

# Validity of Project Based Laboratory Learning: An Innovative Physics Laboratory Learning to prepare Sciences Process Skills and Creativity of Physics Teacher Candidate

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**Abstract**— The purpose of this study was to describe the validity of the project based laboratory learning (PjBLL) model to increase science process skills and scientific creativity of students. Collecting data use preliminary research and validation phase of physics learning expert in the focus group discussion. Data were analyzed using descriptive qualitative and quantitative. The tests have shown that there is conformance to requirements, design models meet the novelty scientific knowledge, and there is consistency between the components of internal models. The PjBLL model has valid can be used to improve the science process skills and scientific creativity of students. The PjBLL model has been able to support the implementation of the National Qualifications Framework Indonesia to results the competence of graduates of higher education of project based laboratory learning.

**Keywords**—Sciences process skills, creativity, physics teacher candidate, project based laboratory learning

## I. INTRODUCTION

Learning physics means learning facts, principles, concepts, theories, laws and skills, as well as fostering a sense of curiosity and developing creativity [1]. Physics laboratories include essential courses for Surabaya State University physics education students who have a large role in supporting the performance of professional physics teacher candidates, training students to skillfully study and solve problems in physics learning critically and analytically and able to create physical equipment products that can be used in learning or research [2].

Learning in physics laboratories must be able to facilitate the development of student competencies as candidates for professional and independent physics teachers in facing future challenges [3,4], initiative, personality, and independence in finding and finding knowledge. When process skills are accustomed and creativity is developed in the learning process, students are considered to foster creative thinking as a key element for personality development and effective learning. Students are equipped with the ability to solve real life problems [5] adapt to new demands and new opportunities [2] as well as scientific discoveries and technological innovations [7]. Thus, habituation of creativity and process development skills for physics teacher candidates as a key element to provide success in their lives and careers and their students in the future.

The success of physics laboratory courses can be measured based on two important aspects of process and product skills of creativity. When quality process skills, students will be able to perform quality scientific processes and quality scientific processes will be able to produce creative and useful products [8]. The learning process is able to provide meaningful experiences for students to confirm the material they have learned [9]. In line with the S1 level qualification standard that physics education students are able to apply the field of expertise and utilize science and technology in their fields in solving problems and adapting to the situation at hand [10]. The KKNi Unesa Physics Education Department also stipulates that the standards of physics education graduates' competencies include: (1) mastery of the material, structure, competence, physics concepts and their application in technology; (2) the application of principles, concepts and laws of physics in the form of prototypes of science and technology products that are relevant to the needs of the community; and (3) able to utilize information and communication technology to strengthen and disseminate scientific products of physics [11].

The effort to print student competencies as qualified physics teacher candidates is still a major problem in the world of education in Indonesia [12]. The learning process that is still product oriented and memorized makes the process and development skills of creativity still tend to be ignored [13]. Survey results found that the process skills of undergraduate students of Biology, Physics and Chemistry FMIPA Unesa 2014 have not reached 60; because they are less competent in planning and carrying out experiments with procedures that are not correct [14]. The value of certain aspects of process skills such as observation, manipulating variables, and controlling variables is still under 50. In addition, the product of creativity produced by students is still limited to creative and imaginative ideas, so it is necessary to improve the quality and usefulness of creative products in real life [15]. The practicum guide or Student Activity Sheet as a creative student product which contains process skills (formulating problems, formulating hypotheses, identifying variables, defining operationalization variables, designing data tables, designing procedures, analyzing data, drawing conclusions) is still low since 1982 until now [16,31,15,32]. This is consistent with the results of the researchers' preliminary study that there are still problems with students in completing the tasks of physics laboratory courses; among others: (1) lack of basic concepts

and basic skills in laboratory materials, (2) skills to identify laboratory problems in physics learning and engineering solutions are not appropriate, (3) the design of tools produced by students has not been able to meet the standards of science teaching aids, and (4) equipment design made by students cannot be operationalized for practicum activities complete with instructions [19]. Thus, there are indications that if there is no treatment or intervention on the process skills and creativity of physics teacher candidates, their process skills and creativity tend to stagnate.

