Characteristics and practicality of problem-based project learning

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Characteristics and practicality of problem-based project learning to improve process and product performances of prospective physics teachers

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Abstract: This study aims to describe the characteristics and practicality of a problem-based project learning model to improve process performance and product performance of prospective physics teachers. The problem-based project learning (PBPL) model uses the design of the Plomp. The trial subjects are the PBPL model and the Unesa laboratory physics course students. The trial used a one-group pretest-posttest design. The data were collected using theoretical and empirical study sheets, observation sheets for the implementation of the Lecture Program Unit (LPU) PBPL Model, an instrument for student learning material readability assessment sheets, an instrument for Student Activity Sheet (SAS) readability assessment sheets, an instrument for observing field constraints during learning process. The data were analyzed descriptively by calculating the percentage and proportion then looking at the category group. Data analysis used quantitative descriptive statistics. The results showed: 1) The characteristics of the developed model have: syntax consisting of 5 steps, supported by a solid theoretical foundation, specific learning environment, and specific learning objectives. 2) The model developed is included in the practical category in terms of: (a) The implementation of the model with implemented criteria; (b) Students are active in learning physics using the PBPL model; (c) small and insurmountable learning constraints. It is concluded that the PBPL model developed has certain characteristics and is practical to improve process performance and product performance of prospective teachers.

1. Introduction

Prospective physics teachers should be given the opportunity to study the nature of science, to understand not only what they know from the product aspect but how the facts of knowledge are obtained rationally from the aspect of process and how to put it into practice as experts find it. Five important principles established by the National Society of Colleges of Teachers of Education as a guide when learning a skill are: (1) professionally serving laboratory facilities for observation and participation by prospective teachers, (2) conducting research and experimentation on growth and children's development in using learning materials and teaching procedures, (3) tests and demonstrations that pay attention to exercises in school, (4) enrichment programs for graduates, (5) leadership training for teachers through in-service training [1, 2].

The laboratory is very important as a vehicle for producing competent and professional teacher candidates in their fields. Knowledge and skills about laboratories in Physics Laboratory courses are important, so they must be managed in such a way that they can become a superior subject for physics education students because in addition to developing knowledge and skills about laboratories, they can also develop skills in designing tools and producing them. The Physics Laboratory course is an essential subject for Physics Education students who have a major role in supporting the performance of professional physics teacher candidates. The prerequisite for the student programming this course is to have attended Basic Physics I and Basic Physics II courses. This Physics Laboratory course, not only teaches basic knowledge of Physics but trains students to be skilled at assessing and solving problems in learning physics critically and analytically and being able to create products of physics tools that can be used in learning and research [3]. Students are equipped with knowledge about physics laboratory tools and their use, techniques for analyzing data from laboratory activities, skills in designing and managing laboratories, designing skills for practicum or experiments and designing physics tools that can be used to support learning and research activities [4].

Competency Standard 3 in this course: Applying the principles, concepts, and laws of physics in the form of prototypes of science and technology products that are relevant to the needs of society. Sub competency 3.1: Producing prototypes of science and technology products for strengthening and developing physics education. This prototype needs attention in lectures. Competency passing standard 7: Developing and managing a laboratory for school physics learning. Sub competency 7.3 Designing physics experiments for learning or research purposes also still needs to be improved. The competency bill must be accommodated and achieved through lectures. Designing a product and complete with operational practical instructions for practicum titles that do not yet exist need to be made by prospective physics teacher students [5].

Practical instructions or Student Activity Sheets which are the output of process performance in which contain Science Process Skills (SPS) with components: formulating problems, formulating hypotheses, identifying variables, defining variables, designing data tables, designing procedures, analyzing data, drawing conclusions, still low since 1982 until now [6, 7, 8, 9]. There are indications that if there is no treatment or intervention on student teacher candidates' SPS, Science Process Skills tend to be stagnant. The application of the Creative Responsibility Based Learning model was able to increase the average proportion of correct answers from 0.32 to 0.72 in the Physics education study program [9].

