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Developing Physics Subject-Spesific Pedagogy on Problem Based Learning Model Assisted by E-learning to Enhance Student's Scientific Literacy Skill

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Abstract

This research aims to produce eligible physics Subject-Spesific Pedagogy (SSP) on Problem Based Learning (PBL) model assisted by e-learning and to know the effectiveness of physics SSP on PBL model assisted by e-learning in enhancing student's scientific literacy skill. The design of this research is research and development which refers to 4D model. Sampling technique used in this research is cluster random sampling to determine the experimental class and control class. The samples of this research were students in X grade at MAN 1 Yogyakarta. The total of students in each experimental and control classes are 30 students. The product of this research is physics SSP consisted of lesson plans and student's worksheet. The result of this research indicate that physics SSP on PBL Model is eligible to use in physics instruction based on judgement expert and learning completeness. Physics SSP on PBL Model was effective to enhance student's scientific literacy skill. The average value of pretest result of experment class was 5.41 and enhance to 7,03 with average gain 0,35 in medium category.

Keywords: Subject-Spesific Pedagogy (SSP); Problem Based Learning (PBL); e-learning; Scientific Literacy Skill.

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1. Introduction

The globalization in 21st century is very massive. This globalization makes technology developed and stimulus other area to develop. Asean Economic Society marked the globalization in Southeast Asia Country. Asean Economic Society makes the competition in Asean country increase in every area. This goes along with Pratiwi [30], She found that the competition in Southeast Asia will be more competitive in every line in the future.

People in Southeast Asia especially Indonesian people must have a good skill to adapt with globalization era. To face the competition in globalization era, every individual has to develop their own skills to survive in this era. Based on The Partnership of 21st Century Skills, those skills consist of scientific literacy, critical thinking, enviroment literacy, analytical thinking, interpreting, creativity, planing, etc. The best way to develop and enhance those skills is by education.

By education, students learn to prepare their readiness to face the competition in the real world. Based on Indonesian government, the goal of education in Indonesia is to prepare all students to live and compete in the global society. Through education, students can change their knowledge, attitude, skills and the most important is their character.

Kurikulum 2013 developed in Indonesia to adjust many skills so students will be ready to face globalization era. Based on [11], the instruction process in Kurikulum 2013 uses scientific approach. The students are trained to observe the problem, then analyze and solve the problem, and finnaly communicate their result in verbal or oral. The result of using this approach are students can develop their skill to think with reason, to process and to present it communicatively, collaboratively, and effectively.

Physics is a basic subject that can help students to understand and master in technology. To understand the concept, principle, and the laws of physics need a good physics instruction. Through a good physics instruction, students would be able to understand physics concepts and its relation. With a good understanding in physics knowledge students can face and solve the problems related to daily life. If students can solve their daily problem with their physics knowldge, their will be more ready to face the competition in global society.

The use of scientific knowledge especially physics knowldge in the daily life is related with scientific literacy. Scientific literacy skill is important skill that every individual should master it in 21st century. Scientific literacy facilitate the development of digital age literacy [41]. In the recent study, Fives and his colleagues [13] explained that there are 5 aspects in scientific literacy. Those aspects are, role of science, scientific thinking and doing, science and society, mathematics and science, science motivation and beliefs.

Scientific literacy of Indonesian students are still low [24]. It means that indonesian students solve their daily problems not by using their own science knowledge. Because of this result it can be cocluded that Indonesian students still not ready yet to compete with students from other country in the 21st century.

Recent study found that scientific literacy skills of Indonesian students is still low because of some meaningless instruction [24]. In spite of Indonesian government developed a good curriculum, the fact in field is different.

Many teacher still do not fully understand about the curriculum so they still teach directly. It makes the instruction meaningless and makes the students passive.

In Kurikulum 2013, Indonesian government suggest to used Problem Based Learning (PBL) in the instruction. PBL model focuses in the learning process. PBL model makes students more active to engage in the learning process. The use of PBL makes students face the problem directly and students actively solve the given problem [33,7,29]. Mayasari, Kadarohman, and Rusdiana [38] suggest PBL model to use in instruction process to prepare students to face globalization era. According to Tan [25], the syntax of PBL are: meeting the problem; problem analysis and learning issues; discovery and reporting; solution presentation and reflection; overview, integration, and evaluation.

