Improving Students' Science Process Skills through Simple Computer Simulations on Linear Motion Conceptions

P Siahaan, A Suryani, I Kaniawati, E Suhendi and A Samsudin*

Universitas Pendidikan Indonesia, Departemen Pendidikan Fisika.
Jl. Setiabudhi No. 229, Isola, Sukasari, Isola, Sukasari, Kota Bandung, Jawa Barat, 40154, Indonesia

Email: achmadsamsudin@upi.edu

Abstract. The purpose of this research is to identify the development of students' science process skills (SPS) on linear motion concept by utilizing simple computer simulation. In order to simplify the learning process, the concept is able to be divided into three sub-concepts: 1) the definition of motion, 2) the uniform linear motion and 3) the uniformly accelerated motion. This research was administered via pre-experimental method with one group pretest-posttest design. The respondents which were involved in this research were 23 students of seventh grade in one of junior high schools in Bandung City. The improving process of students' science process skill is examined based on normalized gain analysis from pretest and posttest scores for all sub-concepts. The result of this research shows that students' science process skills are dramatically improved by 47% (moderate) on observation skill; 43% (moderate) on summarizing skill, 70% (high) on prediction skill, 44% (moderate) on communication skill and 49% (moderate) on classification skill. These results clarify that the utilizing simple computer simulations in physics learning is be able to improve overall science skills at moderate level.

1. Introduction

Nowadays, science and technology develops rapidly. Technology development has an impact on the development of learning methods and media, particularly in the use of computer and the internet. The use of information and communication technology (ICT) will make the learning process more interesting and challenging, facilitatingthe teachers and students in teaching-learning processes [1, 2,3]. Because of that ICT is able to deliver information simply and quickly. In broad-spectrum, the use of computer media by teachers in schools is restricted on Microsoft Power Point program to enhance students' understanding of the concept. Therefore, the skills obtained by the students are merely memorizing skill. It is in line with Prince [4] and Bobadilla [5] who stated that at the moment, learning tends to be based on memorizing the theories without utilizing students' experiences. In contrast, the most important point in learning is improving wide range of skills that can be used to solve problems in the real life situation, such as science process skills (SPS).

Learning model applied by teachers in secondary schools, both junior and senior high school are 70% lecturing models (transfer of knowledge), and the rest are discussion, demonstration and experiment models with the percentage of 10% for each model [6]. Based on the questionnaire distributed to high school students in Bandung City, the score obtained by physics students in the test or quiz is still low because of some reasons such as unfavorable class conditions, students' poor math

skills, and monotonous learning process (lecturing), occasional experiments, and demonstrations without showing a video or animation that support the explanation of the concept. In fact, sufficient amount of computer media is available in the laboratory and projector is able to be used in the classrooms.

On the contrary, based on interviews to one of physics teachers, lecturing is generally used as the learning because the time is limited compared with the amount of discussion topics demanded by the curriculum. The elaboration above shows that the learning is conducted with the teacher as a source of knowledge, and students rely on the memorizing skill rather than discovery skill, and learning with multimedia is occasionally done.

Science process skills are skills that focus on the learning process to develop students' skills in understanding the knowledge or concepts, independently discovering and developing necessary facts, concepts, and values [4, 7]. Science process skills are a learning approach that integrates science process skills into the system of integrated material presentation [8, 9]. The learning approach is not only transferring knowledge, but also emphasizing on the process of scientific inquiry. In this learning approach, the teacher acts as a facilitator who guides and manages students' learning activities so that students are able to construct necessary facts, concepts, and new values in their lives independently.

The skills in the science process skills according to Gultepe [10] and Ramig, Bailey & Ramsey [11] are observing, summarizing, identifying and manipulating variables, predicting, hypothesizing, organizing and interpreting data, investigating, experiments and surveys, and reproducible for independent investigation. Meanwhile, according to Rauf et al. [12] aspects of the science process skills are skills to observe, to conclude, measure, predict, communicate and classify. In this research, science process skills indicators used are five skills proposed by Rauf et al. [13] that are, observation skill, summarizing skill, predicting skill, communication skill and classifying skill.

Based on these considerations, researchers did research to determine the development of students' science process skills in learning linear motion topic using computer multimedia. Several previous studies suggest that the use of interactive multimedia on the uniformly accelerated motion topic appeals to be very interesting [13], the motivation of students after studying with computer multimedia increases by 6,016% [7, 8], and the increase of science process skills when learning by utilizing interactive multimedia is about 29% [8]. It shows that the use of computer multimedia is able to develop students' science process skills.

2. Methods

The method utilized in this study is a pre-experimental research. The research design is one group pre-test-post-test. In this study, students were given an early test in the form of questions that had been adjusted based sub-concepts and science process skills indicators. After that, students acquire learning by using multimedia computer as a moderate of learning and the last activity is the students obtain the final test. The research design is shown in the Figure 1 as follows.