Problem Based Learning has been used successfully as an instructional strategy in higher education and some of its principles are effectively used in learning [10]. The results of PBL [11] research design on force and motion showed that there was no significant N-gain difference in knowledge between the experimental class and the control class, but there was a change in attitudes towards science. The project-based learning model was chosen in teaching science, because through a science project, especially physics, it becomes more interesting [12]. The focus of the project-based learning model is on the main concepts and principles of a discipline, involving students in problem-solving activities and other meaningful tasks, giving students the opportunity to work autonomously constructing their own learning, and ultimately producing student work products. [13].

To encourage prospective teachers to produce intellectual work either individually or in groups, it is advisable to use project-based learning which is in line with Permendikbud No. 66 of 2013 concerning Project-Based Assessment Standards. Project Based Learning (PjBL) uses projects as a medium. Students carry out exploration, assessment, interpretation, synthesis, and information to produce various forms of learning outcomes. PjBL, which uses problems as a first step in gathering and integrating new knowledge based on their experiences in real activities, is designed to be used on complex problems that students need to investigate and understand. Through PjBL, the inquiry process begins by raising a guiding question and guiding students in a collaborative project that integrates various subjects (materials) in the curriculum. When the question is answered, one can immediately see the main elements as well as the various principles in a problem that is being studied. PjBL is an in-depth investigation of a real world topic, this will be valuable for student attention and efforts. Given that each student has a different learning style, project-based learning provides an opportunity for students to explore material content using various ways that are meaningful to themselves, and conduct collaborative experiments.

The SPS survey at the Faculty of Mathematics and Natural Sciences Unesa of the 2014 undergraduate students of Biology, Physics and Chemistry has not reached 60. Not yet competent in planning and implementing experiments. There are indications they are experimenting with incorrect procedures. This indication is reinforced by the value of certain PPP aspects such as observation, variable manipulation, and variable control below 50. Even the variable control for the four generations is below 40 [14]. The low PPP value above is confirmed by international scale research that Indonesia is one level below Brazil and one level above Tunisia. Indonesia ranks 39th out of 40 countries in the world [9].

The Project Based Learning (PjBL) model combined with Problem Based Learning (PBL) was chosen to solve problems related to the lack of learning performance of prospective physics teachers because it can provide a learning experience that uses problem-solving activities through investigations and produces products such as those contained in syntax of PjBL and PBL. In connection with the above problems, it is necessary to develop a learning model that is combined between a process-oriented PBL with a product-oriented PjBL in the Physics Laboratory course which is expected to be able to improve the performance of prospective physics teachers.. The model developed is called Problem Based Project Learning, abbreviated as PBPL.

Based on the description on the background, the general problems to be answered through this study are: (1) What are the characteristics of the PBPL learning model to improve process performance and product performance of prospective physics teachers ?; (2) How is the practicality of the PBPL model developed to improve process performance and product performance of prospective physics teachers when applied? This second problem formulation can be described as follows: (a) How is the PBPL model developed when it is implemented ?; (b) How are the activities of the prospective physics teacher during the implementation of the developed PBPL model ?; (c) What obstacles were faced when the developed PBPL model was applied?

In general, this study aims to: (1) Find the characteristics of the PBPL model that can improve process performance and product performance. (2) Describe the practicality of the PBPL model that was developed when it was implemented. The objectives of this second study can be described as follows: (a) To describe the implementation of the PBPL model that was developed when applied. (b) To describe the activities of prospective teachers as long as the developed PBPL model is applied. (c) What obstacles were faced when the developed PBPL model was applied.

