

**PROJECT BASED LEARNING (PBL) TO IMPROVE PSYCHOMOTORIC SKILLS: A CLASSROOM ACTION RESEARCH****W. Sumarni*, S. Wardani, Sudarmin, D. N. Gupitasari**Department of Chemistry, Faculty of Mathematics and Natural Sciences
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Accepted: August 16th 2016. Approved: September 4th 2016. Published: October 2016**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.

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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 Pamela-sari, 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's 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's 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's 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 & Lunnetta, 2004). In addition, teachers can also improve the self-confidence and motivation of students (Saad, R. & BouJaoude. 2012; Chanlin, 2008); help them learn about themself;

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 & Lunnetta, 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's 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 at 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).

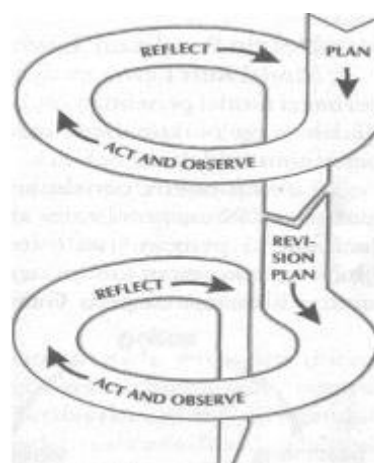


Figure 1. Model of Classroom Action Research by Kemmis & Mc Taggart

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.

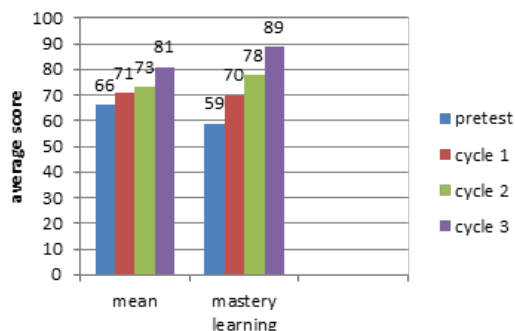


Figure 2. The average value of cognitive and completeness of classical study of the cycle I-III, $n = 37$.

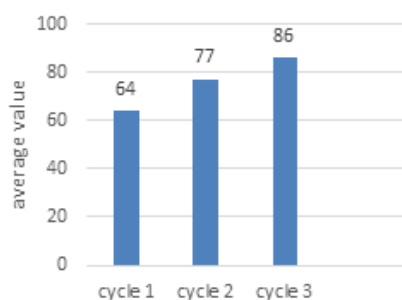


Figure 3. The increase in the average value of students' psychomotor of the cycle I-III., $N = 37$

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.

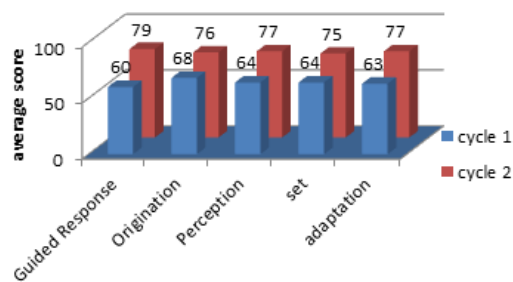


Figure 4. Results of psychomotor skills achievement of students in cycle 1 and 2.

In comparison, the results of cognitive value obtained in the cycle 2 shows 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 occurred 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 31.25% 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 Pamela-

sari (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 distillation 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.

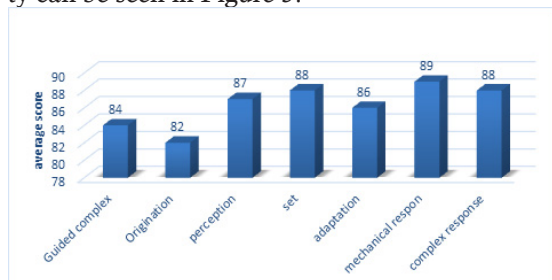


Figure 5. The results of the practice at the end of the cycle.

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 fluorescent 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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STEM VIRTUAL LAB : AN ALTERNATIVE PRACTICAL MEDIA TO ENHANCE STUDENT'S SCIENTIFIC LITERACY

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ABSTRACT

This research aimed to develop a STEM-based virtual lab as an alternative media in improving scientific literacy of junior high school students on the theme of water pollution. Development is done by using 4D methods: Define, Design, Develop, and Disseminate. After the implementation was done, its effectiveness in increasing scientific literacy was examined using one group pretest-posttest design. At the define stage problems from PISA 2012, KDs, and STEM characteristics were analyzed. Design of flowcharts, storyboards, and user interface were done on design phase. Phases of develop includes the creation of virtual labs and validation by media expert and a science teacher. Phases of disseminate this research is to implement limited to two classes of junior high school students. The results from media expert validation and science teachers validates that STEM-based virtual labs that have been developed shows very decent used in the feasibility study by percentage according to media expert at 86.24% and 82.71% according to science teacher. The results show that the implementation of the STEM-based virtual lab that has been developed can improve scientific literacy of students with a large increase (N-gain) in the class 7B of 0.46 which falls in to medium category and class 7D of 0.29 with medium category.

