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PROJECT BASED LEARNING (PBL) TO IMPROVE PSYCHOMOTORIC SKILLS: A CLASSROOM ACTION RESEARCH

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ABSTRACT

This paper discusses the application of project-based learning (PBL) to improve student' psychomotor skills and concept understanding, as well as knowing what PBL contribution to the improvement of student' psychomotor skills in chemistry learning. The study was conducted in three cycles. Each cycle consisted of planning, implementation, observation, and reflection steps. One set of data consists of student' psychomotor skills assesment, student' conceptual understanding and questionnaire responses were obtained from the action research. Learning process was performed in the eleventh grade students included 37 students (10 males and 27 females) and 3 collaborators. The successful research was indicated by 85% of students achieve the mastery learning on concept understanding and well on psychomotor aspects. Data collection was performed using documentation method by questionnaire, observations, and tests. Data was analyzed quantitatively and qualitatively. The results show that all aspects of the psychomotor assessed include sets, mechanical response, complex response, adaptation, and origination were in high category. At the end of the lesson, the project assigned to students were evaluated jointly between teachers and students. The project results in the form of a series of distillation apparatus is applied to separate the natural compounds.

Keywords: Classroom action research, PBL strategy, Project Based Learning, psychomotor skills

INTRODUCTION

Practicum in chemistry learning is an important approach to get the better understanding and chemistry application. The laboratory-based learning helps students to find the facts of theories learned in lectures. However, the psychomotor dimension is more important since science learning is not only a collection of knowledge, but also the human enterprises with application of motor skills, such as tools stringing and measurement. These skills are also useful for learners in everyday life. The aims of practicum are to increase the concept understanding and student' psychomotor (Millard and Abrahams, 2009). Supported by the opinions of Hofstein (2004), chemistry learning is less successful if it is not supported by the practical activities.

Project-based learning is a form of constructivist and collaborative learning in which the learning process using student-centered learning, which allows students to work together to solve problems, and learn from one another along to build their knowledge (Whatley, 2012) (Gulbahar & Tinmaz, 2006). Yalcin, et al., 2009 states that PBL is a comprehensive learning model for students. They can work individually or in groups to investigate a topic. PBL is a systematic learning that engages students in knowledge and skills learning through the inquiry development to obtain a product (Widiyatmoko and Pamelasari, 2012). Also, Sumarni (2015) states that PBL

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is a systematic teaching method that engages students in learning through research assignments, authentic questions and well-designed products. PBL enhances the student' creativity and psychomotor skills through learning activities that lead the student to produce a product (Bell, 2010); (Doppelt, 2003); (Tiantong & Siksen, 2013); and (Yalcin, et al., 2009).

Akinoglu (2008), Doppelt (2003) and Yalcin et al (2009) state that PBL is effective in improving the student' performance by a product creation through a trial. In PBL, student can actively involved in learning activity and the teacher can observe their activity during the learning process. Also, during the project, the student' psychomotor can be assessed optimally. Students can improve their psychomotor abilities, thinking skills, creativity and imagination, in line with the increasing of the learning process and its quality. The project which is given to students must stimulate them to create educational product such as the teaching props. The props can be used to provide a basic experience in experimenting and explaining concepts (Glaser & Carson, 2005) and also teachers should help the students to visualize the abstract concepts to be tangible and easily understood by the students (Pekbay & Kaptan, 2014).

A concept that needs a clear visualization is the separation of compounds based on their differences in boiling point using a series of distillation equipment. This separation concept is related to the compounds' colligative properties and the separation of essential oil fraction. In highschool, there is no distillation equipment; therefore, student can do the action research by giving them a project to produce a series of distillation equipment using secondhand materials. The results of the study by Widyatmoko & Nurmasitah (2013) on project-based learning by teaching props production show that the student activity increased 25%. In addition to student activities, the research of Deta et al (2013) also show an association between PBL and the students' skills. It shows 55% improvement on the aspect of props assembling skills. .

Through practice activities, science educators can direct students towards scientific work. Moreover, teachers give the opportunity to understand and to recognize the environment, doing observation and establishment of a causal relationship, and also learning with hands-on activity (Hofstein & Lunneta, 2004). In addition, teachers can also improve the self-confidence and motivation of students (Saad, R. & BouJaoude. 2012; Chanlin, 2008); help them learn about themselves; develop their ability to solve problems, develop psychomotor and mental abilities; provide meaningful learning; improve the ability to think analytically; and supports the relationship between science and everyday life (Hofstein & Lunneta, 2004; Mc Donnel, 2007)

Assessment of psychomotor in chemistry learning can be enhanced through practical activities (Aksela & Juntunen, 2013). Psychomotor domain is all about "doing something" through imitation, practice and habituation of new skills, while two types of learning in Bloom's Taxonomy is the cognitive domains, focusing on knowledge, and the affective domain is focused on attitude (El-Sayed, 2011) (Witteck, et al., 2007). The laboratory practice can development of psychomotor skills potency (Witteck, et al., 2007) which aims to develop the direction of the students' performance (Tafa, 2012). The seven major categories which is listed from the simplest behavior to the most complex is expressed by Samson (1972) in (Clark, 2014) as shown in Table 1.