2. Research Methods

This type of research is a development research that produces a PBPL model product in the form of a learning syntax which consists of several phases [15]. The PBPL model development design went through three stages adapted from [16], namely: preliminary research, prototyping stage, and assessment phase. In this study, only two stages of development are reported to answer problems regarding the characteristics of the model and the practicality of the resulting model. Meanwhile, the assessment phase is an advanced development process to get a final prototype that is valid, practical and effective. The research subject is the PBPL model and its supporting devices. The research subjects for limited implementation were students of the Unesa Physics Education Study Program who program the Physics Laboratory course for the 2018/2019 academic year even semester. The instruments used to collect data used: Theoretical and Empirical Study Sheets, LPU-PBPL Model Implementation Observation Sheet, Student Learning Material Readability Assessment Sheet, SAS Readability Assessment Sheet, Field Obstacle Observation Sheet during learning activity. The data were analyzed descriptively by calculating the percentage or proportion then looking at the category groups.

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3. Results

3.1 Characteristics of the Problem Based Project Learning

The PBPL model was developed by conducting a needs analysis and context analysis for students majoring in physics, as well as reviewing relevant learning and research theories. The characteristics of the PBPL model developed refer to the four features of a model proposed by [17], namely: (1) it is designed to achieve certain learning outcomes, (2) has theoretical and empirical support, (3) has a syntax or learning steps, and (4) management of the learning environment necessary for learning outcomes to be achieved.

The first characteristic of the PBPL is that it is designed to achieve certain learning outcomes, namely: improving the process performance and product performance of prospective physics teacher students. The indicators of the two learning outcomes are presented in Table 1 below.

Table 1. Learning Outcomes Indicators with the PBPL Model

No	Learning outcomes	Indicator
1.	Process Performance: (Science Process Skills)	1. Formulate the problem; 2. Formulate a hypothesis; 3. Identify experimental variables; 4. Creating operational definitions of variables; 5. Designing the data table; 6. Designing experimental procedures; 7. Analyze data; 8. Make conclusions.
2.	Product Performance: Produce Practicum Instructions.	Practicum Instructions for practicing Science Process Skills 1. Formulate the problem; 2. Formulate a hypothesis; 3. Identify experimental variables; 4. Creating operational definitions of variables; 5. Designing the data table; 6. Designing experimental procedures; 7. Analyze data; 8. Make conclusions.
3	Product Performance: Produce Tool Kits According to practicum istructions	1. The suitability of the material with the real needs of the school; 2. The appropriateness of the equipment to conduct experiments on related materials; 3. Practicality in manipulating variables; 4. Accuracy in measuring data; 5. Practicality in recording data; 6. Product authenticity; 7. Product aesthetics; 8. Product safety.

(References: [18, 19, 20, 21]

The second characteristic of the PBPL Model is that it has theoretical and empirical support. The learning theory used as the basis for developing the PBPL model rests on cognitive and constructivist psychological theories: scaffolding, metacognitive skills. Problem solving theory of complex cognitive processes, divergent thinking to produce creative products. Cognitive learning theory information processing theory, advanced organizers. Ausubel's meaningful learning, Brunner's method of discovery. Empirical support that is used as a consideration in developing this PBPL model is a variety of relevant studies, namely: (1) [5] Recommending the implementation of integrated learning strategies to improve product and process performance for prospective physics teacher students. (2) Research [22] students can implement the PjBL model in the world of work and improve academic achievement. It is important to equip students with laboratory mastery skills in terms of tools and application [4]. (3) [12] shows that the activities that are built up among the project groups take place full of enthusiasm, enjoying the developed way of learning. (4) [23] recommend that project activities are suitable for use in physics learning at other materials and other educational levels. (5) [24] It is important to prepare prospective physics teachers to accommodate and master laboratory equipment and its functions and to use it in various types of experiments. (6) Research [25] collaborative problem solving can be trained to produce a product. (7) [26] giving creativity assignments can expand the reach of creativity, planning creative ideas needs to be realized in real learning and works in the form of real products. (8) recommending that creative products are limited to creative and imaginative ideas that need efforts to improve the quality and usefulness of creative products in real life [21, 27].