O_1	X	O_2
Pre-test	*Treatment*	*Post-test*

Figure 1. One Group Pretest-Posttest Research Design.

The data obtained in this study is a quantitative data of pre-test and post-test results is the form of students' multiple choice test score. The population in this study is the seventh grade students of Junior High School (SMP) in Bandung, which consists of eleven classes with the average number of students in each class are 35 students, while the sample is one of grade VII in the school with 36 students. But the test results that can be analyzed are only from 23 students.

The data processing in this research began by calculating pre-test and post-test score. Subsequently, the effect of multimedia computers learning on students' science process skills was determined by using normalized gain analysis. The development before and after the computer multimedia learning was calculated by computing normalized gain equation <g> as follows.

$$\langle g \rangle = \frac{score\ of\ \ posttest - score\ of\ \ pretest}{score\ of\ \ ideal - score\ of\ \ pretest} \quad (1)$$

Normalized gain criteria which proposed by Hake [14] can be seen in Table 1.

Table 1. Normalized gain criteria.

<g>	Criteria
(<g>) ≥ 0.7	High
0.3 < (<g>) < 0.7	Moderate
(<g>) < 0.3	Low

3. Results and Discussions

Learning linear motion by using computer multimedia was implemented in three sub-concepts that should be discussed: the definition of motion; uniformly linear motion and uniformly accelerated motion. The results of the normalized gain analysis of each topic are presented in Table 2.

Table 2. Normalized gain recapitulation in each sub-concept.

	Average Score			
Sub-concept	Pre-test	Post-test	<g>	Criteria
1	1.57	2.74	0.34	Moderate
2	1.65	3.83	0.65	Moderate
3	1.30	3.52	0.60	Moderate
Overall	4.52	10.09	0.53	Moderate

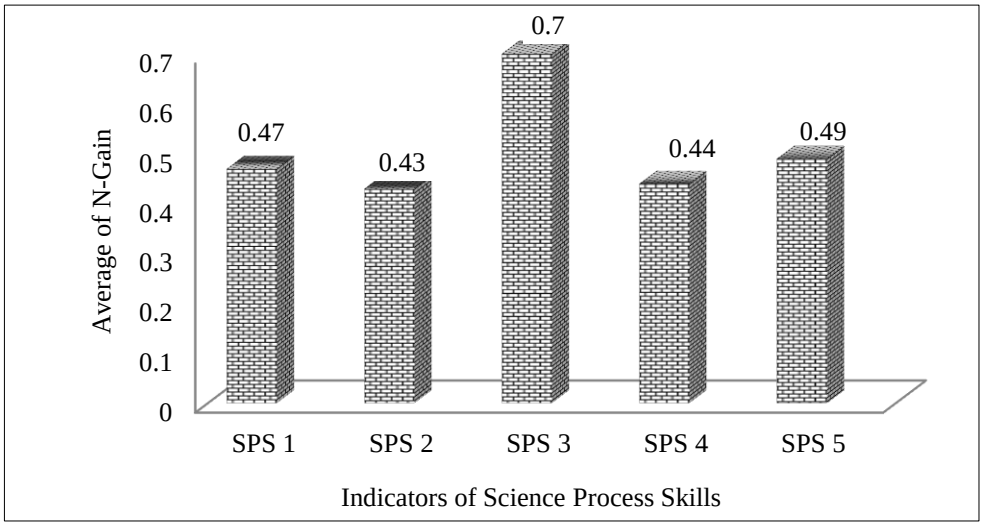
Based on Table 2, there is a gradually increase in students' science process skills at each sub-concept with similar normalized gain scores and they can be included in the moderate category. As found in previous studies [12, 13], those studies also showed the identical results that learning with computer multimedia is able to improve students' science process skills. The reason is the use of multimedia computers in the learning process will stimulate students to conduct their own investigations in order to understand knowledge, so that students will be more active during the learning process. The significant rise occurred in a second sub-concept in which uniformly linear motion was discussed with N-Gain score is at 0.65. While the lowest increase occurred in the first sub-concept with N-Gain score is only 0.34. However, it is still in the moderate category [14].

At the first sub-concept, a relatively lower increase is reasonable because in this first lesson students were not familiar with the learning method. During the learning process, students were required to be more active in comprehending knowledge independently. Meanwhile, the nature of the students was still accustomed to learning with the traditional way by making the teacher as the only source of learning. In the other words learning process was centered on the teacher (teacher-centered) and it focused on rote learning by memorizing the knowledge from textbooks. In addition, students were not familiar with the types of questions given to measure the knowledge they had understanding from the learning process. Another point showed that students were totally preoccupied to complete LKS (Students' Worksheet) even though they had not been accustomed to such a way of learning.

Table 3. Normalized gain recapitulation for each science process skills indicator.

