USEJ 7 (1) (2018)

Unnes Science Education Journal

http://journal.unnes.ac.id/sju/index.php/usej

SCIENTIFIC APPROACH-INTEGRATED VIRTUAL SIMULATION: A PHYSICS LEARNING DESIGN TO ENHANCE STUDENT'S SCIENCE PROCESS SKILLS (SPS)

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Article Info

Received November 2017
Accepted December 2017
Published February 2018

Keywords:
Scientific approach, Virtual simulation, Science Process Skills

Abstract

Physics learning using scientific approach-integrated the real laboratory is a process to train student's science process skills in the classroom. However, it is little known that using scientific approach-integrated virtual simulation has huge potential in training student's science process skills. This study carried out was to acquire the descriptionof enhancing of student's science process skills in physics learning that its learning activities refer to syntax of scientific learning activities. The activities of learning were conducted with integrating virtual simulations during two times face to face in the classroom activities. There were 31 students as participants in one public senior high school in Bima, Indonesia. Pre-experiment method with one group pretest-posttest design is shown to illustrate the intervention of training of science process skills involved in the classroom. The data sources for this studywere the result of the student's score about science process skills measured by essay test combined rubrics.Furthermore, thescience process skills measured from students encompassed skills of observing, communicating, clarifying, measuring, predicting, and interpreting. The results of study depicted that there were significant increase of student's science process skills (<g>=0.34; intermediate level) and significant difference between pretest score and posttest score (z=-4.861; p=0.0001).

p-ISSN 2252-6617
e-ISSN 252-6232

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INTRODUCTION

Physics is one of science subjects that examine the natural phenomena. The Physics instruction model recommended by many experts (Heuvelen, 2001; Lippmann, 2003) was student-centered learning, which gave students the opportunity to learn discovering like a scientist. In addition, the process of learning physics should be familiarized with experimental activities (Gilbert, 2010). Experimental activities in the physics learning could make the learning process becomes more meaningful and fun (Stern, 2017).

Scientific activities in physics learning—experimental activities are important to be implemented because they are able to teach students understanding how a concept is obtained. By conducting observations, experiments or practicum activitiescan guide students to build their own knowledge, for instance. In addition, the process of physics learning not only understands the concepts of physics but also guides students to think constructively. Therefore, the learning process in physics learning cannot be separated from the development of science process skills.

Science process skills are basic skills that must be mastered by students both in primary and secondary education (Rustaman, 2006) and most of which are intellectual intelligence. Scientific process skills encompass the ability to observe, interpret, classify, predict, communicate, hypothesize, plan experiments, apply concepts, and ask questions.

One of the learning activities facilitating students to act like a scientist (training the science process skills) is learning activities using a scientific approach. By this approach, students learn to carry out scientific work in order to solve problems similar to be conducted by scientists. This aims at the final result which students discover the concepts of physics by themselves. Learning by integrating scientific approach involves observing, questioning, reasoning, trying, and communicating (Christine, 2010; Kaniawati, 2014). Scientific activities can be carried out in a diverse of learning situations. This learning trains students to skillfully use scientific syntax in learning something especially in the stages of experimental activities. In addition, the stages of learning activities are able to facilitate to train the students' science process skills (Siswanto et al, 2017).

However, not all physics phenomena studies can be experimented in the classroom. In physics learning, there are some concepts that are difficult to be experimented and observed directly. The phenomenon of parabolic motion-the motion of a ball kicked by a football player, motion projectile on cannon, and others are example for these situations. In the learning practice, it is difficult to understand the concept of parabolic motion formed by a combination of uniform and accelerated motion. Therefore, to teach the concept comprehensively, it is necessary anapproach that facilitates students understanding the phenomenon totally. However, although learning activities are conducted on difficult materials to be observed in real condition, the science process skills have to be constructed within each student.

In this study, learning activities on a scientific approach were conducted by integrating virtual simulations which lead to virtual physics phenomenon in pre-learning and experiment process. In this study, using *"Phet Simulation"* as a tool that can be accessed at *https://phet.colorado.edu/in/simulations/category/physics.* These simulation activities were carried out to make easier students in comprehending the physics concepts that werenot easy to be observed in real laboratory (Zacharia, 2008a; Zacharia, 2011b; Olympiou, 2012; Myneni, 2013; Sullivan, 2017). Therefore, researchers were interested to examine how the effectiveness of learning using scientific approach-integrated virtual simulation in enhancing SPS. Science process skills measured in this study consist of observing, communicating, classifying, measuring, predicting andinferring.