Various efforts have been made to maximize the role of physics laboratory courses to encourage students to produce both individual and group contextual work by applying Problem Based Learning (PBL) and Project Based Learning (PjBL). PBL is able to improve the learning achievement of physics teacher candidates and enable them to educate students in work teams and high research abilities [20]. PBL is able to improve students' ability to understand physical phenomena, share knowledge, conduct research, solve various problems [21]. Primary and secondary school science teachers recognize the importance of PBL as an inquiry approach that helps them explain the essential aspects of science [22]. PBL application for physics teacher candidates is faced with real problems and is expected to be able to use and develop the basic abilities of PBL that are owned and can use various strategies to solve problems faced. Students can solve authentic problems, construct their own knowledge, develop inquiry and high-level thinking skills, develop independence and confidence [23].

PjBL is to help students carry out exploration, assessment, interpretation, synthesis, and information to produce creative products. PjBL uses the problem as a first step in gathering and integrating new knowledge based on its experience in activities that are actually designed to be used in complex problems that students need to investigate and understand it. Through PBL and PjBL, the investigation process begins by raising guiding questions and guiding students in a collaborative project that integrates various subjects in the curriculum.

The application of PBL and PjBL in physics laboratory courses emphasizes the activities of active participation, collaborative work, and authentic assessment. Both models use a real-world problem approach as a context for students to learn about creativity and problem solving, and to acquire essential knowledge from subject matter, intellectual skills and learn to be autonomous students. Both are designed to stimulate high-level thinking in problem-oriented situations. PBL encourages students' competencies in formulating problems, collecting data, and analyzing data (related to the diagnosis of the need for equipment in the laboratory and instructions); while PjBL encourages student competency in the design process: formulating work, designing tools, calculating, carrying out work, and evaluating results. Considering the two competencies are the instructional objectives of laboratory subjects; therefore it is necessary to develop innovative learning as improvements to PBL and PjBL in maximizing the role of process skills as basic skills in physics laboratory courses and developing creativity as key elements for printing creative and useful physics products.

The innovative learning model of Project Based Laboratory Learning (PjBLL) as an improvement of PBL and PjBL models in physics laboratory courses in which aspects of process skills and creativity are characteristic of the PjBLL model. The phase design of the PjBLL model begins with motivating student independence in the project, organizing student needs in the project, guiding group project investigations, monitoring student creativity in developing projects, presenting and assessing creative products, then ending evaluation and reflection. The design of PjBLL as an innovation PBL and PjBL in physics laboratory courses, especially in phases 3 and 4. Phase 3 is in PBL but not in PjBL; where the lecturer accustoms students to using process skills as basic skills to plan and complete project tasks, review and discuss examples of creative products as insight for students when designing their project tasks. Conversely, phase 4 is in PjBL but not in PBL; where students are facilitated to develop their creativity and independence in completing project tasks according to selected topics, conducting group consultations and discussions to produce creative and useful products. Thus, the PjBLL model syntax design is complementary between the syntax of PBL and PjBL models in physics laboratory subjects.

The main objective of this research is to describe the validity of the PjBLL model and its tools that have been developed to improve the process skills and creativity of physics teacher prospective students in terms of the validity of the content and constructs of models and supporting devices.

## II. RESEARCH METHOD

This study uses educational research design to develop problem-based solutions to research in solving complex problems in the field of education [24]. Model development is equipped with supporting tools in the form of Semester Lecture Plans (RPS) and the Physics Laboratory Practicum Handbook (PPLF), PjBLL Model Validation Sheet along with its Supporting Devices to explore the validity data of the developed model. The stages of developing the PjBLL model and its supporting devices are adapted from Model Plomp [24] which is divided into three main stages, namely preliminary research, stage prototype, and assessment phase. The procedure for developing the PjBLL model carried out by the researcher will be described until the stage of the prototype stage.

### A. Preliminary Research

Used to find out the basic problems needed in the development of the PjBLL model along with the supporting devices carried out through: (a) Literature study; analyzing model development needs by reviewing various literatures on challenges and demands of 21st century competencies, Republic of Indonesia Presidential Regulation Number 8 of 2012 concerning IQF, Permendikbud Number 73 of 2013 concerning Implementation of IQF in Higher Education, Permendikbud Number 49 of 2014 concerning National Standards for Higher Education, learning theories and Plomp's [24] model development theory so that a description of learning patterns is considered ideal. (b) Analysis of the

context to be taught using the PjBLL model is done through: (1) analysis of the material, selecting and defining, detailing and systematically composing relevant physics teaching materials, (2) analyzing tasks, identifying key competencies in the curriculum emphasized development of learning outcomes, especially process skills and creativity, then analyzing them on a framework of academic sub-skills that will be developed in learning, and (3) competency specifications, converting competencies from material analysis, and task analysis into basic competencies to be achieved. (c) Field studies on learning problems in physics laboratory courses, analyzed the characteristics of mastering process skills and student creativity. Students in cognitive analysis are assumed to have entered the formal operational development stage. (d) Develop a conceptual and theoretical framework for research that will be the basis for conducting research.