The use of PBL in instruction process have many advantages. With discovery and reporting syntax, PBL model can make the instruction more meaningful. The meaningful learning process can enhance children's scientific literacy [5]. PBL can enhance student's learning outcome [8]. In other study, it is found that PBL can enhance many skills [26], such as: problem solving skill [9,16,18, 21,29], concept understanding [7], communicating skill [35], PBL also can reduce student's misconception [21].

Based on the result of school observation, it is known that there is a lack of time to study using scientific approach. This problem made teachers difficult to enhance student's scientific literacy. Pablos [26] discovered that the problem to use PBL is the lack of time and tools in the school. Solution for this problem is by integrating e-learning in the process of instruction [33]. E-learning can be done everywhere and everytime so it will reduce interaction time in the class [1,31]. E-learning stated here is especially about the use of Edmodo to increase the interaction between teachers and students inside or outside the class. The use of Edmodo can makes communication in instruction effective [2].

The integration of e-learning in PBL needs a relevant tool so that it can bear a maximum result. Reference [37] discovered that the fact is not every teacher used relevant tool in their instructions. It can be concluded that teacher needs a relevant instruction tools to use e-learning in PBL model. Instruction tool here must be able to educate students to maximize the process of PBL. That educate instruction tool is called SSP (Subject-specific Pedagogic).

Reference [17] discovered that SSP unites the contents of subject matters into one comprehensive and educative instruction tool. The instruction written in SSP focus on the topic and the process. SSP has to be developed so that it can be a match to PBL assisted by e-learning.

The development of SSP is based on Pedagogy Content Knowledge (PCK). PCK explain challenges faced by the teachers while teaching and also explain the strategy used by the teachers in learning situation. Reference [34] explained that PCK is a concept about how to teach physics, teachers must understand the content of physics matter (knowing science) and how to teach it (how to teach). In 21st century demand, teacher should pay attention in the integration of technology especially e-learning in instruction. The 21st century demand makes relation between PCK and technology become Technological Pedagogical Content Knowledge (TPACK)

[20]. TPACK became a main focuse in integration e-learning in the instruction [40]. The model of TPACK can be seen in Figure 1 below.

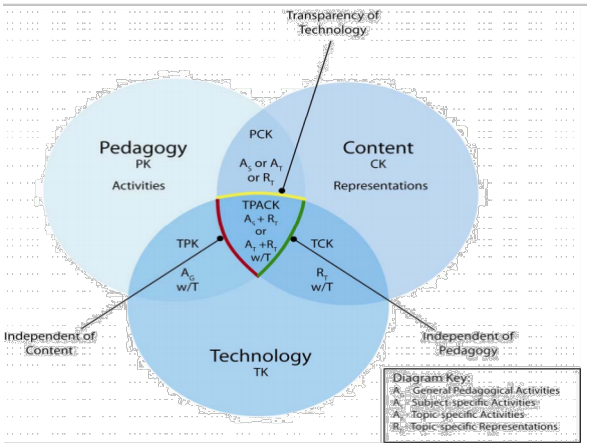

Figure 1: TPACK Model. [10]

The development of SSP based on TPACK would result a product of SSP. SSP as a product unites the contents of subject matters into a comprehensive instruction tool. This unity include the core of competencies, subject matters, strategy, method, media, and assessment. Based on [44], SSP as a product consist of: lesson plan, student worksheet, and assessment instrument.

2. Method

The method used in this research is 4 D Model by [39]. This 4 D Model method consist of 4 steps: define, design, develope, and disseminate. Quasi experiment method used in develop step along with pretest and posttest design. The objective is to produce eligible physics SSP on PBL model assisted by e-learning and to know the effectiveness of physics SSP on PBL model assisted by e-learning in enhancing student's scientific literacy skill. This study took place at MAN 1 Yogyakarta on January 2018. The samples of this research were students in X grade at MAN 1 Yogyakarta. The total of students in each experimental and control classes are 30 students. This research focus on Newton's Law of Motion subject matter. In the instruction, this research use PBL model assisted by e-learning on step meeting the problem, problem analysis and learning issues, and part of step discovery and reporting. The integration of e-learning in syntax PBL are listed in Table 1 below.

