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# Effectiveness of Electronic Student Worksheets (LKPD) Problem-Based Learning (PBL) Based on Social Scientific Problems (SSI) in Improving Problem Solving Skills

Dilla Eka Septiani [1*], Sri Wardhani[1], Marlina Ummas Genisa[1]

[1] Biology Education, Postgraduate Program, Muhammadiyah University of Palembang, Indonesia

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Related Authors:
Sri Wardhani
tugasdillaekas@gmail.com

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**Abstract:** Efforts to improve the quality of education can be made in various ways, one of which is the use of innovative and technology-based teaching materials. Student Worksheets (known with LKPD) are one of the learning tools used by educators to deliver material and improve student understanding. This research intended for developing electronic LKPDSSIPBL based on circulatory system material at SMAN Palembang which is valid, practical and effective. The development model using 4D refers to Thiagarajan which goes through 4 stages, namely define, design, develop, and disseminate. The population and sample of the study included SMAN 4, SMAN 9, and SMAN 19 Palembang, while the sample of the study was 36 students of class XI.1 and 36 students of class XI.2. Data collection techniques used questionnaires and written tests. Data analysis used validity, reliability, and N-Gain. The results of this study consisted of (1) The define stage obtained a result of 41% meaning that teachers and students need SSI Electronic LKPD (2) The design stage obtained a value of 95% (3) The develop stage showed validation from language experts 83%, materials 81%, media 96%, and learning devices 83% were qualified as very feasible. Practicality, seen from student responses 82% and 2 teachers 98% and 97% showed very practical responses; (4) The dissemination stage shows that the use of PBL-based Electronic Practical Worksheets can improve critical thinking skills and problem-solving skills.

**Keywords:** Circulatory System; Electronic LKPD; PBL; Problem Solving; SSI

## Introduction

21st century education is indirectly influenced by the industrial revolution 4.0, especially the change in perspective on the concept of education which must always involve information and communication technology (ICT). The development of ICT is growing very rapidly and has an influence on the field of education, including in terms of learning (Akbar & Noviani, 2019). ICT is used in dynamic learning and can create student learning activities and interactions, because technology provides convenience and comfort (Sudarsana et al., 2018). The most influential application of ICT in education is the use of the internet. The use of the internet is expected to provide opportunities for teachers and students to develop learning in order to obtain maximum results to meet the demands of 21st century education (Iskandar & Yulanto, 2020).

21st century education must emphasize critical thinking and problem-solving skills, communicate effectively, collaborate, and create and innovate. In addition, one of the demands of the 2013 curriculum and the independent curriculum in accordance with the objectives of biology learning is that students must be able to develop their potential so that they have problem solving skills (Palennari et al., 2021). Problem solving skills are basic skills that students must have because in the problem solving process, a decision-making process occurs which is interpreted as selecting the best solution from a number of available alternatives (Bahri et al., 2018). The use of issues in everyday life or socio-scientific issues, hereinafter abbreviated as SSI, as a learning context is starting to be of interest in science

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education. SSI-based science learning is a strategy that can encourage students' interest in learning, especially functional science literacy.(Presley et al., 2013). SSI aims to facilitate students in contextualizing, increasing interest in learning, developing scientific concepts, problem-solving skills, and students' skills in making decisions (Dawson & Venville, 2013).

In the 21st century education era, learning is not only done face to face but also online, so that the existence of printed LKPD is difficult for students to access because it is limited by time and distance. This is an indication of the lack of learning resources, the teaching materials used are not yet effective and efficient. In addition, the LKPD that is usually used has a less attractive appearance, in line with research conducted (Zuhriyah & Trimulyono, 2019). Regarding the use of LKPD, it was found that students were not very interested in the LKPD used because the appearance of the LKPD was not attractive and varied, so that students became bored. Other research was conducted by Salsabila & Susantini (2022) also mentioned the same thing that LKPD usually contains black and white images so that students are less able to understand. LKPD used has not been integrated with a particular learning model. This has an impact on students where students have not been given the opportunity to develop skills, especially problem-solving skills.

