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The Analysis of Project-Based Learning Integrated with Entrepreneurial Science Thinking in Terms of Symbolic Language Enhancement of Science Generic Skill

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Abstract

Project-based learning integrated with *Entrepreneurial Science Thinking* (EnSciT) is a model that involves the students in playing the learning based on their own discovering, researching, and creating project using science knowledge to produce a science-based and innovative product that can be accepted by the people. The purpose of this research is to analyze the implementation of project-based learning integrated with EnSciT in terms of students's symbolic language enhancement. The method of this research is *One Grup Pretest-Posttest Design*. This research using instruments of generic science skill test, observation sheet, and questionnaire. The analytical technique using n-gain test. Students's science generic skill enhancement resulting gain factor of 0,523 in medium criteria. The characteristics of project-based learning integrated with EnSciT growing creative thinking that trains the symbolic language. Symbolic language skill increased signifcantly resulting gain factor of 0,82.

Keywords: entrepreneurial science thinking, project-based learning, science generic skill, symbolic language

1. Introduction

The impact of globalization on market needs for labor from year to year is increasing. The International Labor Organization reports that there has been an increase in the labor population ratio of 3.3 percent between 2006 and 2016. The number of workers employed in skills and higher education jobs has also increased over the past decade. The percentage of women as professionals/ technicians in 2016 increased by 4.4 percent, while men increased by 1.9 percent (ILO, 2017). School graduates are expected to have quality work skills. Work ability is defined as the minimum level of generic skills needed by school graduates to enter the labor market (Clarke, 2007).

Generic skills in science are important to be developed in Indonesia. Senior analyst of the market research institute of e-Marketer, Monica Peart, as reported by the Ministry of Communication and Information of the Republic of Indonesia, reported that Indonesia was ranked 6th in the world in the number of internet users on November 2014. A survey by the Indonesian Internet Service Providers Association (APJII) in 2016 reported that Indonesian internet users reached 132.7 million people, which means 51.8 percent of Indonesia's population is very close to technology. Generic science skills aim to make the knowledge and skills gained from the learning process applicable in real life and to answer the challenges of an increasingly developing era, especially in terms of science and technology (Kusdiwelirawan et al., 2015).

Some of terms used to refer to generic skills include core skills / common skills (UK), key competencies / employability skills / generic skills (Australia), key qualifications (Germany), transferable skills (France), employability skills (Canada) and basic skills / necessary skills (United States) (NCVER, 2003). Some generic skills that can be fostered through physics teaching according to Brotosiswoyo (2001) include observation, sense of scale, symbolic language, logical self-consistency framework of natural law, logical inference, causality law, mathematical modeling, and conceptual building.

Many physical phenomena in daily life are easier to understand in quantitative languages than daily communication languages. As we discuss about focus distance, lens magnification, the eye near point, etc. The magnitude, units, and symbols are used to facilitate the discussion in question. Symbols represent a lot of subject matter so that it is more practical and easy to understand (Venisari et al., 2015). Good symbolic language mastery will facilitate students on understanding physics learning and giving a positive impact on students's generic science skill.

Through project-based learning, students play learning based on their own findings, researching and creating projects using the knowledge they have learned (Bell, 2010). Students involved in real problems, working with teams, and building real solutions so that the student interest increased are positive values of project-based learning (Blumenfeld et al., 1991). Research shows that project-based learning gives positive results on student learning outcomes in physics subjects (Luthvitasari et al., 2012; Amanda et al., 2014; Fitrianingrum et al., 2016).

The knowledge gained from learning physics is very important to be applied to deal with the current development. Students are taught about the nature of science, how scientific inquiry produces products, products produce facts, concepts, principles, theories and laws (Zeidan & Jayosi, 2015; Feyzioğlua et al., 2012). Entrepreneurial Science Thinking (EnSciT) is a process of integrating scientific knowledge innovatively and creatively with thought oriented on entrepreneurship (Buang et al., 2009) Entrepreneurial programs in science and engineering education increase self-employment related to generic skills (Souitaris et al., 2006).

Project-based learning integrated with entrepreneurial science thinking (EnSciT) is a model that involves students in playing learning based on their own findings, researching and creating projects using science knowledge that has been learned to produce a science-based and innovative product that can be accepted by the people. project-based learning integrated with EnSciT has the characteristics of centrality, driving questions, constructive investigations, autonomous, realism, creative, innovative, and future product development.

Based on the study above, it is necessary to conduct research on the implementation of project-based learning integrated with Entrepreneurial Science Thinking (EnSciT). The purpose of this research is to determine the implementation of project-based learning integrated with enscit in terms of symbolic language enhancement of students's science generic skill.