### B. Prototype Stage

The design process is carried out cyclically in the form of a more micro-research process and uses formative evaluation to improve and improve the intervention model [27] carried out by: (a) Design of a prototype; using a qualitative research approach to produce the Draft Model of PjBLL and its Supporting Devices, and Research Instruments. Draft Design of the PjBLL Model adapts the learning model format developed by Arends [23] to include a model overview, theoretical and empirical support, syntax, planning and implementing learning, learning environment, assessment and evaluation. Learning device design as a form of operational model in learning physics laboratory courses includes the Semester Lecture Plan (RPS) and the Physics Laboratory Practicum Handbook (PPLF). Designing Research Instruments as a means of gathering information about the validity of the PjBLL model and the supporting tools developed. Realization of the prototype design in the form of a product called Prototype I. (b) Prototype validation. Prototype I was reviewed by researchers and supervisors to find out the adequacy of the supporting theories of the model and its application to each component of the model so that its validity was tested by experts and practitioners in terms of theoretical rationales and consistency of construction. The average score of third assessment validator result is adapted to the validity criteria in Table 1.

TABLE I. VALIDITY CRITERIA OF MODEL PjBLL[29]

Score Interval	Assessment Criteria	Information
$3.25 \leq P < 4.00$	Very Valid	Can be used without revision
$2.50 \leq P < 3.25$	Valid	Can be used with little revision
$1.75 \leq P < 2.50$	Less valid	Can be used many revision
$1.00 \leq P < 1.75$	Not valid	Not to be used and still require consultation

Reliability of the assessment of the validity of the model and its tools is calculated using the percentage of agreement formula [30]. The reliability of the PjBLL model's performance observations is calculated using the percentage of agreement formula. Observation results are said to be reliable if the reliability value is  $\geq 75\%$ . Calculation of reliability of

the instrument is also reinforced by the analysis of Cronbach's Alpha [30].

## III. RESULTS AND DISCUSSION

### A. Project Based Laboratory Learning (PjBLL)

The innovative learning model of Project Based Laboratory Learning (PjBLL) as an improvement of PBL and PjBL models in physics laboratory courses in which aspects of process skills and creativity are characteristic of the PjBLL model. Model development uses cognitive learning theory, cognitive complex process theory (divergent and problem solving thinking), sociocognitive theory and constructivism (attention, retention, production, motivation, and scaffolding), various relevant researches, and Plomp's [26] model development theory. The results of the developed Sintak can be seen in Table 2.

TABLE II. SYNTAX OF PjBLL HYPOTHETIC MODEL

Syntax	Lecturer Activity	Student Activity
1. Motivate student independence in the project	a. Convey learning objectives b. Motivate students to try creatively and independently in the project activities that will be carried out	Listen carefully to the lecturer's explanation of learning and motivation goals; and realize the importance of being creative and independent in the project activities that will be carried out
2. Organizing student needs in the project	Organize project needs related to group tasks, topic selection, project schedule, and project logistics.	Organize project needs related to group tasks, topic selection, project schedule, and project logistics.
3. Guiding project investigations in groups	c. Guiding group discussion to understand KPS as a basic skill in the project d. Guiding students in reviewing and discussing examples of creative products.	Actively participate in group discussions to understand process skills as basic skills in project work; review and discuss examples of creative products (props and technical instructions).
4. Monitor student creativity in developing projects	a. Facilitating the development of students' creativity and independence in completing project assignments according to the chosen topic. b. Facilitates group consultation and discussion so that creative products are produced.	Actively participate in group discussions and consultations in exploring creative ideas to best solve selected project tasks.
5. Presenting and assessing creative products	a. Guiding students to present and present their creative products in front of the class. b. Provide an assessment and input to improve student creative products within the allotted time.	Trying to present and present their creative products in front of the class, then revise the product based on input from the lecturer in the allotted time.
6. Evaluation and reflection of experience	Guiding students to evaluate and reflect on their project experience during learning and follow-up.	Actively participate in evaluation and reflection activities regarding their project experience and follow-up.