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Keywords: virtual lab, STEM, Scientific Literacy, media learning science, Development

INTRODUCTION

Science, technology, engineering, and mathematics (STEM) is a thematic approach in the development of science education. STEM education is constructed as a new whole and holistic body of knowledge based on constituting disciplines (Sanders, 2009). STEM is an important component in 21st century education. It is of an utmost importance to promote STEM in today's education system (Becker & Park, 2011). Integration of several disciplines into one comprehensive subject is hoped to help build not only a knowledgeable, but also competent student who are able to implement the concepts on daily everyday life. The learning itself is hoped to bring

deeper meaning to student, provide a better learning condition through experiments, and hoped to help student generates a comprehensive understandings on important issues (Davison, 1995). STEM approach is a combination of science, technology, engineering, and mathematics in to a curriculum as a unit (Jones, 2008). Integrated approach of the STEM will help the students with analytical and problem solving aptitude to prepare them for real life working environment. Knowledge with applicable implementation on solving problems is the definition of scientific literacy. Scientific literacy defined as knowledge and skills required to identify problems, acquire new knowledges, explaining natural phenomena, and drawing conclusion based on presenting evidence.

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ment (PISA) is an international study designed and executed by *Organization for Economic Cooperation and Development* (OECD) as a means of international assessment regarding the efficacy of education system in preparing the students for real life dynamics. Of several PISA tests held, Indonesia consistently scored worrisome results. The 2012 testing saw Indonesia placed at the 64th out of 65 participants (OECD, 2014). This result could be tied to several factor including the lack of learning media. Computer technology could be the answer to this problem. Computer technology has not been used to it's full potential as a learning media by the teacher.

The use of computer technology as learning media requires the teacher to play the role as a facilitator to improve the student's understanding on the subject matter (Kutluca, 2010). An application of computer based learning media is in the form of virtual lab. Virtual lab is a computer program designed to simulate the real life laboratory works and experiments (Keller, 2005). According to Hampell (2001), virtual lab is a tool to achieve a high quality learning by providing virtual apparatus, algorithm, and other equipment in particular discipline.

Main component of virtual lab is: 1) laboratory setting and equipments; 2) computer set; 3) computer network; 4) virtual lab program; 5) partnership management and policy; 6) engineering division (Dillon, 2007). In this study the virtual lab used is based on offline platform, so point three is null.

According to experts, characteristics of virtual lab base education is as follows: a) creates novel knowledge, b) builds knowledge and internalizes informations, c) motivates and guides the students, d) registers student informations automatically and evaluates them, e) simulates experiments that are either dangerous and/or expensive, f) optimizes time consumption on learning process, g) improving student's academic achievements, h) improving student's conceptual understandings, i) specially suitable for children with visual learning style (Carnival, 2003; Keller, H.E&Keller, B.E., 2005; Jian, Brown, & Billet, 2005; Saleh, Mohamed, & Madkour, 2009; Dobrzanski&Honysz, 2010; Taskin&Kandemir, 2010; Gunhaart&Srisawasdi, 2012).

Virtual lab uses computer program to simulate series of experiments without physically doing them. It provides students with tools, material, and laboratory set virtually on the computer to carry experiments subjectively anytime and anywhere (Babateen⁺, 2011). Virtual lab also enable students to simulates the laboratory works

that are impossible to carry on real life. Virtual lab can help students to explore visualize abstract concepts in science application (Baser & Dumus, 2010). Some benefit of virtual lab are : 1) enable students to create alternative experiments because of the time and cost efficiency, 2), enable students to achieve understanding on macroscopic, submicroscopic, and symbolic level (Murniza, *et al.*, 2010), 3) provides dynamic representation of submicroscopic particle, 4) contibutes to a better understanding on chemical compunds, 5) strongly motivates students (Herga et al, 2014). Virtual lab can also improve conceptual thinking and investigation performance (Chien, et al, 2015)

Despite the overwhelming benefits, virtual lab has several disadvantages i. e: a) lack of physical interaction between hardwares, equipments, teacher, and students; b) the need of computer and specific tools; c) the need of technical expert staff, instructor, and curriculum expert to design and produce the lab; d) virtual lab can not enhance social and psychomotor skill as good as real lab should (Carnival, 2003).

Regardless of the disadvantages, virtual lab has the ability to bring the STEM learning closer to students through interesting activity social interaction (August, et al. 2011). Real life practice could not help build STEM skills, so virtual lab can provide a solution on this aspect. Based on above logical framework, a STEM virtual lab has been developed and the effectiveness on enhancing student's scientific literacy was examined.

METHOD

This study use the four stages educational research and development model with define, design, develop, and disseminate phase (Thiagaraan, *et al.*, 1974). On define phase, problems from PISA 2012 testing were analyzed to identify content and context which will be build in to virtual lab. Analysis from PISA test the triangulated with curriculum analysis, in this case is the 2013 curriculum. Next step was to do literature research in order to define the concept of STEM.