2. Methods

The implementation of project-based learning integrated with EnSciT was conducted at SMA Negeri 6 Semarang with a population of class XI MIPA in the academic year of 2017/2018. The sample in this research was taken using purposive sampling technique which is a sample determination technique with certain considerations. The research takes the optical instruments as the material study.

This research using the One Group Pretetest-Posttest Design method. The treatment is carried out without involving the control class and lasts for 4 meetings (8 x 45 minutes). Data analysis was carried out based on the pretest and posttest values of the science generic skill essay questions. Science generic skills enhancement can be known using the gain test with the formula according to Meltzer (2002) as follows:

$$g = \frac{posttestscore - pretstscore}{maximumpossiblescore - pretestscore}$$

where:

g : *the normalized gain*

N-gain calculation results are then categorized into 3 (three) categories according to Hake (1998) as follows:

3. Results and Discussion

TABLE 1: Category of N-Gain calculation.

N-gain Range	Criteria
$g \geq 0{,}7$	High
$0{,}7 > g \geq 0{,}3$	Middle
$g < 0{,}3$	Low

3.1. Normality test

Normality test is done to find out whether the pretest and posttest data are normally distributed or not. Normality test of students's science generic skill data acording to Sudjana (2005). The results of these calculations are shown in Table 2, for the pretest and posttest values.

TABLE 2: Uji Normalitas.

Result	x^2_{hitung}	x^2_{tabel}	Criteria
Pretest	653	11.07	Normally distributed
Posttest	2.95	11.07	Normally distributed

Based on Table 2, it is seen that x^2_{hitung} is less than x^2_{tabel} so that the initial data are normally distributed. This means that the sample has represented the population. Data that is normally distributed illustrates that there are few students with few high and low ability and many students with moderate abilities.

3.2. N-gain test

N-Gain is used to determine the students's science generic skill enhancement in optical instruments material. The results of the research resulted in an average pretest score of 74.36 and an average posttest score of 87.77. The increase in students's generic science skills has increased by 0.523 which is included in the medium category. This means that project-based learning integrated with entrepreneurial Science Thinking (EnSciT) influences students' s science generic skill. The results also show that the project-based learning integrated with EnSciT can be used to improve students'S science generic skill. Fitrianingrum's research (2016) also states that the experimental-based project-based learning model is effective enough to improve the mastery of students's concepts.

The increase of N-Gain on this research is the same as the results of research conducted by Luthvitasari (2015) on the implementation of physics project-based learning whose N-Gain value is 0.64 and is included in the medium category. Research conducted by Rais (2010) in an effort to improve academic achievement also resulted in the medium category from the results of the pretest and posttest of 0.51. This shows that the enhancement that occurs is not much different between the project-based learning integrated with EnSciT and only project-based learning. The similarity is because the integration of EnSciT in project learning does not change the characteristics of project-based learning.

Centrality, driving questions, constructive investigation, autonomous, and realism are the 5 characreristics contained in project-based learning (Thomas, 2000). These five characreristics are seen when project learning is integrated with EnSciT applied in the research class. The meeting that took place during the research aimed to make projects related to entrepreneurship science. Students learn the physics concept of the optical instruments material used in making this project. This shows the characreristic of centrality, where the project is the center of learning.

Students are driven through several questions related to the use of lup in daily life. Questions about the phenomenon of everyday life will be easier for students to understand because each student experiences it directly. Driving questions aim to make students develop their understanding related to the material used as a project, so that they can complete a project.

A project in the research class requires students to complete their own project assignments. Mastery of concepts will be useful in constructing students's knowledge in order to complete project design tasks. In order to complete the project students must investigate, and build knowledge first.

Students make project designs, determine tools and materials, and improvise according to their own abilities. The teacher gives the freedom to determine the projects that students will develop themselves. Project learning provides opportunities for students to work autonomously.

A project integrated with EnSciT provides a direct role for students to participate in playing their duties in making projects. Real impression will be felt in students because the knowledge they learn is not monotonous just memorized. Learning with the project changes the concept that is absorptive becomes real.

Students must apply optical instruments concept that has been studied into a product. Direct student involvement will make students master the concepts used in making the project. This is in accordance with the opinion of Rahayu et al (2015) that direct experience will be more attached to students' memories so that learning processes occur from not knowing to knowing.