Based on the problems stated in this section, the classroom action research was conducted in this study. This study aims to improve the students' concept understanding and psychomotor skills through teaching props production. The expected benefit of this research is to expand the knowledge about the use of props in an effort to visualize the abstract topic and also to improve psychomotor skills. Practically, PBL can increase the student' concept understanding in the topic of solution vapor pressure and the separation of mixtures by boiling point. Moreover, by using teaching props, the students can see, feel, express the thought about the living objects they learned. Also, they can observe the abstract concept, inherent and durable in the students. In addition, it broaden the students' knowledge about the application of used materials as the learning tool. It also can improve students' creativity and activity.

METHOD

The classroom action research was conducted in collaboration with teachers of one high school in Semarang. Subjects were students of class X as many as 37 students (23 females and 14 males). This research was referred to the Spiral Model Kemmis & Mc Taggart, where there are four important stages in classroom action research, namely (1) planning, (2) actions, (3) observation, and (4) reflection, resulting in cycles as shown in Figure 1. This study was carried out in three cycles.

Students' achievement of this study was

Table 1. *Simson's Psychomotor Domain of Taxonomy*

Level/learning Outcomes	Characteristics
Perception (awareness)	The ability to use sensory cues to guide motor activity. This ranges from sensory stimulation, through cue selection, to translation.
Set	Readiness to act. It includes mental, physical, and emotional sets. These three sets are dispositions that predetermine a person's response to different situations (sometimes called mindsets).
Guided Response	The early stages in learning a complex skill that includes imitation and trial and error. Adequacy of performance is achieved by practicing.
Mechanism (basic proficiency)	This is the intermediate stage in learning a complex skill. Learned responses have become habitual and the movements can be performed with some confidence and proficiency.
Complex Overt Response (Expert)	The skillful performance of motor acts that involve complex movement patterns. Proficiency is indicated by a quick, accurate, and highly coordinated performance, requiring a minimum of energy. This category includes performing without hesitation, and automatic performance.
Adaptation	Skills are well developed and the individual can modify movement patterns to fit special requirements. Adjustment.
Origination	Creating new movement patterns to fit a particular situation or specific problem. Learning outcomes emphasize creativity based upon highly developed skills.

measured with at least 75% of the number of students reach the minimum criteria of cognitive and achieve very good criteria on psychomotor aspects. Data analysis technique used quantitative and qualitative methods. Assessment in the psychomotor domain was performed and it was observed repeatedly using a ranking scale. Also, the observers were involved in the study to minimize the potential for such variability. Top of Form

Simpson approaches on the psychomotor domain have seven levels, starting with the simplest level: perception, set, guided response, mechanic response, complex response, adaptation, and origination.

RESULTS AND DISCUSSION

From the research which was conducted on from pre-cycle to the third cycle, we obtained the cognitive learning outcomes and the percentage of classical completeness, as shown in Figure 2.

From Figure 2, it appears that in the first cycle, cognitive learning outcomes of students not in accordance with indicators of successful achievement at 75%. However, then it was achieved in the second cycle. Based on Figure 1, it can be seen that the same learning model as the previous cycle, there is an increase in cognitive learning outcomes at the second cycle. Improved cognitive scores of students from cycle 1 to cycle 2 occurs was caused by most of the students who were excited to learn chemistry. In addition, the teacher gave them instructions to carry out an orderly and purposeful learning, as submitted by Lee et al. (2012) and Harman et al. (2016).

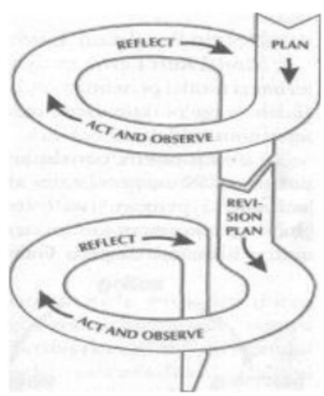

Figure 1. Model of Classroom Action Research by Kemmis & Mc Taggart

However, action still needs to be continued to the third cycle, because as shown in Figure 2, indicator of the successful achievement of psychomotor skills, had not been achieved in cycle 2.