Based on the needs analysis that has been carried out, a worksheet is needed that can support improving problem-solving skills in students, namely the worksheet used is a worksheet based on the Problem Based Learning (PBL) model in electronic form because it makes it easier for students to access the worksheet, not limited by time and distance. Learning to use a learning model that is interesting and not boring will facilitate the learning process (Fadhila et al., 2018). In addition, the use of the PBL model is because it uses various types of intelligence needed to face real-world challenges, skills to face everything new and problems that arise (Bwefar et al., 2019; Ripai & Sutarna, 2019). So it can be said that the purpose of this study is to develop teaching materials in the form of electronic LKPD SSI integrated with problem-based learning models to improve problem-solving skills in students in biology learning. Similar to research conducted by The Last Supper (2021)that innovative electronic LKPD can be developed to meet the demands of 21st century learning by utilizing technology.

## Method

This study uses the 4D model from Thiagarajan (1974) including define, design, develop, and dissimulate. The author chose to use the 4D development model because this model is systematic and facilitates the process of developing PBL-based SSI electronic LKPD on the circulatory system material.

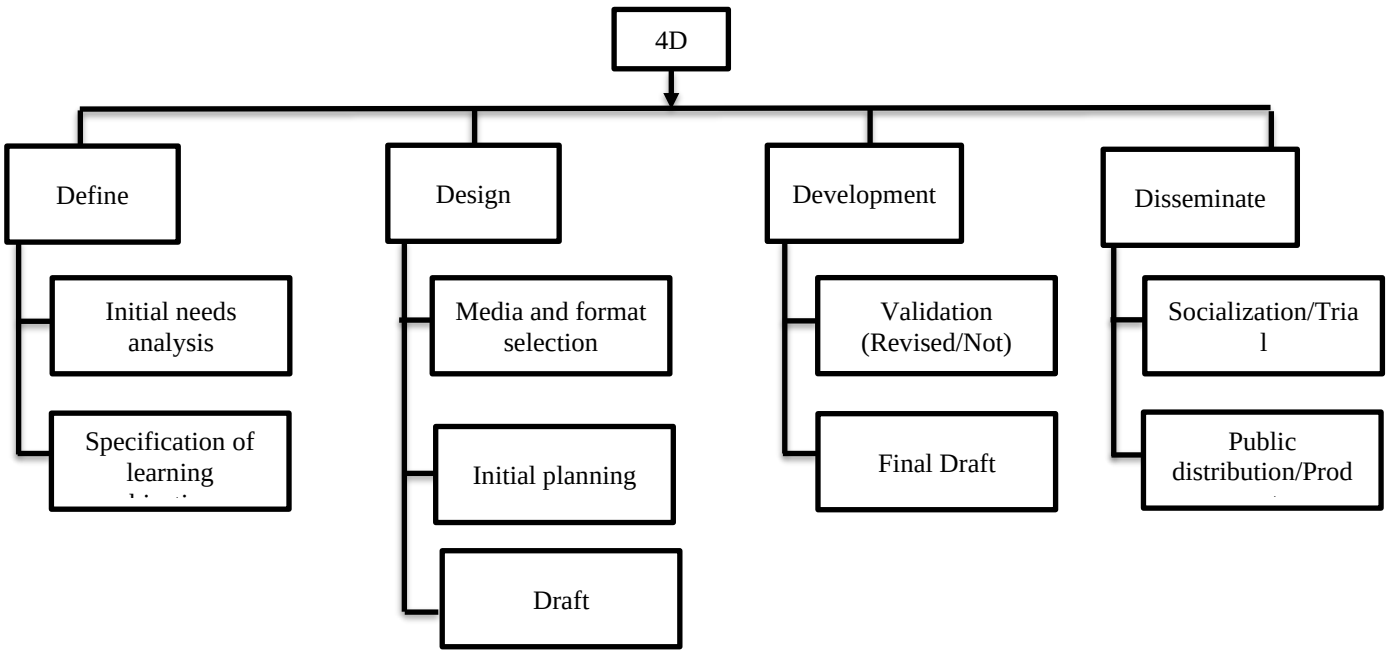


**Figure 1.** Thiagarajan 4D Model Steps

The first stage define is to conduct front-end analysis, learner analysis, task analysis, concept analysis, and determine learning objectives; the second stage design is planning to prepare benchmark tests, media selection, format and initial design; the third stage develop is the initial product that will undergo

validation testing by expert lecturers and development trials; the fourth stage disseminate is to disseminate the product that has been developed, through the stages of validity testing, packaging, distribution and adoption. The procedure for developing electronic LKPD SSI based on PBL on the material of the circulation system at SMAN 4 Palembang, SMAN 9 Palembang and SMAN 19 Palembang.