Students must complete the project by developing their own ideas. This makes students enthusiastic in making projects. Students enjoy the learning process and create a pleasant learning atmosphere. This is in accordance with Lestari's opinion (2015) that fun learning and being able to give freedom to students will increase learning interest. In addition, student interest can be increased by involving students in real problems (Blumenfeld, 1991)

Projects made by students are not only based on science but also must be innovative and can be accepted by people. This certainly forces students to create creative and innovative ideas. The confidence and independence of students emerge from the projects they are working on. Therefore, with the project task integrated with EnSciT, the attitudes possessed by an entrepreneur will grow, and the generic skills of students will increase. This is in accordance with the opinion of Soutaris et al (2006) that entrepreneurial programs in science and engineering education increase self-employment related to generic skills.

3.3. Description of science generis skill enhancement

Description of the generic science skill enhancement can be seen from the pretest and posttest scores. The results of an analysis are shown in Figure 1.

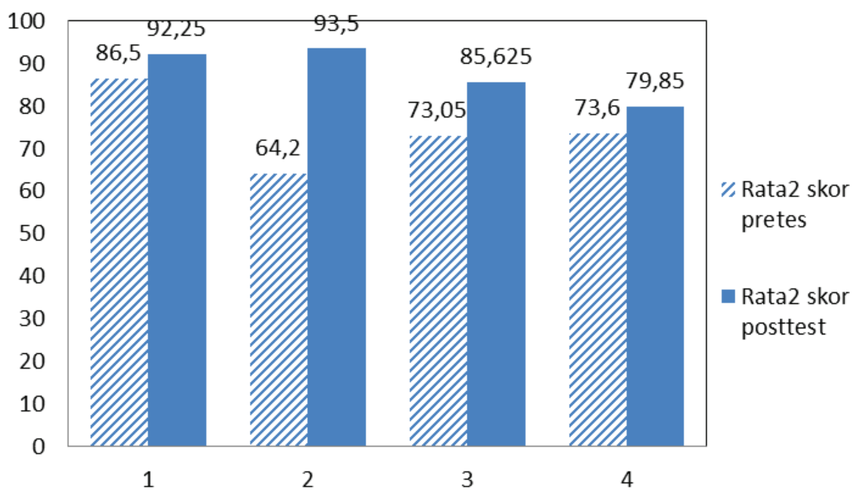

Figure 1: Science Generic Skill Enhancement.

Based on Figure 1. it can be seen that observation skill increase in score from 86.5 to 92.25. The students's initial ability to observe is very good, based on Arikunto and Cepi's assessment criteria (2009: 18-19). Observation is a sensing activity to recognize natural events around. This skill shows how to observe physics as a symptom and behavior of nature as long as it can be observed by humans (Brotosiswoyo, 2001). The problem given in this skill is about mirror concept. In this skill students must remember their experiences when observing a convex mirror on a vehicle and using a concave mirror in a flashlight.

The pretest score of symbolic language skills was 64.2, then increased to 93.5. Having symbolic language skills will make it easier for students to understand natural behavior that is difficult to understand in everyday communication languages (Brotosiswoyo, 2001). In the optical instrument material, this skill is used to determine the magnification of the optical intruments. The use of symbols, quantities and physical units is more understandable because many and difficult explanations have been summarized in short language. Symbols represent a considerable amount of subject matter so that it is more practical and easy to understand.

The skill of the logical self-consistency framework of natural law increased from a score of 73.05 to 85.625. In this skill, students' understanding of the magnifier is indirectly tested. The logical self-consistency framework is one of the difficult skills. This is because physics is based on a long experience that has the nature of logical compliance must be proven. In the problem solving process students are required to be able to explain the law as a solution to the problem.

The pretest score of causality skill was 73.6, then increased to 79.85. In this research, among the four measured skills, causality skill is the most difficult skill. This is because students must be able to estimate the causes and consequences of a phenomenon. The causality states the relationship between two variables or more in a certain natural phenomenon (Fatimah et al., 2015). The problem given to this skill is about the cause of eye defects in a person and the way to overcome the eye defects suffered. The initial value is quite good because the problem in this skill is a phenomenon that is often encountered by students.

After implementing the EnSciT integrated project on generic science skills in the research class, the results of pretest and posttest were obtained. Through the analysis of an increase in N-Gain can be known the level of increase that occurs so that it can determine the significant level of each skill tested. N-Gain enhancement results for each generic science skill are shown in Figure 2.

Based on Figure 2 shows that there is an increase of 0.43 in the observation skill. There was an increase in the medium category. Students will more easily understand something that has been his experience because of the interaction with the environment.