Table 1: The integration of e-learning in syntax PBL

Syntax	**Activity**
meeting the problem;	Online
problem analysis and learning issues;	Online
discovery and reporting,;	Online and interface
solution presentation and reflection;	Interface
overview, integration, and evaluation	Interface

Data in this research consist of the effectiveness of SSP data and scientific literacy skill data. The effectiveness of SSP data include the effectiveness of lesson plans and student's worksheet. The effectiveness of lesson plans is obtained using questionnaire of lesson plans and judgement expert. The effectiveness of student's worksheet data reviewed by judgement experts. Judgement experts consist of 3 lecturers, 2 physics teachers, and 2 friends in charge. The scientific literacy skill data is obtained from the result pretest-posttest.

Data analysis technique consists of descriptive and inferential analysis. Descriptive analysis used to evaluate the eligibility of SSP. In the descriptive analysis, the data explained based on average, standard deviation, maximum score, and minimum score. The data analyzed here is data which has been reviewed by judgement experts stated above and the result of pretest-posttest. After being analyzed, the result are divided into some criteria shown on Table 2 below [12].

Table 2: Criteria of Quantitative Score

Quantitative Score Range	Category
$\boldsymbol{X > \overline{Xi} + 1,8SBi}$	Very Good
$\boldsymbol{\overline{Xi} + 0,6\,SBi < X \leq \overline{Xi} + 1,8SBi}$	Good
$\boldsymbol{\overline{Xi} - 0,6\,SBi < X \leq \overline{Xi} + 0,6SBi}$	Fair
$\boldsymbol{\overline{Xi} - 1,8\,SBi < X \leq \overline{Xi} + 0,6SBi}$	Poor
$\boldsymbol{X \leq \overline{Xi} - 1,8SBi}$	Very Poor

The data of the result from lesson plans completeness obtained from 2 observers. Based on Pee [28] lesson plans completeness analyzes by IJA (Interjudge Agreement). An eligible lesson plans that can be used in the instruction has to reach 75% in the IJA score.

The improvement of scientific literacy skill of students can be seen from Standard Gain. Standard Gain can be obtained from the equation below.

$$\text{Std gain } (g) = \frac{\bar{X}_{posttest} - \bar{X}_{pretest}}{\bar{X} - \bar{X}_{pretest}}$$

With:

$\bar{X}_{posttest}$ = average score after instruction

$\bar{X}_{pretest}$ = average score before instruction

$\bar{X}$ = maximum score

Reference [23] categorized the index of Standard Gain as stated below.

$(g) \geq 0,7$: High

$0,7 > (g) \geq 0,3$: Medium

$(g) < 0,3$: Low

Meanwhile, in the inferential analysis, data elaborated based on independent sample t-test using SPSS 22 software. The data analyzed in inferential analysis are the standard gain data. Before the data analyzed using independent sample t-test, they were tested with prerequisite test. This prerequisite test consist of normality and homogenity test. After all the prerequisite test, the data are ready to be analyzed by using independent sample t-test.

The hypothesis for independent sample t-test are:

H0 : There is no significant effectiveness difference between the average of enhancement result in scientific literacy skill of students taught using developed SSP and students taught in conventional way.

Ha: There is significant effectiveness difference between the average of enhancement result in scientific literacy skill of students taught using developed SSP and students taught in conventional way.

Criteria that is used to conclude the hypothesis is H0 rejected and Ha approved if sig. (2 tailed) < α (0,05).

3. Result and Discussion

3.1 The Result of SSP

The analysis result of the completeness of lesson plans using IJA can be seen on Table 3 below.

Table 3: IJA score of Lesson Plans

Instructions	IJA Score (%)
1st Meeting	100
2nd Meeting	91
3rd Meeting	98
4th Meeting	96
5th Meeting	98
6th Meeting	100
Average	97

The analysis result of the completeness of lesson plan using IJA shows that in all meeting in the experiment class reach IJA score above 75%. The average score of IJA reaches 97% which means that the lesson plan is

eligible to be used in instruction based on the learning completeness.

The analysis result of lesson plan analysis from the expert judges can be seen in the Figure 2 below.

