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Development of tools problems-based learning model assisted by virtual experiment to increase students' generic science skills

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Abstract. Type of research is research and development (R &D). This development research aims to produce physics learning tools using qualified problem based learning model assisted by virtual experiment has a valid, practical, and effective which to increase students generic science skills in subject of optical instruments.In this study, the generic skills that discussed on the science field, called generic science skills. The development model had used a four-D model consisting of define, design, develop and dessiminate phases. Trial of product conducted in students of eleventh grade of the state senior high school 1 east Praya in second semester the academic year 2018/2019and the method used was pre experiment. Generic science skills (GSS) was measured using student worksheet when the learning process was descriptively analyzed based on descriptors appeared on the observational sheet. Based on GSS observation data, that students were in the category "skilled" and "highly skilled".

1. Introduction

People must be responsive in facing an increasingly advanced world development since many jobs require a variety of high-level skills and demand an ability to be able to learn in each change, think creatively, make decisions, reason, and an ability to solve the problems. Improving the quality of natural science learning, especially physics, at all levels in the world of education is always sought. This challenge can be faced through a new paradigm in learning sciences, namely providing the number of experiences to students to understand and guide them to implement scientific knowledge. Engaging students actively in the learning process is a basic demand in physics learning. To survive one requires flexibility, creativity, emotional mastery, ability to take on many different tasks and to learn from the experiences [1].

Based on the results of interviews conducted by the researchers at one of the high schools in Central Lombok Regency, the facts showed that in the process of learning physics, the teachers rarely gave physics materials through direct experience by performing laboratory experiments. In general, the teachers directly provided the materials so that they paid little attention to the students' initial knowledge, and the teacher also dominated the learning because of the limitations of time and the density of the lessons. Physics learning in the school had not shown the development of generic science skills as learning objectives. The fact showing the skills are very important for the students is that because it

is needed in developing their future career according to their respective fields, especially in the field of sciences. Generic abilities are not directly obtained, but it must continuously be trained in order to increase these skills. Brotosiswoyo [2] generic science skills (GSS) are an ability that can be used to learn concepts and solve problems in sciences, indicators of PBL include (1) indirect observation, (2) direct observation, (3) symbolic language, (4) mathematical modeling, (5) principal framework obedience, (6) causal relationship, (7) logical consistency, and (8) logical inference.

The purpose of developing generic science skills is that the knowledge and skills obtained from learning results in teaching and learning process can be applied in real life and answer the challenges of the times that have rapidly developed, especially in terms of sciences and technology. Kusdiwelirawan et.al [3] generic skills are regarded as basic skills that are very useful for students to be able to solve problems in their surroundings and certain circumstances during the process .According Yeung et.al [4] generic skills are very useful for an individual in continuing his or her education and for the success of career. Based on argument above, its mean that GSS are skills to pursue career in field of work. Therefore, teaching and learning should be design to give opportunity to develop their generic skills.

The solution for appropriate learning model is needed to improve GSS. The right learning model is a problem-based learning (PBL) model since it is in line with concept understanding and problem solving. Downing [5] PBL is a learning that uses real-world problems as a context for students to learn about critical thinking, creative activities and problem-solving skills, and to acquire conceptual knowledge that is essential from the materials. The advantages of PBL, in process, student learn by solving real-world problems and reflecting on their experiences because real- world problems are complicated, students work together in groups where they pool, they expertise and experiences together and cope with complexities issues that must be considered [6].

Teachers are important ones to pay attention to the learning media in teaching and learning activities in addition to determining the right learning model. Hastuti et.al [7] the use of model PBL will be more optimal if this is collaborated with the use of learning media in the form of simple and technology-based media. Araz et.al [8] the use of simulation to increase effectiveness of PBL and stated that computer simulations facilitate to learn concepts and processes. One alternative for the learning media is virtual experiment (VE). It is a learning media in conducting experimental activities in the form of computer simulations or virtual laboratories. The advantages of VE media is it becomes the solution when real laboratory equipment is broken and limited [9]. The use of VE in learning process makes learning activities more effective in terms of time and can improve achievement [10]. Simulation in learning contributes o good performance and meaningful learning for student [11].

Learning activities that are not supported by the right tools and learning methods will be difficult to achieve the planned learning, so the appropriate learning method is further needed. The research result of Mulyani, Liliasari, Wiji, Hana& Nursa'dah through learning using ICT based media on reaction rate and osmotic pressure material was effective to increase GGS students [12]. The researsh before only assessment four until six GSS indicator. Reffering to these problem of research so in this reaserch learning process used model problem based learning assited by virtual experiment to increase GGS for optical instruments material. The assessement eight GSS indicators. Virtual experiments are not only usid to experiment but are eqipped with practice test related to the material optical instrument and eqquiped with teaching material.

2. Method

The present study was a development research that had been originated from the development of PBL model learning devices assisted by VE. Learning devices were developed using 4-D models [13]. An analysis of the needs and preparation of learning devices was then carried out. Before the trial, the learning device was first consulted and validated by the Mataram University Physics Education team. The revisions were made and tested for limited groups and analyzed their effectiveness for reflection and improvement. The results of the trial were applied to the broad trial group. The criteria for developing the device are valid, practical and effective.