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

### B. Validations Result of PjBLLs

The validity of the PjBLL model illustrates the quality of innovative learning models that are developed in terms of fulfilling content validity with regard to needs, up-to-date and construct validity or consistency.

#### Contents Validation Results of the PjBLL Model

Summary of validation results The contents of the model provided by three physics learning experts can be seen in Table 3.

TABLE III. CONTENTS VALIDITY OF THE PjBLL MODEL

Assessment Aspect		Validity		Reliability	
		avg	info	R (%)	info
Model development needs	a. The need for 21st century competence	3.00	V	100	Rel.
	b. The need for KKNi demands in the PT sector is primarily the use of scientific approaches and the development of creativity	3.33	SV	86	Rel.
	c. a. Needs to overcome problems in physics lab courses	3.67	SV	86	Rel.
	d. Improvement innovations from PBL and PjBL in physics laboratory courses	3.33	SV	86	Rel.
Update	a. Development of model goals	4.00	SV	100	Rel.
	b. Use of theoretical foundation	3.67	SV	86	Rel.
	c. Use of an empirical foundation	3.33	SV	86	Rel.
	d. Use of an empirical foundation	3.33	SV	86	Rel.
	e. Development of a learning environment	3.33	SV	86	Rel.
	f. Assessment and evaluation development	3.00	V	100	Rel.

Description: V = Valid, SV = Very Valid, R = Coefficient of inter-observer agreement, Rel.=reliable

Table 3. shows the results of the validation of the content of the model in terms of the need for 21st century competencies and the latest development of assessment and evaluation in valid criteria; and the need for KKNi demands in the PT, the need to overcome problems in physics laboratory courses, and the up-to-date in the development of internal model components (the purpose of the model, theoretical foundation, empirical foundation, syntax, learning environment) in very valid criteria. This indicates that the PjBLL model developed is able to equip graduate students' competencies in physics laboratory courses that are suitable for 21st century skills (critical, creative, collaborative, communicative) and the demands of the Higher Education KKNi especially meet the content standards and process standards related to the approach scientific and creativity development in the learning process. In addition, it also

addresses the problems in physics laboratory courses to increase students' creativity in developing products of physics teaching aids along with their technical instructions. The updated PjBLL model can be seen from the more recent international journal references and other major reference sources. All aspects of validity that were assessed all got  $p \geq 3.00$  above the limit of  $p$  part 2.50 and some were at  $p \geq 3.25$ , so the model developed was valid and very valid.

Other than that; The reliability coefficient of all aspects of the assessment of model content validity is above 75%, so the results of the validation of physics learning experts using the instrument content validity of the PjBLL model in high reliability criteria and excellent reliability with Cronbach's Alpha reliability ( $\alpha$ )  $\geq 0.70$  for all aspects developed.

#### Construction Validation Results of the PjBLL Model

A summary of the construct validation results of the model provided by three physics learning experts can be seen in Table 4.

TABLE IV. CONSTRUCT VALIDITY OF THE MODEL PjBLL

Assessment Aspect		Validity		Reliability	
		avg	Inf.	R (%)	Inf.
Purpose of the model	Consistency of the objectives of the PjBLL model with the objectives of the physics lab course, the core competence of the IQF / 21st century, the novelty of the PjBLL model compared to PBL and PjBL, and the supporting theoretical basis	3.33	SV	86	Rel.
Theoretical and empirical support	Consistency between the supporting theory and the PjBLL model component	3.00	V	100	Rel.
Syntax	Consistency between phases, activities of lecturers and students, achievement of learning outcomes, and supporting theoretical basis	3.33	SV	86	Rel.
Learning planning	Consistency of learning plans with learning objectives, syntax, learning environment, assessment and evaluation	3.33	SV	86	Rel.
Implementation of learning	Consistency in the implementation of learning with syntax, learning environment, and learning outcomes	3.33	SV	86	Rel.
Learning environment	Consistency between learning atmosphere, supporting theory, and learning outcomes	3.33	SV	86	Rel.
Assessment and evaluation	Consistency between assessment, evaluation, supporting theory, and learning outcomes	3.67	SV	86	Rel.