METHODS

This study was conducted using pre-experiment method with one group pretest-posttest design. The pretest was given before the interventionphysics learning using scientific method-integrated virtual simulation, was conducted and posttest given to participants in the end of learning process. The participants were 31 students-first year students in one public senior high school in Bima, Indonesia. All participants who involved in this study did not learn the concepts of parabolic motion, and they came from the same class so that they acquired the learning materials daily. The data resources were collected from the scores of science process

skills that were measured by essay tests using assessment rubric.

There were several stages in analyzing data: (1) testing normalized data tests, (2) determining the averages of pretest and posttest scores, (3) testing student test (t-test) between pretest and posttest scores, (4) determining the average whole of gain SPS, and (5) determining the averages of gain for each indicator of SPS. Enhancing of student's SPS was analyzed by using normalized gain (Hake, R.R, 1999). The formula of normalized gain can be stated on equation (1).

$$< g >= \frac{(posttest\ score)-(pretest\ score}{(ideal\ score)-(pretest\ score)} \quad (1)$$

The categories of normalized gains (<g>) could be differed by the ranges of value gains: high category (<g> ≥ 0.7), intermediate category (0.7<<g> ≤ 0.3), and low category (<g>< 0.3).

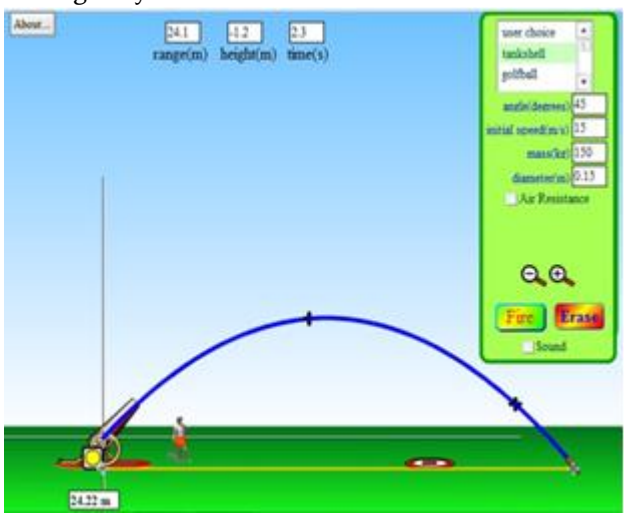
RESULTS AND DISCUSSION

This study was carried out in two time face to face meetings in the classroom. The learning activities were conducted using scientific approach-integrated virtual simulation. The sample of learning activities that were designed by infusing SPS indicators can be seen in table 1.

There were some SPS indicators of learning activities to be achieved: (1) observing maximum ranges and height of parabolic motions, (2) classifying the variables that were influent maximum ranges and height when the particle did the parabolic motion, (3) inferring the relationship between elevation angel and maximum ranges and height, (4) communicating data from table to graph, (5) measuring the value of elevation angel of particle that did parabolic motion, and (6) predicting interval time of particle during the motion.

The learning activities designed in this study can be seen in the Table 1 that facilitates teachers to be able to train the science process skills to students. The result of t-test, normality test, and normalized gain can be also seen in table 2. The data in table 2 depicts that distribution of data do not follow normal curve so as Wilcoxon test used for testing the difference means.

Table 1. Learning activities using scientific approach-integrated virtual simulation infused SPS

The learning syntax	Description of Learning activities	Indicators of SPS
Observing	▪ Students observed virtual simulation that was emerged by teacher  https://phet.colorado.edu/sims/projectile-motion/projectile-motion_en.html	Observing
Questioning	▪ Students questioned everything dealing with virtual simulation. ▪ Student wrote some questions in worksheet	Inferring and predicting

The learning syntax	Description of Learning activities	Indicators of SPS
Reasoning	▪ Students guided by teacher to discuss some question made by each another group ▪ Every group answered these questions with the same opportunities. ▪ Students given some question by teacher related to parabolic motion "How did the maximum ranges and height of particle if the elevation angel always increased?" ▪ Students were given the chances to discuss with the others and predicting the solving of questions made by teacher.	Inferring and predicting
Experimenting	▪ Students offered by teacher to run the virtual experiment using: https://belajar.kemdikbud.go.id/LabMaya/Experiments/virtuallab-parabolicmotion/	Observing Classying Communicating Measuring Predicting Inferring
Making connections	▪ Students offered for representing the result of experiment ▪ Students guided to discuss the result of experiment by teacher	Communicating

Table 2. The result of test of normality and difference means.

