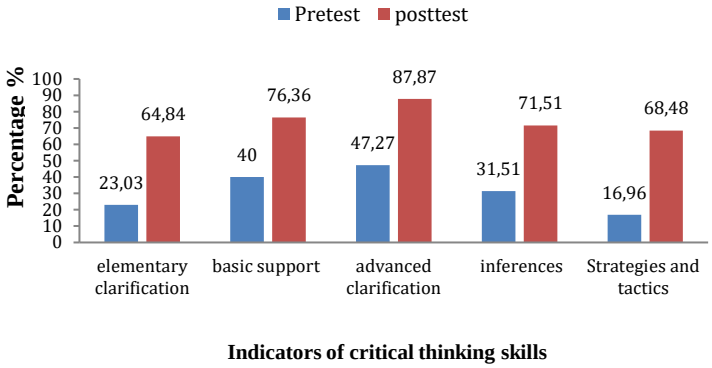

Figure 9. Chart of pretest posttest results.

The results of N-gain can be seen in Table 5.

Table 5. Results of N-gain.

Data	Pretest	Posttest	N-gain	Category
Minimum value	8	60		
Maksimum value	48	88		
Average	31.75	73.81	0.62	Keep

N-gain analysis is used to evaluate differences in outcomes or achievements in each critical thinking skill indicator before and after the application of Electronic Worksheet [18]. In the table of N-gain analysis results, the pretest with an average of 31.75 and the posttest with an average of 73.81. So that the average N-gain value obtained is 0.62 with the medium category. This is in line with Wati's research [20] stated that the results of the analysis of the N-gain value obtained were 0.58 in the medium category. So, based on table 5, it can be stated that there is an increase after students before and after the use of Electronic Worksheet Based on Project Based Learning using Liveworksheet can improve critical thinking skills.

3.5. *Evaluation*

The evaluation stage is carried out to assess or revise the product media to be developed. This stage is carried out at each stage of development (formative evaluation) and the end of the development process (summative evaluation) to improve the Electronic Worksheet Based on Project Based Learning using Liveworksheet so that Electronic Worksheet becomes better and in accordance with the needs of students. At the stage of the analysis process, revisions are made to the interview sheet and questionnaire of students' needs, namely by adding questions related to critical thinking skills and the media to be used. At the development stage, revisions are carried out in accordance with the criticism and suggestions on the expert validation questionnaire, namely the color contras are made brighter so that they are not monotonous.

4. Conclusion

The results of the research that has been conducted can be concluded that the development of Electronic Worksheet Based on Project Based Learning using Liveworksheet to improve critical thinking skills

resulted in a product feasibility validation of 90.62% with a very feasible category. Thus, the Electronic Worksheet Based on Project Based Learning using Liveworksheet is feasible and can be developed and used in physics learning. In the results of the N-gain test, an N-gain result of 0.62 was obtained with a moderate category, so that there is an increase in students' critical thinking skills before and after using the Electronic Worksheet Based on Project Based Learning using Liveworksheet. Thus, the conclusion of this study is that Electronic Worksheet Based on Project Based Learning using Liveworksheet is feasible to use and can improve the ability of critical thinking skills of students.

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