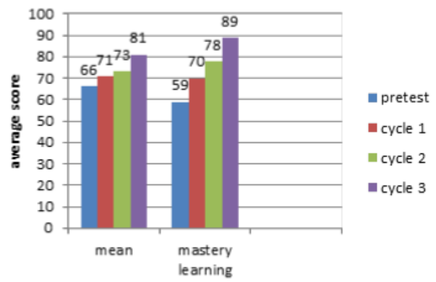

Figure 2. The average value of cognitive and completeness of classical study of the cycle I-III , n = 37.

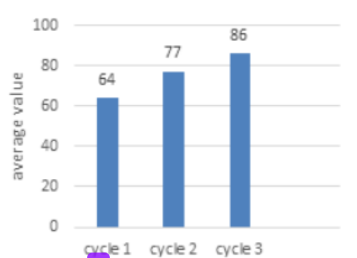

Figure 3. The increase in the average value of students' psychomotor of the cycle I-III., N = 37

From Figure 2 and Figure 3, it appears that the psychomotor aspect in cycle 1 of each indicators, i.e. guided response, origination, perception, sets and adaptation has not reached the good category.

In the first cycle, the skill to prepare the tools, materials, and completion of the work were low because students had not understood the props of distillation components and its functions. In the aspect of readiness (set) students tended to pay less attention to the teacher's explanation about preparation of props distillation and how to formulate and measure a working solution before distillation process. Students also were not accustomed to prepare tools and materials lab independently. This result was in line with the statement as disclosed by Onwuagboke and Osuala (2014) that the psychomotor aspect—especially in the aspect of planned activities and the use of tools and materials, the ability of students—tends to be low due to unpreparedness of students in subject participation and experiments independently.

Based on the result of reflection in cycle 1, the learning cycle 2 was conducted by providing a project assignment for students to make a distillation apparatus which has been planned for the cycle 1t. The project gave the students a task to create a series of distillation apparatus using the used materials.

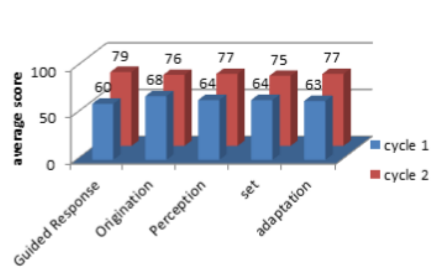

Figure 4. Results of psychomotor skills achievement of students in cycle 1 and 2.

In comparison, the results of cognitive value obtained in the cycle 2 showes that students have increased their score compared with the cycle I. The improvement on the cognitive value of students from the first cycle to the second cycle was occured because most of the students began to enthusiastically participated in chemistry learning and teachers have given signs that learning takes place in an orderly and purposeful. In the second cycle, in general psychomotor skills of students had increased. Five aspects were considered to reach good category. Increased psychomotor aspects of the students in the second cycle is consistent with that presented by Witteck et al. (2007) that the laboratory does not only provide a platform to learn hands on activity, but also to collect scientific knowledge in a different way (Lee et al. 2012) and contributes to equipping students psychomotor skills. In the first cycle, the readiness (set) skills of students was low, then, in the second cycle, preparation of the distillation apparatus the components and their functions was conducted in discussion at first. This activity as a means to know the aspects of adjustment (adaptation) with the presentation.

The results of students' skills for adaptation aspects was seen from the performance of students when the presentation and the students' understanding of the material was included in high criteria. In Figure 3, it is also seen that guided response (guided movement) and origination (creativity) are already included in high criteria. In this aspect of the student has mastered how to arrange a distillation apparatus properly.

However, most of the students imitated the teacher's example in making a series of distillation apparatus, only about 31.35% of students were creative by developing several different components of the series distillation apparatus as exemplified by the teacher. This is consistent with the findings of Widiyatmoko and Pamelasari (2012) as well as Hakimzadeh et al (2013) which states that students are still experiencing difficulties in terms of producing and modifying the the props. Based on the results of the implementation of the second cycle reflection, the third cycle was designed by focusing on improving the psychomotor skills in order to achieve the very good category.

In the third cycle, the students carry out the practice of distilliation as well as to evaluate the distillation props they made. In third cycle, each group of students distilled the different materials. Group I distilled frangipani, group II distilled roses, group III distilled magnolia, and group IV distilled pandan leaves. Two aspects i.e. mechanical responses that include skills in using tools to perform complex distillation response and smoothness in operating a series of distillation apparatus were measured in third cycle. The results of students' skills in this distillation activity can be seen in Figure 5.

Figure 5. The results of the practice at the end of the cycle.