Description: V Consistency between assessment, evaluation, supporting theory, and learning outcomes = Valid, SV = Very Valid, R = Coefficient of inter-observer agreement, Rel.=reliable

Table 4. shows the results of construct validation on the internal components of the PjBLL model including the objectives of developing the model, syntax, planning and implementation of the model, learning environment, assessment and evaluation getting very valid criteria; and theoretical and empirical support in valid criteria. This indicates that the internal components of the PjBLL model have been developed

consistently and logically to improve the process skills and creativity of students in physics laboratory subjects. In addition, the reliability coefficient of all aspects of construct validity assessment models is above 75%, so the results of construct validation by experts meet reliable criteria.

#### Model PjBLL Device Validation Results

The PjBLL model developed is the RPS and the Physics Laboratory Practicum Handbook. The results of device validation conducted by three validators of physics learning experts are presented below.

#### RPS Validation Results

Semester Learning Plan (RPS) was developed as a learning process plan for physics laboratory courses in one semester. The results of RPS validation are presented in Table 5.

TABLE V. VALIDITY OF SEMESTER LEARNING PLANS

Assessment Aspect		Validity		Reliability	
		avg	Inf.	R (%)	Inf.
RPS identity	a. Faculty	4.00	SV	100	Rel.
	b. Study program	4.00	SV	100	Rel.
	c. Course name / SKS	4.00	SV	100	Rel.
	d. Prerequisite subject	3.33	SV	86	Rel.
	e. Name of lecturer	4.00	SV	100	Rel.
RPS content format	a. Learning outcomes of courses	4.00	SV	100	Rel.
	b. Course description	4.00	SV	100	Rel.
	c. Reference	3.00	V	100	Rel.
	d. KKNI core competencies	4.00	SV	100	Rel.
	e. Basic competencies	3.33	SV	86	Rel.
	f. Sub competence	3.00	V	100	Rel.
RPS content format	a. The final ability is emphasized in understanding aspects of process skills and developing creativity.	3.33	SV	86	Rel.
	b. Indicator of learning according to final ability, sub-competence, and core competencies of IQF	3.67	SV	86	Rel.
	c. Study materials support the application of the PjBLL model	3.00	V	100	Rel.
	d. Approach / model / method / learning strategy according to the PjBLL model	3.33	SV	86	Rel.
	e. Learning / media sources involve the whole of learning	3.33	SV	86	Rel.
	f. Time allocation for 12 meetings	3.33	SV	86	Rel.
	g. Learning experience according to student activity activities in PjBLL	3.33	SV	86	Rel.

Description: V = Valid, SV = Very Valid, R = Coefficient of inter-observer agreement, Rel.= Reliable

Table 5. shows the results of RPS identity validation including faculties, study programs, courses, prerequisite subjects, lecturers, learning achievement of courses, description of courses, references to get valid/very valid assessment criteria. The RPS format component includes final capabilities, learning indicators, study material, approach/model / method / learning strategy, learning resources / media, time allocation, and learning experience to get valid/very valid

assessment criteria. In addition, the reliability coefficient of each aspect of assessment is 86% to 100%; so that the results of the RPS validity assessment are reliable. Thus, the developed RPS is valid to be used as a supporting device for the PjBLL model.

#### Validation Results of the Handbook of Physics Laboratory Practicum

Physics Laboratory Practicum Handbook (PPLF) as a guide for lecturers in understanding process skills as basic skills in laboratory subjects; and develop students' creative ideas in designing physics teaching aids and technical instructions. A summary of the PPLF book validation results is presented in Table 6.