Design phase consists of: making flowchart, storyboard, and user interface of the program. Develop phase is where the virtual lab was made by using adobe flash CS 6.0, which was then validated by media expert and teacher as the user. Disseminate phase saw the distribution of the virtual to end user to be implemented and tested. Trial was done at SMP IT Azkia Sukabumi. Two class with gender segregation was selected to examine the practicality of virtual lab developed by using one group pretest-posttest design

(Fraenkel *et al.*, 2011). The sample consist of 59 students, 29 from 7B class and 30 from 7D class.

RESULT AND DISCUSSION

Virtual lab was designed and developed based on the STEM concept (Zolman, 2012). The theme covered was water pollution from science subject. Pictures below is the user interface of STEM virtual lab developed.

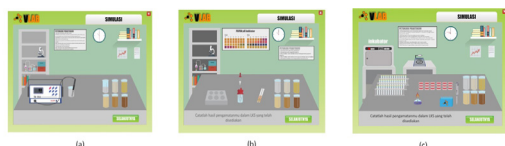


Figure 1. Screenshots of STEM virtual lab user interface; a). Turbidity experiment, b). pH value testing, c). Dissolved pathogenic bacteria examination

Scientific literacy framework referred here was established by *National Science Education Standards* (NSES) and *Organization for Economic Cooperation and Development* (OECD). Scientific literacy defined as an ability to employ the scientific knowledge and understandings of science in decision making process in real life scenario especially on the subject of health and sanitary, earth, environment, and technology.

The virtual lab developed exhibits experiments with three water pollution indicators: water turbidity as physical indicator, pH value as chemical indicator, and pathogenic bacteria as biological indicator. These indicators were selected to be included on the software because of these concepts are abstract and need to be made easy for students.

Characteristic of technology literacy implemented on this virtual lab was established by *National Assessment Governing Board* (NAGB), *International Society for Technology in Education* (ISTE), dan *International Technology Education Association* (ITEA). Author combines and integrates the characteristics proposed by mentioned professional organizations. Characteristic of technology literacy referred on developing this virtual lab is the use of advanced technology in learning, to help the students use, understand, investigate, dan solve problems with technology. Manifestation of technology.

Engineering literacy which also referred on this research was proposed by OECD and *Accreditation Board for Engineering and Technology* (ABET) as an ability to sistematically and creatively act on the guidance of scientific principles with practical

use on product design, manufactures, and structural operations. One particular ability enforced by this virtual lab is sistematic and creative ability on scientific principles corridor. On this virtual lab students will be tasked to work systematicly, organizing steps that has been randomized, as seen on Figure 3.



Figure 2. Virtual lab content internalizes characteristics of technology literacy

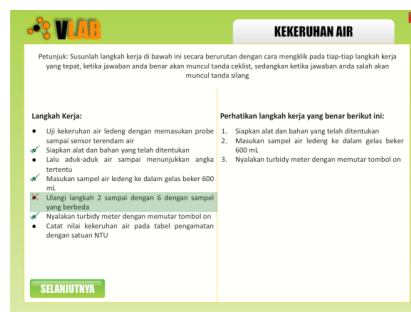


Figure 3. Manifestation of engineering literacy on virtual lab.

In Figure 3 we can two column with directions for student to organize the randomized work steps. Students should arrange the activities randomized in left column into correct order on the right column. In the process if student manage to arrange the activities correctly, checklist mark will appear on the left column. But if the students messed the order of the activities, a large red x will appear on left side to signify that the answer is not correct. In placing the steps of activities, students need to be careful as to not a mistake since the amount of clicks is measured. If the amount of click needed to arrane the activities is more than the amount of steps, the programs calculated it as mistake, thus reducing the point.

Mathematics literacy referred on developing this STEM based virtual lab is proposed by PISA and National Council of Teacher of Mathematics (NCTM) which states that mathematics literacy as an ability to identify, read, listen, creatively think, communicate, understand, and

involved in mathematics and making informed judgement on certain situation. Mathematical skills enforced through this virtual lab are identification, reading, and communicating in the form of data generalization on table and graph. It manifested on the virtual as shown in Figure 4.

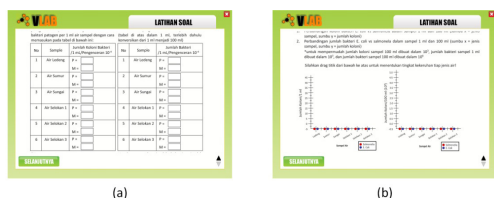


Figure 4. Screenshots of virtual lab showcasing mathematics literacy characteristics, a). Generalizing data to table, b). Generalizing data to graph.

Mathematical skill integrated on the virtual lab in the form of data generalization skill into graph and table. This skill was trained in the virtual lab along with mathematical unit conversion skill. Data generalization training is included in the virtual lab posttest menu on every experiment section.