The subjects in the electronic LKPD development research were grade XI students at SMAN 9 Palembang. Data collection was based on the sub-district area representing the Ulu part of Palembang City. The selection of subjects was carried out using the simple random sampling technique, which is a technique where sample members are taken from a population randomly without considering the strata in the population. The subjects in the PBL-based SSI electronic LKPD development research were grade XI students at SMAN 9 Palembang. The effectiveness test used a pretest and posttest in the form of essay questions based on problem-solving skills and used one control class and one experimental class. This aims to provide a comparison to show some improvements.

**Table 1.** Test Subject

| Class | Name of high school that represents Ulu Palembang area | Pre-exam | Treatment | Post-exam |
|---|---|---|---|---|
| Experiment | SMAN 9 Palembang | O1 | X1 | O2 |
| Control | SMAN 9 Palembang | O3 | X2 | O4 |

**Information:**
X1: Treatment in the experimental class (using PBL-based SSI electronic LKPD, using the PBL model and using SSI questions)
X2: Treatment in conventional classes (not using PBL-based SSI electronic LKPD, using PBL-based SSI electronic LKPD) models and using SSI questions)
O1: Pretest given to the experimental class
O2: Posttest given to the experimental class
O3: Pretest was given to the control class
O4: Posttest was given to the control class

The instruments used to collect data in the field test of the PBL-based SSI electronic LKPD were teacher and student questionnaires, validity, practicality and effectiveness.

**Table 2.** Aspects used to Collect Data in Field Tests

| Rated aspect | Technique | Instrument | Respondents |
|---|---|---|---|
| Needs analysis | a list of questions | a list of questions | Teachers and students |
| Electronic LKPD Validator Assessment | a list of questions | a list of questions | Validator of materials, media, language, teaching aids, and learning experts |
| Practicality Level of Electronic LKPD | a list of questions | a list of questions | Teachers and students |
| Effectiveness of Electronic LKPD | Hand | Hands (Pretest and Posttest) | Learner |
| Implementation of the PBL model | a list of questions | a list of questions | Observer |
| Student Response | a list of questions | a list of questions | Student |

To determine the effectiveness of the use of PBL-based SSI electronic LKPD, an assessment was carried out from the Test (Pretest and Posttest) using questions based on problem-solving skills. The effectiveness of the use of PBL-based SSI electronic LKPD was carried out using the N-gain test (Formula 1).

$$N - Gain = \frac{S\ post - S\ pre}{S\ maks - S\ pre} \quad (1)$$

Information:
S post = Posttest shoes
S max = Ideal maximum score
S for = Pretest score

The N-gain test is conducted to determine how much learning outcomes have increased.(Majdi et al., 2018). N-gain Value The results obtained are grouped based on the N-gain score acquisition criteria in Table 3.

**Table 3.**N-Gain Value Criteria

| Mark N-profit | Criteria |
|---|---|
| *N Advantage*≥ 0.7 | Tall |
| *0.3 ≤ Profit N* ≤0.7 | At the moment |
| *Advantage N* ≤0.3 | Low |

The following is an assessment of the N-gain results converted into the problem-solving skills domain as seen in Table 4.

**Table 4.** Learning Achievement Score Criteria in the Problem Solving Skills Domain

| Score | Information |
|---|---|
| 4 | Very good |
| 3 | Good |
| 2 | Enough |
| 1 | Not enough |

Source: Minister of Education and Culture Regulation, (2013)

Observation analysis of the implementation of the learning model at each meeting, then data processing is needed to display data in percentage form. To calculate the percentage of implementation of the learning model, use Formula 2.

$$\%\text{Model Implementation} = \frac{\sum \textit{Observations that answer yes or no}}{\sum \textit{Complete observations}} x\ 100 \quad (2)$$

To find out the criteria for implementing the learning model, see Table 5.

**Table 5.** Learning Model Implementation Criteria

| Shoes P (%) | Criteria |
|---|---|
| 80 < P100≤ | Very talented |
| 60 < P80≤ | Finished |
| 40 < P60≤ | Enough is done |
| 20 < Page 40≤ | Not implemented |
| ≤20 | Absolutely not workable |

Source: Widyoko, (2012)

## Results and Discussion

The product developed in this study is an electronic LKPD SSI based on PBL to improve problem solving skills using the 4D Thiagarajan model (1974), namely Define, Design, Develop, and Dessiminate. The results of observations indicate that the product is feasible and can be applied by students and teachers as teaching materials in schools. In addition, LKPD containing SSI can also contribute to increasing the meaningfulness of learning as a whole.(Aini et al., 2024).