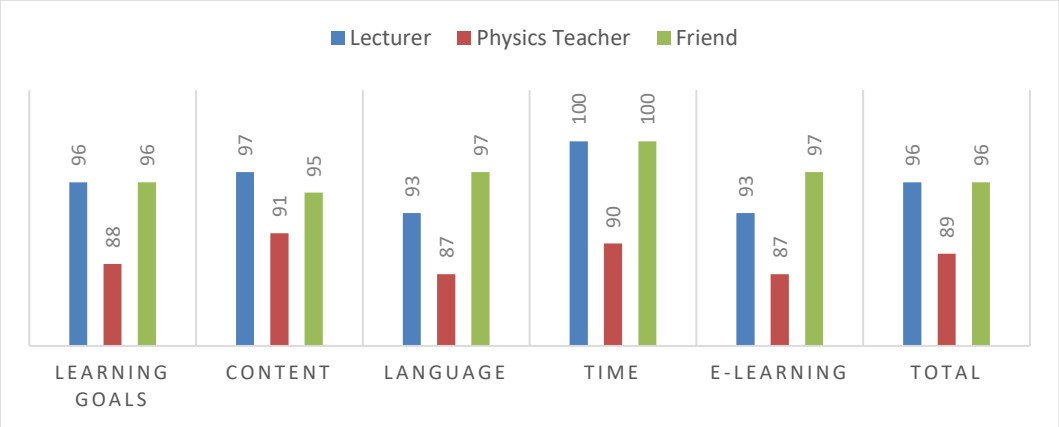

Figure 2: Judgement of Expert Judges on Lesson Plans

The result on Figure 2 shows that lesson plan is on very good category in all aspect based on all validators. This result also shows that the lesson plan is eligible to use in instruction based on the judgement expert.

The analysis result of student's worksheet analysis from the expert judges can be seen in the Figure 3 below.

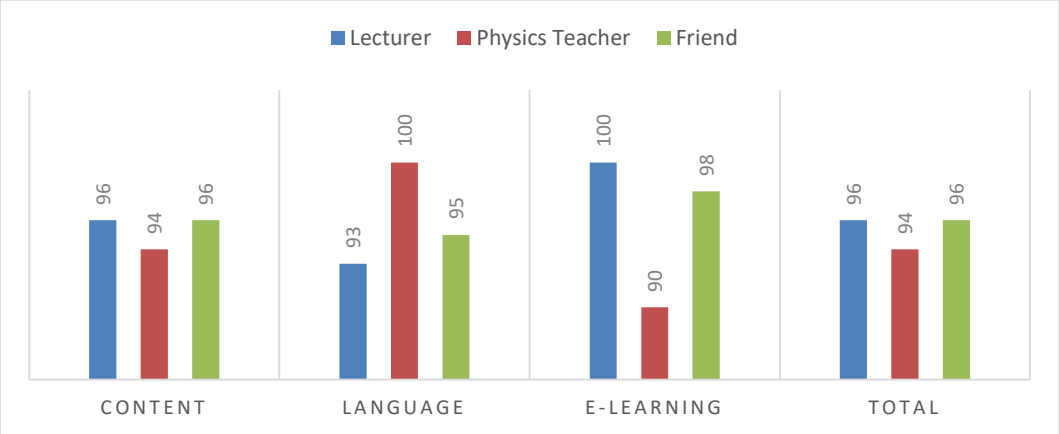

Figure 3: Judgement of Expert Judges on Student's Worksheet

The result on Figure 3 shows that student's worksheet is on very good category in all aspect based on all validators. This result also shows that the student's worksheet is eligible to use in instruction based on the judgement expert.

3.2 The Result of Student's Scientific Literacy Skills

Scientific literacy skills from the control class (X Science 2) shows in **Table 4** below.

Table 4: Scientific Literacy Skills from the Control Class

	Pretes t	Posttest
Maximum Score	6,22	6,76
Minimum Score	4,16	3,53
Deviation Standard	0,71	0,79
Average Score	5,21	5,79
Average Gain	0,11	
Category	Low	

Scientific literacy skills from the esperiment class (X Science 1) shows in **Table 5** below.

Table 5: Scientific Literacy Skills from the Experiment Class

	Pretest	Posttest
Maximum Score	6.56	7.90
Minimum Score	3.86	5.92
Deviation Standard	0.78	0.53
Average Score	5.41	7.03
Average Gain	0.35	
Category	Medium	

Inferential analysis used independent sample t-test to know the effectiveness of developed physics SSP in enhancing student's scientific literacy skills. This calculation was assisted by software SPSS 22. The significance degree in this analysis is $\alpha = 0,05$. From the analysis using independent sample t-test, it is shown that the score of the sig. is 0,000 which means there is significant effectiveness difference between the average of enhancement result in scientific literacy skill of students taught using developed SSP and students taught in conventional way.