Validity check performed by media expert and science teacher declared the STEM based virtual lab developed to be of high quality and suitable to be used on learning process. Validity check from curriculum expert stated that the product falls in to “very good” category and is suitable to be used on science learning. Validation data is provided in table 1. This result conform to what is expected from a learning media which states that learning media should be able to facili-

tate the information exchange, transmit concepts, and help constructs meaningful learning to motivate the students as well as enhancing their science skill (Kutluca, 2010; Gundogdu, *et al.*, 2011).

Validation was done by two media expert, with satisfactory result. Virtual lab developed is found to be valid and suitable for science learning in the topic of water pollution, as shown in table 2. Judgement from expert determine the product is of high quality and attractive, provides interactive platform, coherent with the referred curriculum, and succesfully implement STEM concept. The virtual lab scores high result as media as it incorporates three important elements of mutimedia product i.e. voice, picture, and text. The virtual lab is found to be able to simulate the real laboratory experiment as also been stated by Keller at 2005. Authenticity of the experiments provided is kept to the highest with the embedding of particular equipment essential on real life practice such as turbidimeter on turbidity experiment simulation, pH indicators, and colony counter. This helps give the authenticity and resembling learning experience to the real life practice, which is also the case on Harms (1998) and Hamper's (2001) research.

Next step was to check the combination of scientific theme in the virtual lab. To ensure that biology, physics, and chemistry content are fused together in harmony, the virtual lab was validated by three independent experienced teachers from each discipline. Validators unanimously stated that the virtual lab developed is potential to motivate student, enhance their scientific literacy,

Table 1. Data recapitulation from STEM based virtual lab validation analysis by curriculum expert

Criteria	Score	Max Score	%	Category
Aspek kebenaran konsep	15	16	93.75	very good
Aspek kedalaman dan keluasan konsep	17	20	85.00	very good
Aspek peningkatan literasi sains	11	12	91.67	very good
Total	43	48	270.42	very good
Mean	14,33		90.14	very good

Table 2. Data Recapitulation from media expert validation of STEM based virtual lab

Criteria	Score (%)		Mean	Category
	Validator 1	Validator 2		
Design quality	88.89	8,89	88.89	very good
Visual attraction	75	95	85,00	very good
Interactivity	79.17	100	89.58	very good
Coherency with curriculum	75	100	87.50	very good
Incorporation of STEM concept	75	87,5	81.25	very good
Mean	78,61	94,28	86.24	very good

stimulate them to learn actively, and train their thinking skills.

Validation from both curriculum expert, media expert, and science teachers declared that the product is of high quality. Experts validations are then supported by data from virtual lab implementation in the classroom. The use of virtual lab on learning process significantly improved student's scientific literacy. Improvements in science literacy are observed in content domain and competence domain in the scope of context domain, in this case is environmental context, as well as attitude domain. Both of the class tested showed improvements in scientific literacy level, but with different gain.

In content domain, topics included are water pollution, indicators of water pollution, components of water pollution, and effect of water pollution. Student's mastery over the science content is described in Table 4.

According to Table 4 above class 7b shows

a better improvement on water pollution indicator at 57.89%, while class 7d scored highest at water pollution definition at 54.55%. Content with the lowest gain scored by class 7b was the water pollution definition at 40.74%, while class 7d scored the lowest in water pollution components at 10.93%. Recapitulation of student's science literacy improvements is described in figure 5.

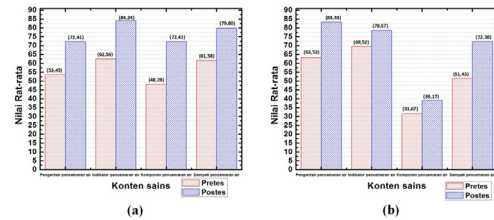


Figure 5. Student's scientific literacy before and after treatment with STEM based virtual lab (a) Class 7B dan (b) Class 7D

Table 3. Data Recapitulation of virtual lab validation by science teachers

Criteria	Score				Ideal score	%	Category
	Teacher 1	Teacher 2	Teacher 3	Total			
Curriculum coherency	14	16	16	46	48	95.83	Very good
Incorporation of STEM concepts	24	21	20	65	96	67.71	good
Virtual lab components	29	29	26	84	96	87.50	Very good
Easy of use on learning set	14	14	12	40	48	83.33	Very good
Usage potential on learning	26	26	24	76	96	79.17	Very good
				312	384	413.54	
						82.71	Very good

Table 4. Data recapitulation of student's scientific literacy improvements

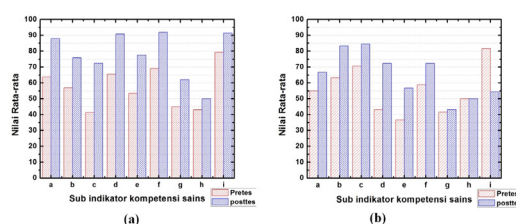
Content	Class (7B)				Class (7D)			
	Mean			Category	Mean			Category
	Pretest	Posttest	N-gain		Pretest	Posttest	N-gain	
Definition of water pollution	53.45	72.41	40.74	Medium	63.33	83.33	54.55	Medium
Indicators of water pollution	62.56	84.24	57.89	Medium	69.52	78.57	29.69	Low
Components of water pollution	48.28	72.41	46.67	Medium	31.67	39.17	10.98	Low
Effects of water pollution	61.58	79.80	47.44	Medium	51.43	72.38	43.14	Medium
Mean	56.47	77.22	48.18		53.99	68.36	34.59	

Figure 5 shows that every science content saw improvement after treatment with STEM based virtual lab, with gain disparity for each content. Class 7b scored highest improvement on water pollution indicators, while the lowest gain was scored for water pollution definition.