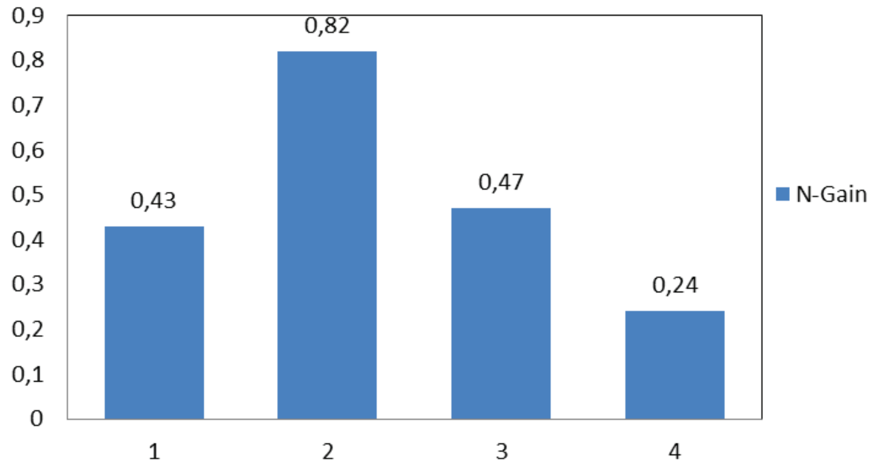

Figure 2: N-Gain Results of Science Generic Skill.

Symbolic language skills increase by 0.82 and are included in the high category. This happens because during the process of making the project students learn about working principle of the magnnifier. After the project is complete the students also present the working principle of the magnifier used in the integrated EnSciT project. Even before project creation, students are involved in the discussion process to answer the problems from the discussion sheet provided. The repetition process that occurs in learning symbolic language makes students' understanding more profound.

Score of logical self-consistency shows results of 0.47 and are included in the medium category. Repetition in learning the concept of lup gives many chances to the students more freely and openly give their opinion so that this skill can increased. As Yuniarita's research (2014) that resulted logical self-consistency of 0,34 in medium category caused of cooperation atmosphare and combine the idea formed in learning process.

There was an increase of 0.24 in causality skills in the low category. This is because students are not yet accustomed to unified phenomena that require high-order thinking. Commonly, students have known the cause of eye defects, but not all students understand why the eye cannot see objects at close range for hipermetropy, what happens to the eye so that is not able to see at close range for miopy.

3.4. Simbolic language enhancement

The overall N-Gain results indicate that integrated EnSciT project-based learning is able to improve symbolic language well. This is because the characteristics contained in the project model integrated with EnSciT turned out to be in accordance with symbolic language skills. EnSciT's integrated projects contain creative, innovative, and future product development characteristics. These characteristics foster the creative thinking attitude needed to train students' symbolic language

Creative thinking is applied when a person forms a symbolic language, logical inference, and finds a logical self-conistency framework (Gunawan et al., 2013). When students make projects integrated with EnSciT, fluency, flexibility, originality, and elaboration that are indicators of creative thinking are trained, this trains students to become fluent in interpreting natural phenomena into symbolic language.

Fluence is the ability to produce many ideas, flexibility is the ability to produce varied ideas, originality is related to the ability to generate new ideas or ideas that were not there before, and elaboration is the ability to develop or add ideas to produce detailed and detailed ideas (Baer, 1993). These aspects have been fulfilled during learning of the projects integrated with EnSciT. This is because there is a process of exchanging ideas between students so that students collaborate to complete different Augmented Reality Viewer (ARV) projects for each group. The practice of these four aspects makes students become competent and accustomed to solving problems. Competent students will find it easier to interpret natural phenomena and change them into symbolic language forms.

4. Conclusion

The implementation of the project-based learning integrated with Entrepreneurial Science Thinking (EnSciT) can improve students's science generic skill in physics. This model is able to significantly improve symbolic language skills.

The creative thinking process takes place during the creation of a project integrated with EnSciT which enables students to discover and construct their own concepts, train independence, create teamwork, and provide opportunities for students to think creatively. This is in accordance with the opinion of Soutaris et al (2006) that entrepreneurial programs in science and engineering education increase self-employment related to generic skills.

Project-bssed learning integrated with EnSciT that contains creative attitudes turns out to provide great value for symbolic language skills. In order for other skills to produce maximum value too, learning can be done by incorporating the concept of creative thinking while discussing a problem. The teacher needs to emphasize when explaining a phenomenon so that the facts of the natural environment can be a factor that supports students to think high-order.

Time management is very important in the application of this model, this is caused by the large number of groups that require more teacher attention. A strategy is needed to control the group regularly so that it runs according to the time specified. Teachers must be able to anticipate things that are not desirable when learning takes place, especially when the project is made.

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