The method used in the present study was pre-experimental design. The subjects were students of class XI MIA 1 in senior high schools 1 East Praya at the second semester of year 2018/2019 consisting of 31 students. GSS was measured using student worksheet when the learning process was descriptively analyzed based on descriptors appeared on the observational sheet.

3. Result and discussions

The present study aimed to describe the students' GSS using PBL learning assisted by VE. Student GGS data during the learning process can be seen in Table 1.

Table 1. Data generic science skills during learning process.

Meetings at	Value of each indicator generic science skills								Averages	Categories
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**		
1	1.90	2.03	3.87	3.77	3.87	3.35	3.39	3.65	3.23	Skilled
2	2.39	2.77	3.74	3.42	2.65	1.65	2.03	2.03	2.59	Skilled
3	2.03	2.00	3.74	3.52	3.00	3.13	3.39	3.39	3.03	Skilled
4	2.41	2.00	3.87	3.87	3.00	3.00	3.00	3.65	3.10	Skilled
5	2.48	2.10	3.87	3.74	3.74	3.26	3.13	3.74	3.26	Very skilled
6	2.48	2.52	3.74	3.77	3.52	3.39	3.26	3.52	3.28	Very skilled

A: Logical consistency; B: Causal relationship; C: Direct observation; D: Logical inference; E: Principal framework obedience; F: Indirect observation; G: Mathematical modelling; dan H: Symbolic language

Based on GSS observation data, it can be said that students were in the category "skilled students" and "highly skilled students". The students' activities in the learning process were inseparable from the model used by the teachers. The PBL model is a learning model that requires students to learning the context of authentic problem so that students are expected to be fully involved in the problem-solving process by applying the PBL model, the activities of students show a very good and good category as well as an increase in students' GSS [14-15].

The findings during the learning process revealed that the students were enthusiastic and active, because the experimental activities became new experiences the students rarely did when there were limitations on practicum tools. Practical activities are replaced using computer simulations to overcome the limitations of laboratory equipment. Virtual laboratory-based media learning had provided opportunities for students to always be active. Cengiz [16] use of virtual laboratories accompanied by learning tools could appropriately involve students to be active in the learning process and Jagodzinzki et.al [17] say that the virtual laboratory has a positive effect on the involvement of the students.

The GSS during the learning process at each meeting showed different results. The material in this paper was grouped into material reflecting of light, refraction of light and optical instrument. The first meeting of the GSS average score was in the category "skilled students" since there were some that had not been reached, namely indicators of logical consistencies and law of cause and effect. The indicator was low since the students had not been able to formulate a problem and make a temporary answer to the provided problems. This happened because the students paid less attention to the teacher's explanation, so they did not understand the tasks. The first meeting learn concept about reflection of light is the material has been taught at the previous level. So, they have a concept more easily.

The second meeting of the GSS average score was in the category "skilled students" since there was a low GSS indicator, namely the indicator of indirect observations, indicators of mathematical models and symbolic languages. The low GSS indicator confirmed that the students were still inaccurate to use measuring instrument as a tool and they did not have enough time to analyze the problems related to practical activities so that they were lack of making graphics or images and the problems using mathematical methods had not been resolved. In this meeting learn concepts about refraction of light and this meeting cannot be fully implemented, it caused close to the rest so get a lowest score average of GSS. The third and fourth meetings of the GSS average scores were in the category "skilled students" since there were low indicators in logical consistencies and law of cause and effect. In this meeting learn

concept about optical instrumental such as eyes, sun glasses, lup and camera. At this meeting there was an increase as compared to the previous meeting since the students had used to conduct investigative activities and the teacher had guided and directed students and groups who still did not understand the learning materials.

This meeting at the fifth and sixth meetings, the GSS average score of the students was in the category "skilled students" because of the easier sub-chapter of material and simpler investigation activities. In this meeting learn concept about microscope and binoculars. In addition, the students were used to learn with the models so that learning activities had been more directed and in line with the required time. The generic science skills of students will be better if during learning process will be collaborative to make relationship each other's. According to Singh et.al [18] working in collaborative builds self-confidence in an individual and helps him to maintain good interpersonal relationships and the generic skills developed through collaborative activities not only increase their chances of success at the workplace but also in their personal life. Therefore, in meeting sixth get highest score of GGS student in learning process. Kulkarni et.al [19] stated that teaching and learning aided by computer with animations and simulations in the classroom gives in alternative to students understanding various alternative s of concepts through visualization of abstract concept. Based on the previous description, a learning process using PBL model assisted by VE could only improve a few GSS indicators. The present study revealed that the students gave positive responses in which they felt that the learning had given them a new impression and improved some GSS indicators [20].

4. Conclusions

Based on the results and discussions it can be concluded that problem-based learning model assisted by virtual experiment has been developed effectively to increase generic science skills students during learning process is in category of skilled and highly skilled. The effect of virtual simulations in science education are caused by nature of the content, the student and the teacher. The highest of GGS indicators in concept binoculars and the lowest for concept refraction of light.

Acknowledgments

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