Class 7d scored highest improvement on water pollution definition, and the lowest was for water pollution components. For science competence domain, science competence indicators studied were identification of scientific problems, explaining science phenomena, and using scientific prove, each with three sub indicators.

Data from table 5 shows that average improvement of identification of scientific problem, explanation of scientific phenomenon, and using scientific prove of class 7b in order are at 54,54%, 62,96%, and 35,23, while in class 7d the gain were 42,51%, 32,01%, and 27,27%. Total mean gain of class 7b is 50,91% while total mean of class 7d was 33,93%, both falls into medium category. There was a result disparity between classes with difference of 16, 93%, class 7b being the higher achiever.

For class 7b the highest improvement was scored on explaining scientific phenomenon indicator at 62.96% which falls in to medium category. Smallest improvement was scored on using scientific prove indicator at 35.23% at medium category. Highest improvement of class 7d was scored on identification of scientific problem indicator at 42.51%. It is understandable that using scientific prove indicator scored the lowest at both class because of student's unfamiliarity with the process of using and proving knowledges. Students used to be the at the receiving end of learning process, turning them in to passive learner, thus causing negative effect on their scientific proving ability. In the following histograms the scores of both classes is described.



Legends :

- a)Recognizing issues with possible scientific explanation
- b)Mengidentifikasi kata-kata kunci untuk mencari informasi ilmiah
- c)Mengetahui ciri khas penyelidikan ilmiah
- d)Mengaplikasikan pengetahuan sains dalam situasi yang diberikan
- e)Mendeskripsikan atau menafsirkan fenomena ilmiah dan prediksi perubahan lingkungan
- f)Mengidentifikasi deskripsi, eksplanasi, dan prediksi yang tepat
- g)Menafsirkan bukti ilmiah dan membuat serta mengomunikasikan kesimpulan
- h)Mengidentifikasi asumsi, bukti dan alasan dibalik kesimpulan
- i)Merefleksikan implikasi sosial dan perkembangan sains dan teknologi

Figure 6. Student's scientific literacy level in the scientific competence aspect before and after treatment with STEM based virtual lab. (a). Class 7b, (b). Class 7d

According to figure 6, the improvement of student's scientific literacy for scientific competence aspect shows the highest gain at indentifying, describing, explaining, and predicting sub-indicator at 74.07%. Lowest gain was scored on using scientific prove at 12.12%. Students have difficulties in using their knowledge in real life

Table 5. Data recapitulation of science competence domain improvement

Science competence indicators	Class 7b				Class 7d			
	Mean			Category	Mean			Category
	Pretest	Posttest	N-gain		Pretest	Posttest	N-gain	
Identification of scientific problems	54.02	78.74	54.54	Medium	63.01	78.16	42.51	Medium
Explaining scientific phenomenon	61.21	84.77	62.96	Medium	47.78	64.44	32.01	Medium
Menggunakan bukti ilmiah	61.21	70.69	35.23	Medium	65.83	70.83	27.27	Low
Mean	58,81	78,07	50,91	Medium	58.87	71.15	33.93	Medium

Table 6. Mean of student's scientific attitude

Indicators of Scientific attitude	Mean (%)							
	Class 7b			Category	Class 7d			Category
	Pretest	Posttest	N-Gain		Pretest	Posttest	N-Gain	
Supporting scientific inquiry	73.28	83.62	38.70	Medium	65.83	72.22	18.71	Low
Scientific curiosity	67.24	76.44	28.08	Low	65.61	75.83	29.73	Low
Responsibility on resources and environment	76.29	87.93	49.09	Medium	75.21	82.50	29.41	Low

scenario. Lowest score was found on using scientific evidence, identifying assumption, evidence and reasons behind conclusion at 0%.

Next domain examined is scientific attitude domain. Scientific attitude measured consist of three indicators : 1) supporting scientific inquiry, 2). Scientific Curiosity , 3). Responsibility on resources and environment. Data from scientific attitude measurement of the student treated with STEM based vitua lab are described below.

Data from the table shows that there are improvements in student's scientific attitude after treatment with STEM based virtual lab. Generally, class 7b showed higher improvement than class 7d. Highest gain of class both classes was scored on the third scientific attitude indicators at 49. 09% for 7b and 29% for class 7d.