Indicators	Average score		. <g>	2. Criteria
	Pre-test	Post-test		
Observing Skill	0.87	1.87	0.47	Moderate
SummarizingSkill	0.57	1.61	0.43	Moderate
PredictingSkill	1.13	2.43	0.70	High
CommunicationSkill	0.91	1.83	0.44	Moderate
ClassifyingSkill	1.04	2.00	0.49	Moderate

In the next sub-concept, students' science process skills arose at its peak because the students got used to the method applied in learning and the questions given. On the other side, at the third sub-concept students' science process skills was slightly decreased due to more difficult sub-concept and longer duration for group discussion so the time for class discussion and confirmation was limited. Aspects of science process skills observed in this study include five indicators, namely observing skill, summarizing skill, predicting skill, communication skill, and classifying skill. The development at each indicator of the science process skills is presented in Table 3.



Descriptions:
SPS 1 : Observing Skill
SPS 2 : Summarizing Skill
SPS 3 : Predicting Skill
SPS 4 : Communication Skill
SPS 5 : Classifying Skill

Figure 2. The development of each science process skills indicators

The developments on students' science process skills are similar for each indicator except for predicting skill which scored the most significant rise with N-Gain (<g>) score at 0.70. On the other hand, the lowest increase occurred in summarizing skill (0.43) and communication skill (0.44) even though all questions developed for these two aspects (respectively 3 questions) are in easy and moderate difficulty level. In addition, communication skill is a skill frequently trained by students in the learning process, as well as predicting skills compared with other skills. However, according to interviews conducted randomly to some students and the observation done during learning process, students did not fully understand how to process and interpret data, either from table to charts, or from chart to chart which is one of the capabilities that exist on the communication skill. Unlike this skill,

students mastered the skill to solve problems in predicting skill well. So, naturally the development result of predicting skill is higher than other skills. In line with Rauf et al. [12], the research result shows that the utilizing of simple computer simulation is able to improve students' science process skills.

4. Conclusions

Based on the research that has been conducted, it was concluded that the use of multimedia computer in linear motion concept for junior high school students is able to increase science process skills with moderate normalized gain score in each sub-concept learnt. The development of science process skills is also found in each indicator with the highest increase in predicting skill indicator, while the lowest increase is on summarizing skill and communication skill indicator.

In practical terms, the use of computer multimedia can be used as an alternative to improve students' science process skills. However, it has not been able to improve summarizing and communication skills well. It is supported by the results of this research which shows that the normalized gain scores are still low. So, to improve these skills, computer multimedia can only be used as the media that supports learning process. It is necessary to get direct experience of learning by doing experiments using real tools even if it is only a simple experiment. For further research, it would be better if the tests are conducted using an essay test in order to access more detail information of students' thinking process in answering questions particularly in interfering the scientific representation, one indicator of communication skill. Besides, performance assessment should be done so that those skills can be observed directly and more accurate.

5. References

[1] Samsudin A, Suhandi A, Rusdiana, D, Kaniawati, I and CoştuB 2016 *Asia-Pacific Forum on Science Learning and Teaching***17(1)**1
[2] Samsudin A, Suhandi A, Rusdiana, D and Kaniawati, I 2016 *Journal of Physics: Conference Series* **739**
[3] Kaniawati I, Samsudin A, Hasopa Y, Sutrisno A D and Suhendi E 2016 *Journal of Physics: Conference Series* **739**
[4] Prince M 2004 *Journal of Engineering Education* **93(3)** 223
[5] Bobadilla C, Marina, Lorza L, Rubén, González V, Eliseo P, Gómez S and Fátima 2016 *International Journal on Advances in Education Research* **3(2)** 38
[6] Crook S J, Sharma M D and Wilson R 2015*Contemporary Issues in Technology and Teacher Education* **15(2)** 126
[7] Yang K andHeh J 2007 *Journal of Science Education and Technology* **16(5)** 451
[8] Park J C and Slykhuis D A 2006 *Contemporary Issues in Technology and Teacher Education* **6(2)** 218
[9] Beyer B K 1991 *Teaching thinking skill: a handbook for elementary school teachers* (New York: Allyn & Bacon)
[10] Gultepe N 2013 *International Journal of Environmental & Science Education* **11(5)** 779
[11] Ramig J E, Bailer J and Ramsey M J 2012*Teaching science process skills* (California: Good Apple Inc)
[12] Rauf R A A, Rasul M S, Mansor A N, Othman Z and Lyndon, N 2013 *Asian Social Science* **9(8)** 47
[13] Samsudin A, Liliawati W, Sutrisno A D, Suhendi E and Kaniawati I 2015 *Advances in Social Science, Education and Humanities Research* (doi:10.2991/icaet-14.2014.16)
[14] Hake R R 1999 *Analyzing Change/Gain Scores* (Indiana: Indiana University)

Acknowlegment

This work was financially supported by "Hibah Fundamental" Kementerian RISTEK DIKTI, Republik Indonesia's Research Grants in the fiscal year 2016.