TABLE VI. VALIDITY OF THE MANUAL OF PHYSICS LABORATORY PRACTICUM

Assessment Aspect		Validity		Reliability	
		Average	inf	R (%)	Inf.
Book Format	a. Activity material is relevant to the purpose	3.00	V	100	Rel.
	b. Balanced text and illustrations	3.00	V	100	Rel.
	c. Appropriateness of physical size for students	3.33	SV	86	Rel.
	d. The level of visual attractiveness of the book	3.00	V	100	Rel.
Book Material	a. Material uses standart book references	3.00	V	100	Rel.
	b. Truth content (facts, principles, concepts, laws, theories, and scientific processes)	3.33	SV	86	Rel.
	c. Content updates	2.67	V	80	Rel.
	d. Material uses standard book references	3.00	V	100	Rel.
	e. Relevant to the LPTK / school curriculum	3.33	SV	86	Rel.
	f. Sub competence	3.00	V	100	Rel.
Linguistic Books	a. Readability is appropriate for students / lecturers	3.33	SV	86	Rel.
	b. Using Indonesian language is good and right	3.33	SV	86	Rel.
	c. The choice of terms is appropriate and easy to understand	3.33	SV	86	Rel.
	d. A steady term	3.00	V	100	Rel.
	e. Communicative and effective language	3.33	SV	86	Rel.
Book Presentation	a. Train students to understand and use process skills	3.33	SV	86	Rel.
	b. Appropriate level of thinking and students' reading ability	3.33	SV	86	Rel.
	c. Encourage students to develop creativity and independence in developing teaching aids	2.67	V	80	Rel.
	d. Interesting and fun	3.00	V	100	Rel.
Support the Innovation and Quality of KBM	a. Conformity with the IQF curriculumb.	3.33	SV	86	Rel.
	b. Emphasize real-world education	3.33	SV	86	Rel.
	c. Facilitate the development of process skills as basic skills in physics	3.00	V	100	Rel.
	d. Facilitate the development of creativity, personality, and independence in finding and finding knowledge	3.00	V	100	Rel.
	e. Utilizing the use of ICT media in learning	3.33	SV	86	Rel.

Description: V = Valid, SV = Very Valid, R = Interobserver of agreement coefficient, Rel.= Reliable

The results of PPLF book validation include assessment of format, material, language, presentation, supporting innovation and improving the quality of KBM to obtain valid / very valid assessment criteria. In addition, the reliability coefficient for each aspect of assessment is 86% to 100%; so that the RPS validation results also meet reliable criteria.

#### IV. CONCLUSION

The conclusions of the results of the study are that the Project Based Laboratory Learning (PjBLL) model developed is valid so that it is feasible to improve the process skills and creativity of physics teacher candidates. The conclusions above are based on the findings that the developed PjBLL model includes content valid and constructively valid, and is supported by the Semester Program Plan learning tools and the Physics Laboratory Practicum Guidebook which is categorically valid for use in physics laboratory subjects.

#### Future research

The quality of Project Based Laboratory Learning models needs to be improved by testing the effectiveness and the practicality of the learning process in the actual class