Considering the improvements of student's scientific literacy after the usage of STEM based virtual lab, we concluded that the product is very effective to be used in learning process. The use STEM based virtual lab on science learning is proven to be effective in enhancing student's scientific literacy, as shown by the test data. This result is at agreement with a research by Adolphus, et al. (2012) which states that ICT can help student in science learning by giving access to information, measuring, and analysis. The use of virtual can also stimulates and motivates student in learning because of the novelty and uniqueness of human-program interactions (Zumbach, et. al., 2006)

CONCLUSION

STEM based virtual lab of water pollution theme has been developed with high STEM characteristics, with satisfactory effectiveness. Validations from experts and users declared that the product is valid and of high quality. The product

is a good alternative for water pollution experiments. The use of this virtual also score a significant gain on student's scientific literacy level as shown in the test data.

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PROJECT BASED LEARNING INTEGRATED TO STEM TO ENHANCE ELEMENTARY SCHOOL'S STUDENTS SCIENTIFIC LITERACY

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ABSTRACT

This study was done to depict Project Based Learning (PjBL) integrated with science science, technology, engineering, and mathematics (STEM), to enhance elementary school students' science literacy. Theme used in this study was air pollution. Research method was quasi experimental with The Matching-Only Pretest-Posttest Control Group Design. It was conducted in 56 seventh graders of SMP Islam Terpadu, Sukabumi in which 28 students were in experiment class, and 28 students were in control class. Data is collected by pretest and posttest of sciences literacy and students questionnaire about PjBL STEM. Based on the data analysis, it was known that the N-Gain averages of sciences literacy were 0,31 in experiment class as middle category and 0,22 in control class as low category. T-test showed that scientific literacy enhancemen in experimental class was more significant than in control class. General students' reponses showed that almost all students was excited to PjBL STEM learning, got impressive experiences during the learning and boost their learning motivation and interest.

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Keywords: Project Based Learning, STEM, air pollution

INTRODUCTION

The essence of sciences learning is not only to remember and understand concept found by scientist. More than it, sciences learning gives direct and meaningful learning experiences which can be applied in the daily activities. The means in sciences learning can be acquired through students' sciences literacy which is beneficial in problem solving activity. Sciences literacy needs scientific concept comprehension, ability to apply it based on scientific perspective, and scientific thinking about evidences (OECD, 2010)

PISA (*Programme for International Student Assesment*) gives interest to students' cognitive and affective aspects which can be applied to construct sciences competencies. The cognitive aspect in-

cludes students' knowledge and their capacity to effectively use and involve cognitive process as one of sciences characteristics in personal, social and global aspects. The affective aspects are related to problems which can be solved by scientific knowlegde and shape students who can make decision in current situation and for the future (OECD, 2010; OECD, 2013).

Scientific literacy is reputed as the main learning outcome in 15 years old – students' education, apart from are the students motivated to keep sciences learning or not after that (Toharudin, *et al.*, 2011). Based on scientific litereracy achievement of PISA year 2012 which involved 65 countries, Indonesia got the socond position from the bottom. The average score of Indonesian student was 382 below PISA average score, 501 (OECD, 2014). Students' low aerage of scientific literacy is one of reason for our goverment to revise 2006 curriculum into 2013 curriculum (Odja

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& Payu, 2014). Therefore It is needed a sciences learning that improve students' scientific literacy.

Sciences learning in curriculum 2013 have given a reference in choosing learning models appropriate to scientific approach. Those learning models involve *Project Based Learning* (PjBL), *Problem Based Learning* (PBL), or *Discovery Learning*. The selection of learning model is given to the teachers by considering learning material characteristic. PjBL is a student centered learning model and it gives meaningful learning experiences to the students. Students' learning experiences or concept acquisition is constructed based on final product produced in the learning.

PjBL implementation in sciences learning was known can improve cognitive learning outcome (Baran & Maskan, 2010), shape environment friendly attitude and behaviour (Kılınc, 2010; Tseng, *et al.*, 2013), scientific process skill (Özer & Özkan, 2012), and effective learning (Cook, *et al.*, 2012; Movahedzadeh, *et al.*, 2012). PjBL is more appropriate in interdisciplinary learning because it naturally involves many different skills, such as reading, writing, mathematical and helps conceptual knowledge construction through assimilation of other different subjects (Capraro, *et al.*, 2013) so that it is expected to construct student's scientific literacy.

Beside PjBL, learning nowadays need to go with the trend in globalization era, one of those is by integrating *Science, Technology, Engineering, dan Mathematics* (STEM). Relationship between sciences and technology or other knowledge can not be separated in sciences learning. STEM is science dicipline which is related each other. Sciences need mathematics as data analysis tool, whereas technology and technique are the sciences application. STEM approach in learning is expected to give a meaningful learning to students through systematic integration of knowledge, concept and skills. Some benefits of STEM approach are improving students' problem solving skill, innovators, inventors, independent, logic thinker, and technological literacy (Morrison dalam Stohlmann, *et al.*, 2012). The more comprehensive way to invest all fourth diciplines each other is by teaching them as an integrated subject. For instance, there are contents of technology, technique and mathemathics in sciences, so that sciences teacher will integrate T, E, and M in S (Dugger, 2010)

STEM learning need to emphasize some aspects in learning (NRC, 2011), such as: (1) proposing questions (sciences) and defining problem (engineering); (2) improving and using model; (3) planing and doing investigation; (4) analyzing

and interpreting data (mathematics); (5) using mathematics, information technology, computer and thinking computation; (6) building explanation (sciences) and designing solution (engineering); (7) being involved in argument based on evidences; (8) acquiring, evaluating, and communicating information.