The third characteristic of the PBPL Model is that it has a specific syntax or learning steps. The PBPL Model syntax consists of 5 phases: (1) Essential Questions and Problem Orientation, (2) Project

Design and Schedule, (3) Monitoring Project and Student progress, (4) Developing and Presentation of Artifacts and Exhibits (5) Analysis and Evaluation.

The fourth characteristic of the PBPL Model is the management or management of a specific learning environment. The specific characteristics of the PBPL model in its management include: (1) The classroom environment is designed to support the construction of knowledge and skills. (2) Early learning settings to improve process performance and final learning settings to improve student product performance in Physics Laboratory learning. (3) Creating a democratic, open and positive learning atmosphere to develop problem-solving abilities and creativity in creating products. (4) The final product of the lesson is in the form of Practicum Instructions which contain Science Process Skills and Practical Equipment Set Products in accordance with the Practicum Instructions.

3.2 Practicality of the Problem Based Project Learning

The practicality of the PBPL Model is seen from the components of the PBPL Model implementation, student activities during the implementation of the model, and the constraints that arise in the implementation of the model.

3.2.1 Implementation of the PBPL Model

The implementation of the LPU Model PBPL is the achievement of the implementation of the model phases during the learning process. Several preparations were made before the learning process, including: (1) Studying the PBPL model and all LPU tools a few months earlier, (2) Discussing with observing lecturers to find an understanding of their respective roles in research, (3) Trying experimental activities in SAS uses the tools and materials or media provided.

Learning activities begin with a pretest, students take a process skills test. These process skills serve as initial provisions for students before participating in the learning process. The skills to formulate problems, formulate hypotheses, identify variables, make operational definitions of variables, design observational data tables, design experimental procedures, analyze data, and draw conclusions are carried out using SAS that have been declared valid and reliable by the validator. Face to face learning using LPU devices for 4 meetings. Researchers carry out learning in class physics education study program students who program physics laboratory courses and observers observe the implementation of LPU, student activities, and constraints in implementing learning. The learning ended with a posttest, then filled out a student response questionnaire, as well as in-depth interviews with several students to clarify the problems found. The learning implementation schedule is presented in Table 2 below.

Table 2. Schedule of Learning Implementation in class

No	Learning Activities	Time Allocation
1	Pretest and filling out the questionnaire	1 meeting (3 x 50 minutes)
2	Grounding of process skills	2 meetings (6 x 50 minutes)
3	Face to face learning	4 meetings (12 x 50 minutes)
4	Posttest and filling out a questionnaire	1 meeting (3 x 50 minutes)
5	Interview	Conditional (4 x 50 minutes)

The LPU implementation assessment was carried out by 2 observers using the LPU Model PBPL Implementation Instrument and the results are presented briefly in Table 3 below.

Table 3. Observation Results of LPU Model PBPL Implementation

Phase	**Face to face meeting**							
	1		**2**		**3**		**4**	
	$\overline{P}$	Inf	$\overline{P}$	Inf.	$\overline{P}$	Inf.	$\overline{P}$	Inf.
1. Essential Questions and Problem Orientation	3.63	VD	3.75	VD	3.75	VD	3.88	VD
2. Design Project Plans and Schedules	3.50	VD	3.00	D	4.00	VD	4.00	VD
3. Monitor Project and student Progress	3.60	VD	3.50	VD	3.70	VD	3.90	VD

4. Developing and Presenting the Work	3.50	VD	3.67	VD	3.17	D	3.33	VD
5. Analysis and Evaluation	3.67	VD	3.75	VD	3.92	VD	4.00	VD
Reliability level	**Reliable**		**Reliable**		**Reliable**		**Reliable**	

Information: VD = Very Done, D = Done, R = Reliable

Table 3 shows that the implementation of the PBPL model phases at face-to-face meetings 1 to 3 has the minimum criteria being implemented, while all the phases at face-to-face meetings 4 are highly implemented. Lecturers can carry out the phases of the model in the learning process as well. The reliability coefficient of the model phases at each meeting was above 75%, meaning that the results of the observations on the implementation of each LPU were in the reliable criteria.