#### REFERENCES

- [1] J. Walker, D. Halliday, and R. Resnick, *Fundamentals of physics*, tenth edition. New Jersey: John Wiley & Sons, Inc., 2011.
- [2] Universitas Negeri Surabaya, *Buku Pedoman Unesa 2014-2015*. Surabaya: University Press, 2017.
- [3] Kemendikbud, *Renstra Ditjen Dikdasmen 2014-2018*. Jakarta: Ditjen Kemendikbud, Jakarta, 2017.
- [4] Kemenristek dikti, *Kurikulum Pendidikan Tinggi. Direktorat Pembe la jaran dan Kemahasiswaan Dirjen Dikti*. Jakarta: BPSDM Penjamin Mutu, 2015.
- [5] OECD. *PISA 2012 results: Creative problem solving: Student's skills in tackling real-life problems (Volume V)*, PISA. Cyprus: OECD Publishing, 2014.
- [6] S. Greiff, S. Wustenber, B. Csapo, A. Demetriou, A. Hautamaki, A.C. Graesser, and R. Martin, "Domain-general problem solving skills and education in the 21st century," *Educational Research Review*, vol. 13, pp. 74-83, 2014.
- [7] ADB, *Creative productivity index: Analysing creativity and innovation in Asia. A report by the economist intelligence unit for the Asian Development Bank August 2014*. Mandaluyong: The Economist Intelligence Unit Ltd. and Asian Development Bank, 2014.
- [8] P. Walker and E. Wood, *Physical science experiments*. New York: Infobase Publishing, 2011.
- [9] K. Rotteram, "Teaching, learning and creativity model for science," *SSR*, vol. 95(1), pp. 79-84, 2014.
- [10] *Peraturan Presiden Nomor 8 Tahun 2012 tentang Kerangka Kualifikasi Nasional Indonesia*.
- [11] Universitas Negeri Surabaya, *Buku Pedoman Unesa 2014-2015*. Surabaya: University Press, 2015.
- [12] Bappenas, *Rencana pembangunan jangka menengah nasional 2015-2019: Buku I agenda pembangunan bidang*. Jakarta: Kementerian Perencanaan Pembangunan Nasional/Badan Perencanaan Pembangunan Nasional, 2015.
- [13] Tim Dikti, *Buku kurikulum pendidikan tinggi*. Jakarta: Direktorat Pembelajaran dan Kemahasiswaan, Direktorat Jenderal Pendidikan Tinggi, Kementerian Pendidikan dan Kebudayaan, 2014.
- [14] E. Sudibyo, *Model Pembelajaran Untuk Menumbuhkan Motivasi Belajar, Meningkatkan pemahaman Konsep Fisika dan Keterampilan Berfikir Analitis Mahasiswa Ilmu Keolahragaan*. Disertasi tidak diterbitkan, Surabaya: Pasca Sarjana Unesa, 2015.
- [15] Suyidno, D. Dewantara, M. Nur and L. Yuanita, *Maximize student's scientific process skill within creatively product designing: creative responsibility based learning*. Proceeding The 5<sup>th</sup> South East Asia Development Research (SEA-DR) International Conference. Banjarmasin, Indonesia, 3 Mei 2017.
- [16] M. Nur, *Modul keterampilan-keterampilan proses sains*. Surabaya: Pusat Sains dan Matematika Sekolah, Universitas Negeri Surabaya. 2011.
- [17] N. Nieveen,. *Formative evaluation in educational design research*. T.J. Plomp & N. Nieveen (Eds). *An Introduction to Educational Design Research*, pp. 89-10, 2013.
- [18] Suyidno, M. Nur, L. Yuanita, B.K. Prahani and B. Jatmiko, "Effectiveness of creative responsibility based teaching model on basic physics learning to increase student's scientific creativity and responsibility," Accepted in *Journal Baltic Science of Education*, 2018.
- [19] A. Asan, and Z. Haliloglu, "Implementing Project Based Learning in Computer Classroom," *The Turkish Online Journal of Educational Technology-TOJET*, vol. 4 (3), pp. 69-81, July 2005.
- [20] P. Celik, F. Onder, and I. Silay, "The effects Of Problem Based Learning On The Students' Success In Physics Course," *Procedia-Social and Behaviorl Sciences*, vol. 28, pp. 656-660, 2011.
- [21] S.R. Ali and N.S.H. Syah, "Impact of project based learning of physics in a technical institution," *Karachi Proceeding International Conference on Physics Education*, August 5-9, 2013. Prague, Czech Republic. pp. 671-677, 2013.
- [22] S. Moutinho, J. Torres, I. Fernandez and C. Vasconcelos, "Problem-based learning and nature of science: A study with science teachers," *Procedia-Social and Behavioral Sciences*, vol. 191, pp. 1871-1875, 2015.
- [23] R.I. Arends, *Learning to teach*. New York: Mc. Graw-Hill, 2012.
- [24] T.J. Plomp, *Eductional design research: An introduction*. In T. J. Plomp and N. Nieveen (eds). *Educational Design Research, part A: An introduction*, pp. 10-51, 2013.
- [25] *Peraturan Menteri Riset, Tekonologi, dan Pendidikan Tinggi Nomor 44 tahun 2015 tentang Standar Nasional Pendidikan Tinggi*
- [26] T. Plomp, *Educational design research an introduction*. T. Plomp and N. Nieveen, (eds), *An Introduction to Educational Design Research*. In *Proceeding of the Seminar Conducted at The East China Normal University*, pp. 9-35, 2007.
- [27] T. Plomp and N. Nieveen, *An Introduction to Educational Design Research*. Netherlands: Netzdruk, Enschede, 2010.
- [28] R.I. Arends, *Learning to teach*. New York: Mc. Graw-Hill, 2015.
- [29] S. Arikunto, *Manajemen penelitian*. Jakarta: Rineka Cipta, 2010.
- [30] G.D. Borich, *Observation skills for effective teaching*. Texas: The University of Texas USA, 1994.
- [31] M. Nur, *Berpikir Kreatif*. Surabaya: Universitas Negeri Surabaya, *Penelitian Unggulan Perguruan Tinggi*, 2014.
- [32] Sunarti, Madlazim, and Wasis, *Literacy Learning Model (LLM) untuk meningkatkan keterampilan membelajarkan literasi sains mahasiswa calon guru fisika*, Disertasi, Tidak diterbitkan, Surabaya: Pasca Sarjana, 2018.