Test	Normality test (Shapiro-Wilk)		The difference means			
	df	Sig	Means	df	Z	sig
Pretest	31	0.020	39.4	23	-4.199	0.0001
Posttest	31	0.200	60.0	23		

The difference means between pretest and posttest data portray that the data of pretest and posttest differ significantly (sig. < 0.05). The mean of posttest score is higher than the means of pretest. This data show that there is a significant increase in the science process skills as a result of the implementation of scientific approach-integrated virtual simulation design. The value of the improvement of students' SPS can be seen in Figure 1.

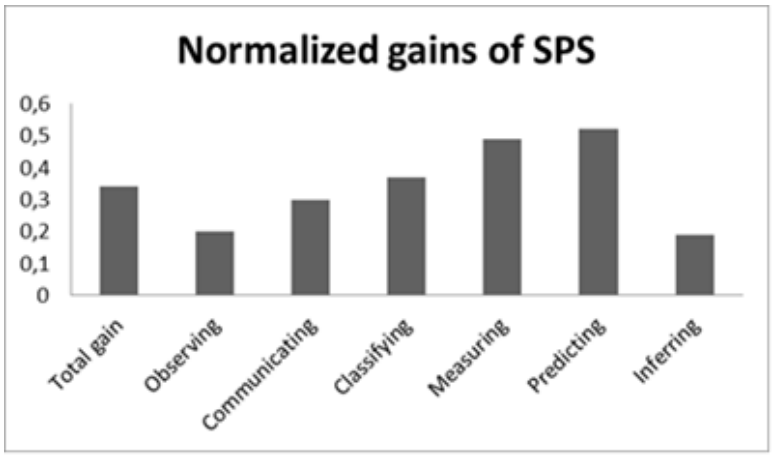


Figure 1. The normalized gains for total improvement and SPS indicators

There is an increase in the science process skills based on Figure 1. Overall, the value of enhancing of SPS is 0.34 with the criteria of intermediate increase. In addition, there is also an increase in each indicator of SPS. The prior studies argue that virtual experimental activities are able to build students' SPS (Xiang Fan, 2010).

According to data, the highest increase of SPS indicators occurred in predicting skill. The main factor that caused was the experiment conducted by students training students to predict a certain concept and analyze these predictions. Meanwhile, the observingand inferring skills are still in the low category. The reason why this happened is the worksheet designed less specifically to train observing and inferring skills. Worksheets presented did not provide many activities to students to conduct observation and inference.

In addition, the low increase of observing skill trained to students was occurred because this was given to students in the early of learning activities. In this situation, students did not prepare fully about learning activities so that the normalized gain was low (<g> = 0.20). The observing skills play an important role in supporting the achievement of other science process skills because when observing skills are low, many students did not capture some concepts properly. This will have an impact on the performance of other skills: critical thinking and argumentation skills.

Further analysis illustrates that the enhancing of SPS totally was only (<g> = 0.34) because the virtual simulation was not designed by the researchers themselves. Researchers used virtual simulations that are already available and created by other researchers. This did not stimulate the students to explore their needs in learning activities. In the learning activities, the students had to make appropriate with activities in the virtual simulation.

CONCLUSION

Based on the results of data analysis, it can be concluded that the learning activities using a scientific approach-integrated virtual simulation can significantly enhance students' SPS. There are two suggestions dealing with this study-the virtual simulation should be developed by researcher to adjust with the learning activities carried out by students, and the further research has to be conducted for knowing the impact of observing skill to other skills in SPS. Additionally, there is a need of making mind mapping to lead students to identify the problems accurately. On the weakness of this study does not make mind mapping framework for students so as almost all students are hard for identifying the problems.

ACKNOWLEDGMENT

We would like to express our gratitude to those who have assisted in this research, such asinstrument validator and supervisor. The researcher also thanked the leaders in our agency, who have given permission to the researcher to carry out the research activities.

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