3.2.2 Student Activities

Student activities describe the activities carried out by students during physics laboratory lectures using the PBPL model. The activities observed were adjusted to the planned learning steps in LPU. The results of observations of student activity on electric and magnetic materials are as in Table 4 below.

Table 4. Observation Results of student activities in the PBPL Model

Activity	Meeting							
	1		2		3		4	
	%	f	%	f	%	f	%	f
1. Essential Questions and Problem Orientation	4.51	6.5	4.51	6.5	6.60	9.5	7.29	10.5
2. Design Project Plans and Schedules	21.18	30.5	22.57	32.5	23.26	33.5	26.74	38.5
3. Monitor Project and student Progress	5.90	8.5	6.25	9	7.29	10.5	7.29	10.5
4. Developing and Presenting the Work	9.03	13	9.72	14	10.76	15.5	10.76	15.5
6. Students ask questions	32.29	46.5	30.90	44.5	28.82	41.5	29.17	42
7. Irrelevant Behavior	20.49	29.5	19.10	27.5	15.28	22	15.97	23
Reliability level	**Reliable**		**Reliable**		**Reliable**		**Reliable**	

Information: f = frequency, % = percentase

Table 4 explains in general that student activities that are relevant to the PBPL model at the time of implementation increase in each meeting and can be said to be good. The reliability of the results of the student activity observations is classified as reliable. Problem orientation activities, project design, project progress, develop work results, evaluate experiences have improved. Student activity asks the lecturer when difficulties and irrelevant behavior has decreased during implementation in class.

3.2.3 Constraints to the Implementation of the PBPL

Obstacles to the implementation of the Problem Based Project Learning (PBPL) model along with alternative solutions were observed by 2 observers and are briefly presented in Table 5 below.

Table 5. Constraints to Learning Implementation in Limited Trials

Agenda	Types of Constraints	Alternative Solutions
SAS-SPS foundation	1.Some students still have difficulty using SPS	1. Lecturers provide additional training on SPS that will be used.
	2.Time is over 21 minutes	2. Orderly time.
Magnetic Electricity Material 1	1.Students are not familiar with the PBPL model and learning activities in the laboratory, problem solving.	1. Briefing and information to the PBPL model in the hope that it will be easier to follow the lessons
	2.Time is over 24 minutes.	2. Pay attention to time.

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Magnetic Electricity Material 2	1. Observers find it difficult to evaluate each participant because participants in the group miss their numbers and in a certain position make closed numbers. 2. Students who ask or argue during the presentation are still few.	1. Students do group work in a sequential seat according to the number of participants 2. Remind students of the importance of asking questions or having an opinion in the presentation.
Magnetic Electricity Matter 3	1. There are some students who have not been able to optimally make experi-mental designs in their groups because they are still weak in process skills; 2.Time is over 15'	1. The lecturer provides direction and Additional problem-solving information associated with the design of the tool that will be made by each group; 2. Order the time.
Magnetic Electricity Matter 4	1.The design of the tool cannot be used optimally, so it confiscates explanations from the lecturer and disturbs several other groups. 2.Time is over 19 minutes	1. Instructions by the lecturer on problem groups and all groups to cooperate more in completing the design of the tool according to the instructions made; 2. Order Time

Table 5 shows that the implementation of learning with the PBPL model at the beginning of the meeting experienced several technical and non-technical obstacles that could be resolved at the end of the meeting.