Research on STEM integration in PjBL to scientific literacy was rarely done. Tseng, *et al.* (2013) revealed that PjBL integrated by STEM can improve students' learning motivation, create meaningful learning, help students in solving daily life's problem, and support future career. Instead of those, STEM in PjBL also gave challenges and motivated students because it trained students to think critically, analytically, and enhanced higher order thinking skill (Capraro, *et al.*, 2013). With STEM learning, students have visible sciences and technology literacy which can be seen from reading, writing, observing, and doing sciences as their skill to live in the society and solving daily life's problem related to STEM (Mayasari, *et al.*, 2014).

National Research Council (2011) stated that in STEM learning, students had a chance to learn sciences, mathematics and technique by solving problems applied in real context. In STEM classroom, students are demanded to solve real life problem and involved in ill-defined tasks to be well defined outcome in their group (Han, *et al.*, 2014). STEM education becomes the priority in soving global issues dan current real life's problem, such as: gloal warming, air and water pollution, fresh drinking water, as well as food safety (Reeve, 2015)

Air pollution theme is one of learning material which is acomodated in Sciences learning in junior high school. Air pollution becomes a big problem in real life and needs a solution in sciences learning. Air pollution comes from human activities and natural phenomenon. Industry, construction, electricity generator, transportation, and agriculture are some human activities which contribute to the pollution (Glencoe, 2005; Raven, *et al.*, 2013). Therefore, the awareness of the importance to save the environment need to be embeded in early education as a preventive way in facing current environmental issues.

Based on explanation above, the problems in this study are (1) Can PjBL STEM learning enhance students' scientific literacy in air pollution theme?; (2) How is the improvement of students' scientific literacy related to STEM aspects?; (3) How is students response to PjBL STEM learning? . PjBL STEM learning in this study was conducted in five steps (Laboy-Rush, 2010), in-

volved reflection, research stage, discovery stage, application stage, and communication stage.

METHOD

This study was done by quasi-experimental method with *The Matching-Only Pretest-Posttest Control Group Design* (Sukmadinata, 2010; Fraenkel, et al., 2011). Class matching in this research was assumed as a class which had equal ability and taught by the same teacher.

This experiment was done by conducting learning in PjBL STEM model in experimental class and common used learning in control class. Both classes are given pretest and posttest which are expected to measure students' scientific literacy before and after treatment. Table of conducted experiment is shown by Table 1.

Table 1. The Matching-Only Pretest-Posttest Control Group Reaserch Design

Matching Class	Pretest	Treatment	Posttest
Experiment	O	X	O
Control	O	C	O

Description:

O : pretest-posttest

X: treatment (PjBL STEM Learning)

C: common used learning (CTL)

Based on the table above, it can be seen that questions given in pretest and posttest are the same. Data of students' answer then analysed and statistically tested to know th eimprovement of students' scientific literacy.

Subjects in this research are students of grade VII in semeseter 2 at SMP IT in Sukabumi in academic year 2015/2016. They would have sciences learning of air pollution theme. We took three classes which are chosen based on matching class (Fraenkel, et al., 2011). Class categorization in this school is based on gender, where woman and man are separated. Election of experimental class and control class is based on the subject teacher's recommendation and school's management permission referred to students' competences. Class VII B (woman class) was taken as experimental class where we conducted the PjBL STEM learning, and VII C (woman class) as the control class who was learning concept to be studied,the air pollution.

Instruments used in this study are literacy question which is refered to PISA 2012 which is related to STEM aspects and attitude scale questionnaire to explore students' response. Scientific

literacy test does not only measure students' comprehension level of scientific knowledge, but also comprehension of sciences competences aspects, ability to apply the knowledge, and scientific attitude, as well as scientific context in students' real context. Whereas, students response questionnaire is statements about response's object which can be represented in rating scale or check list. This study used closed-ended questionnaire; means the respondents can directly choose prepared answer for each question. There are two kinds of questions in likert scale, those are positive and negative statements. Likert scale is categorized as follow; extremely agree, agree, disagree, and extremely disagree.