The questions or exercises given by the teacher are mostly in the form of essays with a presentation of 54%, multiple choice questions with a presentation of 46% and 0% for case questions. As many as 36% of students choose the material on the circulatory system, which is difficult to learn among other materials. This is because it is difficult to understand how the organs in the circulatory system work and are interconnected, so that students are less able to explain and understand the material on the circulatory system. Student learning outcomes in the subject of the circulatory system are below the Minimum Completion Criteria (KKM), which is 24%, in accordance with the minimum completion criteria that have been set58%, above the Minimum Completion Criteria (KKM) of 18%. This is because the teaching materials for student worksheets given by teachers do not contain real examples or cases. Students choose learning video teaching materials as much as 20%, E-LKPD as much as 41%, 3D media as much as 24%, E-Book as much as 6% and E-Module as much as 9%. Based on the needs analysis, the teaching materials needed by students are E-LKPD. Electronic LKPD is teaching material that contains images or other illustrations that are accessed using electronic devices connected to the internet(Sahid et al., 2021).

After analyzing the needs of students, teaching materials are needed that can improve problem-solving skills in the learning process.Asyafaah et al (2024)mentions the problems found in learning in the field of science that are very often found in schools and in places of learning is the weakness of students' problem-solving skills. Other studies state that SSI-based E-LKPD can motivate students to learn and improve their critical thinking skills. The problems presented in E-LKPD are adjusted to real-life problems so that they can be applied to everyday life.(Sirmayeni, 2023). So the researcher developed electronic LKPD teaching materials SSI based on PBL to improve problem solving skills.

The product design is made according to the previously designed format, then made through Canva and saved in PDF format to be used as an electronic LKPD using the Heyzine Flipbook application and then published. The results of the expert assessment include validation of language, materials, media and learning devices. The results of the assessment and suggestions from the media validator, are used to improve the electronic student worksheet SSI based on PBL according to the suggestions that must be improved so that it can be used before being widely distributed. Results of the practicality test for class 2 Based on the questions that have been prepared, validity and reliability tests are then carried out to determine their quality.

The field trial of implementation using SSI electronic LKPD based on PBL was conducted in class XI.1 as an experimental class. To see the effectiveness of using LKPD on learning outcomes of problem-solving skills, it can be seen by analyzing pretest and posttest questions according to problem-solving skills indicators and analyzed using the N-gain formula. Table 6 shows the N-gain results as follows.

**Table 6.**Results of N-gain analysis of experimental and control classes

| Class | *Pre-exam* | *Post-exam* | N-Gain Value | Criteria |
|---|---|---|---|---|
| XI.1 (Experiment) | 52.0 | 92.4 | 0.83 | Tall |
| XI.2 (Control) | 46.9 | 86.9 | 0.75 | Tall |

The results of the N-gain value show that the experimental class XI.1 is 0.83 with high criteria and class XI.2 as the control class obtained an N-gain value of 0.75. This is due to the difference in treatment between the experimental class and the control class. The difference in treatment is that the experimental class uses PBL-based SSI electronic LKPD and the control class does not use LKPD, but still uses the PBL and SSI models in its learning process. This has an impact that PBL-based SSI electronic LKPD is more effective in improving students' problem-solving skills compared to those who do not use PBL-based SSI electronic LKPD.Princess (2020)concluded that LKPD Based on Social Scientific Issues has proven to be effective and useful in learning

The results of observations of the implementation of the PBL model by collecting observation data during 3 meetings in the learning process in the classroom. The observation process was carried out by observers at each meeting in class XI.1 as the experimental class and class XI.2 as the control class. The results of the observation data can be seen in Table 7.

**Table 7.**Results of Analysis of the Implementation of the Learning Process with the PBL Method

| The first meeting | Score | Achievement (%) | Criteria |
|---|---|---|---|
| Class XI.1 (Experiment) | | | |
| 1 | 21 | 100 | Highly Implemented |
| 2 | 21 | 100 | Highly Implemented |
| 3 | 21 | 100 | Highly Implemented |
| Class XI.2 (Control) | | | |
| 1 | 21 | 100 | Highly Implemented |
| 2 | 21 | 100 | Highly Implemented |
| 3 | 21 | 100 | Highly Implemented |

The results of the analysis at each meeting in the experimental class and control class have reached very good criteria. Based on the results of filling in student responses via Google Form, it can be seen in Table 8 and Table 9.