4. Conclusion

This development research resulted in a research product in the form of a Problem Based Project Learning (PBPL) model and its practical supporting tools to improve the process performance and product performance of prospective physics teacher students, the results showed that:

1. The characteristics of the Problem Project Learning model developed are as follows.
    a. This learning model is specifically designed to improve process performance and product performance of prospective physics teacher students.
    b. Supporting learning theories are schema theory, self-determination theory, Piaget's theory of cognitive development, constructivist theory, Vygotsky's theory of cognitive development, meaningful learning from Ausubel, Scaffolding from Brunner.
    c. The syntax of this PBPL model is: (1) Essential Questions and Problem Orientation, (2) Designing Project Plans and Schedules, (3) Monitoring Project and Student Progress, (4) Developing and Presentation of Artifacts and Exhibits (5) Analysis and Evaluation of Problem Solving and Experience.
    d. This learning model requires the management of a specific learning environment, namely: (1) The classroom environment is designed to support the construction of knowledge and skills, (2) Initial learning settings to improve process performance and final learning settings to improve product performance, (3) Creating a learning atmosphere that is democratic, open and positive to develop problem solving abilities and creativity to create products. (4) The final product of the lesson is in the form of Practicum Instructions and Practicum Equipment Kits in accordance with the Practicum Instructions
2. The PBPL model that was developed was practical, because the results of the observation of the implementation of the meeting model phases had the criteria being implemented, student activities were good and various obstacles during the implementation of learning could be overcome.

References

[1] Dwikoranto, Munasir, R Setiani, Suyidno, W A Surasmi, S Tresnaningsih, and Pramonoadi. (2020). Effectiveness of Project Based Laboratory Learning to Increase Student's Science Process Skills and Creativity. *Journal of Physics: Conference Series*. **1491** (2020) 012006 doi:10.1088/1742-6596/1491/1/012006

[2] Suyidno, Susilowati, E., Afiruddin, M., Misbah, Sunarti, T., & Dwikoranto. (2019). Increasing Students' Responsibility and Scientific Creativity through Creative Responsibility Based Learning. *Jurnal Penelitian Fisika dan Aplikasinya (JPFA)* Volume 09, Issue 02, December 2019. p-ISSN: 2087-9946. doi: 10.26740/jpfa.v9n2.p178-188 e-ISSN: 2477-1775 https://jpfa.unesa.ac.id
[3] Universitas Negeri Surabaya. (2014). *Buku Pedoman Unesa 2014-2015*. Surabaya: Upres.
[4] Dwikoranto, Surasmi, W. A, Suparto, A., Tresnaningsih, S., Sambada, D., Setyowati, T., Faqih, A., & Setiani, R. (2018). Designing Laboratory Activities In Elementary School Oriented To Scientific Approach For Teachers SD-Kreatif Bojonegoro. IOP Conf.Series: *Journal of Physics: Conference Series*. 997 (2018) 012041 doi:10.1088/1742-6596/997/1/012041
[5] Anifah, Lilik., Nurkholis, Dwikoranto. (2015). *Pengembangan Disain Pembelajaran untuk Meningkatkan Kinerja Calon Guru Fisika*. Laporan Hibah IDB PUPT. Surabaya: Unesa.
[6] Nur, M. (2011). *Modul keterampilan-keterampilan proses sains*. Surabaya: PSMS Unesa.
[7] Nur, M. (2008). *Pembelajaran berbasis masalah*. Surabaya: Unipres Unesa.
[8] Prahani, B. K., Nur, M., & Yuanita, L. (2016c). Model *group science learning* untuk meningkatkan keterampilan pemecahan masalah kolaboratif, keterampilan proses sains, dan kepercayaan diri siswa SMA. *Laporan Seminar Hasil*. Surabaya: Unesa.
[9] Suyidno, Nur, M., & Yuanita, L. (2017). *Model Responsibility and Scientific Creativity Based Learning (RSCBL) untuk meningkatkan kreativitas ilmiah dan tanggung jawab mahasiswa*. Disertasi pada Program Pasca Sarjana Unesa, Surabaya: Tidak Dipublikasikan
[10] Savery, J. R. & Duffy, T. M. (2001). *Problem Based Learning:* An instructional model and its constructivist framework. Rep. No. 16-20.
[11] Akinogu & Ozkardes Tandagon. (2007). *The effects of problem based active learning in Science education student's achievement, attitude and concept learning.* Eurasia Journal of Mathematics Science and Technology Education. 3(1) 71-81.
[12] Rais. M. (2010). *Pengembangan model Project Based Learning: Suatu Upaya Meningkatkan kecakapan Akademik Mahasiswa Jurusan Teknik Mesin UNM*. Laporan Penelitian Tahun II DP2M DIKTI-LEMLIT UNM.
[13] Kamdi, W.(2008). *Project Based Learning: Pendekatan Pembelajaran Inovatif. Makalah.* Disampaikan Dalam Pelatihan Penyusunan Bahan Ajar Guru SMP Dan SMA Kota Tarakan, 31 Oktober-2 November 2008. Tersedia Pada www.Snapdrive.Net/Files/571708/PBL-Teoretik-Tarakan.Doc. Diakses Pada 12 Desember 2012.
[14] Sudibyo, E. (2015). *Model Pembelajaran Untuk Menumbuhkan Motivasi Belajar, Meningkatkan pemahaman Konsep Fisika dan Keterampilan Berfikir Analitis Mahasiswa Ilmu Keolahragaan*. Disertasi tidak diterbitkan. Surabaya: Pasca Sarjana Unesa.
[15] Nieveen, N., McKenney, S., & van. Akker. (2007). "*Educational design research*" dalam *educational design research*. New York: Routledge.
[16] Plomp, T & Nieveen, N. (2010). *An Introduction to Educational Design Research*. Netherlands: Netzodruk, Enschede.
[17] Arends, Richard. L. (2012). *Learning to Teach*. *9 th edition*. New York: Mc. Graw-Hill Book Corporation.
[18] Chang, C. Y. (2008). *Does Problem Solving*. Prior Knowledge Reasoning Skill in Earth Science. An Exploratory Study. Per Sei Educ (2010) 40:103-116 Published on line: 4 Oct 2008.
[19] H N Hidaayatullaah, Dwikoranto, N Suprapto, H Mubarok, and D Wulandari. (2020). Implementation of Problem Based Learning to Train Physics Students' Problem Solving Skills. *Journal of Physics: Conference Series*. **1491** (2020) 012053 doi:10.1088/1742-6596/1491/1/012053
[20] Zeidan, A. H. & Jayosi, M. R. (2015). Science process skills and attitudes toward science among Palestinian secondary school students. *World Journal of Education*, *5* (1), 13-24.
[21] Dwikoranto, Madlazim, Erman. (2019). Project Based Laboratory Learning As An Alternative Learning Model To Improve Sciences Process Skills And Creativity Of Physic Teacher