3.3 Discussion

This research used PBL model assisted by e-learning on experiment class. The control class used cooperative model without the assist of e-learning. The use of PBL in this research is because on PBL model, students can be more active and PBL engage students to the instruction [7,29]. Furthermore, students should find physics concept by themselves to understand physics concept [36]. PBL model can provide it. As the result, students in PBL class seem to be more active on solving the problems given by the teacher than students in cooperative

class.

On the PBL model, students have to solve the problems given by group. This goes along with Benli and Sarikaya [3], they found that PBL could make students work together to solve the given problem. The given problems in this research are about Newton's Law in daily life. Newton's first law is presented with the problem of a man in pedicap. Newton's second law is presented with a safe distance problem between car in a highway. Newton's third law is presented with the problem from fisherman's speed boat.

The result shows that students using PBL model could enhance their communicating skills. This goes along with the finding about communicating skills by [35]. This is because students have to communicate or discuss the result they found about the problems in front of the class. Besides, students also could understand the concept better [7] and reduce the missconception [21]. This is because students have to find and learn the concept by themselves with the assist of the teacher.

The main problem faced by teacher when implementing PBL model is time. PBL model needs more time than the conventional instruction. This also stated by [19] who found out that teacher has a big problem about the lack of the study time in the class. Along with this, Ali and his colleagues [1] found that to slove the lack of the class time problem, teacher can integrate e-learning in their instruction. E-learning is one of the best way to develop PBL in the class [38]. In this research, the experiment class using e-learning could go well because the class wasn't distracted by the lack of time. Meanwhile, in control class, the instruction process was in a rush because of the lack of time to finish the subject matters.

Instruction process assisted by e-learning in experiment class made the students more motivated. This goes along with the statement from [43] and the finding by Wardono and his colleagues [42] about the use of e-learning can enhance student's motivation. Furthermore, e-learning can enhance student's cooperative skills [27]. E-learning system could also gives a good facility to enhancing communicating between teacher and student and also between students and students [4]. This is shown by student's enthusiasm in experiment class within the instruction process and the enhancement of their communication skills.

PBL model assisted by e-learning in this research consist of some characteristics. Rusman and his colleagues [32] stated that the caracteristic of e-learning are interactivity, indenpendency, accessibility, and enrichment.

Interactivity means that there is a good and various communication media in synchrounus like chatting, messengger, etc or in asynchrounus like forum, mailing list, etc. E-learning process in this research used Edmodo to facilitate chatting or messaging. This helped students to discuss the subject with their group or teacher, and this also proves the finding by [4]. In Edmodo, students could also comment on teacher's post.

Independency means that there is some flexibility in time, place, teacher, and subject matters. Edmodo here could be accesed anytime, everywhere, as long as there is internet connection. Edmodo could also be accesed with smartphone by installing Edmodo application, or with PC by using browser application.

Accessibility means that the source of subject matters are easier to access through the distribution in internet.

This is different with the conventional one since the conventional one needs a real book to distribute to each student. Edmodo facilitate an archived class where students able to share the documents for everyone in class. By using Edmodo, students can download student's worksheet free and easily. Moreover, student can also easily download the sources, refference book, and any other kind of source.

Enrichment is one of the instruction process, including presentation about subject matters and worksheets as enrichment tools. This process can maximize the use of technology such as video streaming, simulation, and animation. In this research, at PBL syntax meeting the problem, uploaded some illustrations in videos and pictures that can make the students meet the problem.

Edmodo as a media in e-learning instruction facilitate a notification in smartphone. This notification can give the students alert about the task or subject matters uploaded by the teacher. This made students have no reason to don't know wether there is a task or no. Moreover, Edmodo also facilitate the quiz with time arrangement. The quiz can take form in multiple choices or essay. The evaluation can also be done by the teacher easily.

This research develop a learning tool to facilitate e-learning in experiment class using PBL model. The learning tool stated before is Subject-specific Pedagogy (SSP). Reference [37] suggested to enhance the quality of physics instruction, teacher should develop SSP based on PCK. To respond with 21st century demand PCK must have a relation with technology became TPACK. SSP here is based on TPACK developed by [20]. This SSP could respond 21st century demand which pursue the use of technology. SSP consist of lesson plan and student's worksheet.