The third cycle is used as a means of products evaluation of props that have been created by students. In the third cycle, the students practice the refining of natural ingredients. As shown in Figure 4, from the five aspects of the psychomotor skills students have been able to achieve high category. This condition is consistent with the statement (Harman, et al., 2016) that learning in the laboratory is important to improve the quality of learning by the method expressed as visualization, realization and implementation, observation and experimentation. (Lee, et al., 2012) also stated that the laboratory experience as an opportunity for problem-solving in the cognitive domain. The science teacher was also found, with laboratory practice with the knowledge they can teach it easier for their students and they can find an interesting experience (Kibirige & Hodi, 2013) (Owolabi & Oginni, 2012); (Lee, et al, 2012); (Hofstein, 2004). If students are trained on an ongoing basis, the ability to increase due to the formation of experience in conducting complex skills. This is in accordance with (Rothgeb, 2008) which states that the practical work can be done in collaboration to improve the problem solving skills.

In the aspect of the set, the students have been able to prepare the tools, materials, and completeness of practical work without the guidance of a teacher. Students have also been able to achieve complex mechanical response and a response that is characterized by smooth movements and skilled in assembling and using props distillation. This statement is also in accordance with (Mioduser & Nadav, 2007) and (Sumarni, 2015) which states that the use of props in PBL improve psychomotor skills of students to form a positive learning.

Thus, in the third cycle, the overall results showed the increase in student psychomotor skills. Widiyatmoko and Pamelasari (2012), (Gulbahar & Tinmaz, 2006) and (Deta, et al., 2013) state that PBL products of props can improve the psychomotor skills of students as students work to improve their ability to plan, organize, and create the understanding to build skills. It is also in accordance with the opinion (Chanlin, 2008), (Yunus, et al., 2010), that PBL increase the knowledge and scientific work of students after practical work using distillation props made from used materials. Therefore, PBL can be applied to increase students' understanding of the material being taught. (Harman, et al., 2016) also stated that the cognitive skills needed to be supported by the ability of psychomotor and affective skills.

This study certainly does not go smoothly; there are some obstacles or barriers. This is in line with what is presented Mudulia (2012) that there is a correlation between the availability of resources and the achievement of science, arguing that high-performing schools have the resources and the availability of laboratory equipment and chemicals are much more than the low-performing schools. Most low-ability students who are still facing the difficulties is expected to compensate with the other students to work in team or group. Thus, students with high ability can help the other students. This can lead to low-ability students become confident in the presentation and lab activities. (Makori & Onderi, 2013) and (Musasia, et al., 2012) said that the factors that can affect students' attitudes towards learning which is the level of understanding, the anxiety, the presence, the workload of teachers, school discipline and time management.

Based on open questionnaire, most students responded positively to the project-based learning. They stated that they were glad to exchange ideas and to do discussion, both with fellow students and teachers directly. This model is a good and easy to follow according to the effort the students themselves, it can motivate them in learning activities, can enhance the creativity of students and educate students to be more disciplined.

CONCLUSION

An overview of the project work in science education, suggesting that the focus remains on cognitive skills. However, cognitive skills need to be supported properly by the psychomotor skills and affective skills. Science teachers believe to thank the laboratory applications where they can teach science more easily to their students. The student can be successful and the scientific process skills of students can increase (Myers & Dyer, 2006).

Based on the results of action research that has been done, it can be concluded that learning with project work in the form of props is a learning laboratory distillation student-centered is essential and beneficial for students to develop the three domains of learning, namely; cognitive, affective and psychomotor. Working practices play an important role in creating links with everyday life, enabling students to understand the lessons, embody the knowledge learned, and to develop their psychomotor skills and dexterity (Pekbay & Kaptan, 2014; Kibirige & Hodi, 2013; Owolabi and Oginni, 2012; Saad & BouJaoude. 2012; Tafa, 2012; Millar, 2009; Teixeira-Dias, 2005) Many of the skills that can be gained from these activities include the skills of observation, measurement, classification, data recording, create hypotheses, using data and gain the ability in creating, changing and controlling variables, and conduct the scientific experiments.

PBL with flourescent distillation can improve the psychomotor skills of the students. However, it is suggested that if the product will apply PBL with props, teacher should consider the ability of students to be sampled with the research projects to be implemented. This is important because the application of learning by creating products that are not offset by the ability of the students can lead to less than optimal research results, making it less in line with expectations desired.

Because the goal of this research to help students in the lab, the lab with limitations in laboratory devices, can be done by creating other teaching aids made from used materials. Thus, PBL can be further developed to overcome the constraints of practical implementation such as the electrolysis process lab to understand the properties of colloids, conservation of mass, and so on.

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