Candidate. *Journal of Physics: Conference Series* 1387 012074. doi:10.1088/1742-6596/1387/1/012074

[22] Kohl, P.B. & Noah, D.F. (2006). Effect of representational on students solving physics problem: A fine-grained characterization. *Physical review special topics-Physics education research*, *2* (1), 1-8.

[23] Wibowo, F.C. & Suhandi, A. (2013). Penerapan model Science Creative Learning (SCL) fisika berbasis proyek untuk meningkatkan hasil belajar kognitif dan keterampilan berpikir kreatif. *Jurnal Pendidikan IPA Indonesia,* 2(1), 67-75.

[24] Mercier, E. & Higgins, S. (2014). Creating joint representations of collaborative problem solving with multitouch technology. *Journal of Computer Assisted Learning*, *30* (6), 497-510.

[25] DeWitt, D., Siraj, S., & Alias, N. (2014). Collaborative mlearning: A module for learning secondary school science. *Educational Technology & Society*, *17* (1), 89-101.

[26] Rotteram,K.(2014).Teaching, learning and creativity model for science.*SSR, 95*(1),79-84.

[27] Suyidno, Nur, M., & Yuanita, L. (2016). *Makalah seminar hasil penelitian: Pengembangan model Responsibility and Scientific Creativity Based Learning (RSCBL) untuk meningkatkan kreativitas ilmiah dan tanggung jawab mahasiswa*. PPS Unesa, Tidak Dipublikasikan.

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