**Table 8.**Assessment of Student Responses in Experimental Class

| Statement Category | Response Assessment Criteria | | | | |
|---|---|---|---|---|---|
| | Very good | Good | Quite good | Not good | Very bad |
| Students' understanding of the material | 36.11 | 77.08 | - | - | - |
| Student motivation in learning | 25 | 76.85 | - | - | - |
| Student confidence during the learning process | 2.78 | 94.44 | - | - | - |
| Students' knowledge of the PBL model | 16.67 | 80.55 | - | - | - |
| Amount | 80.56 | 328.92 | - | - | - |
| Values | 20.14 | 82.23 | | | |

Table 8 shows that students in the experimental class gave a good response to the understanding of the material, namely with a percentage of 77.08%, while student motivation showed a percentage of 76.85% for good criteria and 25% for the very good category. In the realm of self-confidence, students obtained a good percentage of 94.44% and 2.78% of the very good percentage.

Students' knowledge of the PBL model obtained a percentage of 16.67% in the very good category and 80.55% in the good category. This is becausestudents do not have enough experience with the PBL model. Students are more familiar with the discovery learning model, so that students' knowledge of the PBL model is still limited.

**Table 9.** Assessment of Control Class Student Responses

| Statement Category | Response Assessment Criteria | | | | |
|---|---|---|---|---|---|
| | Very good | Good | Quite good | Not good | Very bad |
| Students' understanding of the material | date 22.22 | 77.78 | - | - | - |
| Student motivation in learning | 33.33 | 78.70 | - | - | - |
| Student confidence during the learning process | - | 71.99 | 11.11 | - | - |
| Students' knowledge of the PBL model | 19.44 | 77.31 | 2.78 | - | - |
| Amount | 74.99 | 305.78 | 13.89 | - | - |
| Values | 17.36 | 76.44 | 3.47 | | |

Table 9 shows that the percentage of student responses in the experimental class is classified as good in terms of learning, namely understanding the material is classified as good with a percentage of 77.78%. This is because at the PBL learning model stage students discuss to understand the material through discussion to solve a problem. Meanwhile, student motivation shows a percentage of 78.70% for good criteria and 33.33 for the very good category.

In the realm of self-confidence, students obtained a fairly good percentage of 11.11% and 71.99% good percentage. When compared to the experimental class, the control class had lower self-confidence. This is evident from the results of the value of indicator one, namely understanding the problem is the lowest indicator, where indicator one is the initial indicator in the learning process. At stage one, students had difficulty in writing down facts from the problem scenario due to low student self-confidence and were not facilitated with PBL-based SSI electronic LKPD so that they did not focus when writing down facts. In line with research conducted byThe Last Supper (2024)In his research, he concluded that electronic LKPD was proven to improve problem-solving skills in students.

The creation of PBL-based SSI electronic LKPD is done by uploading a PDF file to Flipbook Heyzine which is distributed in the form of a link and registered intellectual property rights (IPR). Then it is distributed through the class Whatsapp group to be accessed by each student. The PBL-based SSI electronic LKPD that has gone through the trial and refinement stages is then given to Biology teachers at SMAN 9 Palembang to be used in the learning process, especially in the subject of the circulatory system.

The validity of the SSI electronic LKPD based on PBL was tested through stages from language experts, materials, media and learning devices according to the assessment indicators. The assessment results from language experts with an average score of 83% showed very good qualifications and did not need to be revised. The validation results from material experts obtained an average score of 81% with very good qualifications and did not need revision. The material contained in the SSI electronic LKPD based on PBL is included and in accordance with KI and KD. The accuracy of the material in terms of facts and concepts and writing terms in biology is good, the material also supports learning such as providing examples that are close to students. In line with research Milatti & Fitrihidajati (2024). Electronic LKPD containing videos and links makes it easier for students to learn.The Last Supper (2021)stated that the advantages of electronic LKPD are that it makes it easier and narrows down space and time so that learning becomes more effective.

The SSI electronic LKPD based on PBL has been validated by media experts with an average of all indicators of 96% which indicates very good qualifications and no need for revision. In this study, LKPD was designed using the Canva application, then made in PDF format and uploaded to the Heyzine Flipbook website. The use of Heyzine is suitable for learning because Heyzine Flipbook has moving animations, videos, photos and link effects in its design.(Hidayat et al., 2024).