Developed lesson plans in this research is based on Permendikbud No. 22 Tahun 2016 (Kurikulum 2013). The component of lesson plans are: school identity, subject identity, class, subject matter, time allocation, learning goals, indicators, learning methods, media, learning source, learning steps/syntax, and evaluation. The component of lesson plans that developed in this research are: learning goals, indicators, learning steps/syntax. This development is based on PBL model asissted by e-learning. The goal of lesson plans development is to acomodate PBL model asissted by e-learning in physics instruction.

Developed student's worksheet in this research used by students to facilitate them to understand the concept of Newton's Law. Student's worksheet developed based on PBL model asissted by e-learning. On first, second, and a part of third syntax on PBL learning is done by e-learning and the other is by face to face. This developed student's worksheet facilitate e-learning and face to face instruction. Student's worksheet also developed based on scientific literacy skill indicators. The goal of development student's worksheet is to enhance student's scientific literacy skill.

Based on this research, for lesson plan, it is shown that the result of the completeness of lesson plan using IJA shows that in the experiment class reach IJA score above 75%. The average score of IJA reaches 97% which means that the lesson plan is eligible to be used in instruction based on the learning completeness. Meanwhile, the result from judgement expert shows that lesson plan is on very good category in all aspect based on all validators. This result also shows that the lesson plan is eligible to be used in instruction based on the judgement

expert. And as for the student's worksheet, the result based on judgement expert shows that student's worksheet is on very good category in all aspect based on all validators. This result also shows that the student's worksheet is eligible to use in instruction based on the judgement expert.

PBL model assisted by e-learning hopefully can enhance student's skills to face 21st century demand. One of those skills is scientific literacy which is needed in the 21st century [41]. Scientific literacy is very important for the students to solve their daily problems with their science knowledge. This is stated by Bybee and his colleagues [6] which scientific literacy is important for student not only for a dicipline concept but also can be applicated in the daily life to solve daily problem. The purpose of scientific literacy for students are: to identify questions, to get a new knowledge, to explain science phenomenom, to understand science, to make conclusion, and to know the connection between science and technology [14]. PBL model with investigation syntax can enhance student's scientific literacy skill, as [5] stated that investigation in the instruction enhance the meaning of the instruction and that enhance scientific literacy. To measure high school student's scientific literacy, the tool different with PISA has to be developed. Reference [15] discovered that PISA just evaluate scientific literacy for student under 15 years, so for Senior High School we need modoficate PISA. The tool in this research is based on indicators of scientific literacy stated by Fives and his colleagues [13].

The result also obtained from both the experiment and control class shows that there is some enhancement in student's learning result. This goes along with the statement from [8] that PBL model could enhance student's learning result. Furthermore, PBL model could also enhance student's scientific literacy skill. This is shown by some significant difference in independent sample t-test between students before the instruction and after the instruction with PBL model. Standard Gain score of experiment class is 0,35 in category medium which is higher than the control class with score 0,11 in category low. This shows that PBL model assisted by e-learning is better to improve the student's scientific literacy skill than cooperative model without the assist of e-learning.

The situation on experiment class is more condusive than in control class. Students in experiment class look more ready to attend the instruction than the control class. This is because they had learned the concept and the problem in e-learning session before meet in the classroom. Because the lack of the time, students in control class still do not fully understand about the concept. Based on the result and the theory, PBL model asissted by e-learning can enhance the effectiveness and efficiency of the instruction and also can enhance student's scientific literacy skill and analytical thinking skill.

4. Conclusion

Based on the analysis on the process during the control and experiment class, it can be concluded that physics SSP on PBL assisted by e-learning is eligible to be used in the instruction process. Developed physics SSP cosisted lesson plans and student's worksheet. Lesson plans is eligible to be used in instruction process, it is proved by the learning completeness and the judgement of the expert judges. The learning completeness result reached average IJA score 97%. Moreover, the judgement expert result for lesson plans reached very good category in all aspect based on all validators. Student's worksheet is eligible to be used in instruction process, it is proved by judgement expert result reached very good category in all aspect based on all validators. The result

of enhancement of student's literacy science skills shown by the result of gain test and independent sample t-test. The gain test shows score 0,35 on medium category. Independent sample t-test shows there is a significant effectiveness difference between the average of enhancement result in scientific literacy skill of students taught using developed SSP and students taught in conventional way.

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