The results of the practicality test obtained from the two teachers were teacher 1 with 98% with very practical qualifications and teacher 2 with 97% with very practical qualifications. The SSI electronic LKPD based on PBL was declared practical by the teacher as a teaching material that can facilitate students in the learning process. In line with the researchTrimunarti et al (2019)Each stage of the LKPD is designed to make students active, by presenting activity units that train students to find their own concepts from the teaching materials. Based on the results of the student readability test, the PBL-based SSI electronic LKPD achieved 82% with a very practical qualification. This shows that the PBL-based SSI electronic LKPD developed is interesting, easy to understand and can help the learning process, especially in the circulatory system material.

The effectiveness of using SSI electronic LKPD based on PBL is assessed based on the improvement of learning outcomes of problem solving skills and is assessed based on differences in data on improving student learning outcomes. LKPD is a means to help and facilitate teaching and learning activities so that effective interactions are formed between students and educators, can improve student learning activities and achievements.(Radeswandri et al., 2023). The effectiveness of PBL-based SSI electronic LKPD is facilitated by using tests with essay questions based on problem-solving skills.

The difference in learning outcome improvement data from pretest and posttest scores was analyzed using the N-Gain test to determine how much the learning outcome had improved. The N-Gain score results showed that there was a difference in pretest and posttest scores from 1 experimental class and 1 control class. With a high category, the average gain for the control class, where the control class did not use PBL-based SSI electronic LKPD, but still used the PBL model in the learning process and used SSI integrated questions. The experimental class used PBL-based SSI electronic LKPD which was integrated between PBL, SSI and problem-solving skills. The electronic LKPD was facilitated with videos and material summaries and journals, making it easier for students in the problem-solving process. This proves that the application of PBL-based SSI electronic LKPD is effective in improving

problem-solving skills, especially in the circulatory system material.

After the learning process took place, students were directed to fill out a questionnaire to determine the students' responses after using the PBL-based SSI electronic LKPD on the circulatory system material and the majority of students had responses in the good category. This can be seen in Table 9 which shows that the responses of class XI.1 students were in the good category, namely 56.95, very good, namely 17.36, and quite good, namely 2.78. There were no responses in the less and very less categories. This is because the application of the PBL model provides an opportunity for students to develop their own thinking and discuss problems of fish conservation efforts, so that students are motivated and have a strong curiosity in the learning process. According to Suprihatiningrum (2016), the application of the PBL learning model provides an opportunity for students to learn academic material and problem-solving skills by being involved in various real-life situations. This statement can be proven by the data that has been obtained. Students' responses to the student learning motivation indicator showed the highest average value of the other indicators, namely 30.56. As research conducted byArief & Sudin (2016)shows that the PBL model can improve students' learning motivation. Students' responses to the self-confidence indicator showed the lowest average value with a very good category.

The application of the PBL learning model with problem scenarios integrated with SSI can encourage students to express ideas or thoughts in solving a problem. This means that problem-solving skills can be improved by using PBL-based SSI electronic LKPD.Kirana and Arsih (2024)in his research stated that designing LKPD with social and scientific issues (Socio-Scientific Issues) integrated in it is one way to inspire students to actively seek solutions to the challenges faced. The application of SSI in science learning has many benefits, such as making science lessons more relevant in everyday life, increasing scientific literacy, increasing argumentation skills, and increasing students' abilities in evaluating problem information(Sadler & Zeidler, 2005).

## Conclusion

Electronic LKPD SSI based on PBL on the material of the circulatory system is suitable as a teaching material that can improve students' problem-solving abilities, this can be seen from the fulfillment of the aspects of validity, practicality and effectiveness: Validity from language experts 83% are very qualified, material experts 81% are very qualified, media experts 96% are very qualified, and learning device experts 83% are very qualified. Practicality based on the student readability test obtained results of 82% and teachers 97.5% with very practical qualifications. Effectiveness results obtained from class XI.1 of 0.83 and XI.2 of 0.75 with high criteria. Based on the research that has been obtained, there are 2 indicators of problem-solving skills with the highest value, namely problem solving of 2.9 and the lowest is indicator 4, namely re-checking the results of problem solving, which is 2.5 in the experimental class. In the control class, the 2 highest indicators were also obtained, namely the indicator of planning problem solving, which is 2.75 and the lowest indicator is indicator 1, namely understanding the problem, which is 2.4.

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