Each question was arranged and developed based on learning indicators corresponded to scientific literacy indicators which composed by knowledge and scientific competences related to sciences application context and scientific attitude. The items were consulted and validated by expert lecturer then tested. There were 25 items of multiple choices test for knowledge and competence aspect in air pollution context. Whereas, scientific attitude aspect was measured by 15 statements of Likert scale. Correlation coefficient (r_{xy}) of multiple choice testing was 0.58 and its reliability coefficient was 0.73 (high category). Testing of scientific attitude gives *Cronbach's Alpha reliability* of 0.619 (high category)

Raise of students' scientific literacy after PjBL STEM learning is measured by calculating normalized (N-Gain) average score.The formula used is as follow (Hake, 1998)

$$\langle g \rangle = \frac{\% (S_f) - \% (S_i)}{100 - \% (S_f)}$$

where $\langle g \rangle$ is the normalized gain, S_f is average of *posttest score*, and S_i is average of *pretes score*. Hake (1998) interpreted average normalized gain as follow; low category when $\langle g \rangle < 0,3$; medium category $0,3 \leq \langle g \rangle < 0,7$; andhigh category when $\langle g \rangle \geq 0,7$.

After getting average of the normalized gain from both groups, it is then compared each other to see the differences of scientific literacy raise of both classes. If the average of normalized gain average is higher than other from other different learning, it can be said that the learning is more effective to enhance students'scientific literacy skill than other learning. Hypothesis test used here was one tailed t-test for upper class. It is processed by SPSS 17 with two independent samples t-test.

RESULT AND DISCUSSION

Pretest was given before experimental and control class got the treatments to explore students' prior knowledge. Then after treatments they also got the scientific literacy skill for the second time. The raise of students' scientific literacy at in air pollution topic was calculated by normalized gain (N-gain) formula based on pretest and posttest data.

Comparison of students' scientific literacy pretest, post test, gain and N-gain average in aspects of knowledge and competence in experimental and control class at air pollution topic is represented by Graphic of Figure 1.

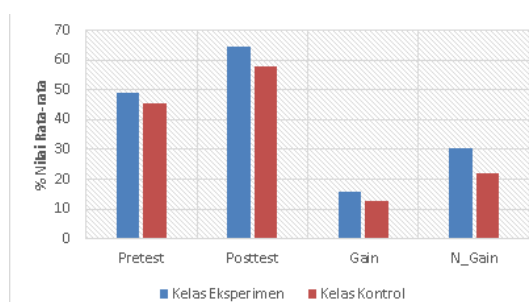


Figure 1. Graphic of Comparison among *Pretest*, *Posttest*, *Gain* dan *N-Gain* in Knowledge and Competence Aspects of Scientific literacy.

Figure 1 shows that there is a difference of students scientific literacy score average between experimental dan control class. The highest pretest score average achievement of knowledge and competence aspects in experimental class was 49.00 of 100, while in control class was 45.29. Posttest score average of experimental class was higher than control class, it is respectively 65.57 and 58.00. The raise of pretest and posttest average in each class was represented by N-gain in percentage where 31 in experimental class (medium category) and 22 in control class (low category). So, it can be concluded that students in experi-

mental class have a higher scientific literacy raise than control class in knowledge and competence aspects.

Scientific attitude aspects score was also different in both class before and after treatment. The raise of students scientific attitude was observed in normalized gain (N-gain). The difference of students scientific attitude in experimental and control class is shown by Table 2.

Table 2 shows that there is a difference between students' scientific attitude achievement in experimental and control class. The highest achievement in pretest, posttest, gain and N-Gain was in experimental class, and the lowest was in control class. The difference of N-Gain from both classes was 12 points. The raise in experimental class was in medium category, while the control class was low category. So, the raise of students' scientific attitude of experimental class was better than control class.

Hypothesis test used to know the raise of students' scientific literacy after PjBL STEM learning treatment was average N-Gain difference test to compare two independent samples. Based on prerequisite test of normality and homogeneity, data of scientific literacy N-Gain used t-test. Result of scientific literacy N-Gain t test is shown in Table 3. Hypothesis test of scientific literacy raise is as follow.

H_0 : There is no difference between the raise of scientific literacy between experimental and control class

H_1 : There is a difference between the raise of scientific literacy between experimental and control class

Reject H_0 if $p\text{-value}/2, (\text{sig.}) < \alpha = 0,05$, and accept H_0 if $p\text{-value}/2, (\text{sig.}) \geq \alpha = 0,05$

Table 3 describes that the significance value acquired from students' N-gain scientific literacy data of experimental dan control class in experimental and control class in aspects of knowledge

Table 2. Recapitulation of Students' scientific literacy in Scientific attitude aspects

Class	Pretest	Posttest	Gain	% <i>N-Gain</i>	Category
Experimental	70.89*	82.32*	11.43*	40*	Medium
Control	69.82	78.39	8.57	28	Low

*the highest percentage

Table 3. Result of Students' scientific literacy N-Gain t-test

Data of Scientific literacy N-Gain	Sig. Value (2-tailed)	Sig.	α	Interpretation
Knowledge and Competencies	0.053	0.026	0.05	Significantly different
Scientific attitude	0.001	0.000		

and scientific competence are smaller $sig. = p\text{-value}/2 = 0,053/2 = 0,026$ from α ($sig. 0,026 < (\alpha) 0,05$), so H_0 is rejected and H_1 is accepted. It means, there is a significance different in the raise of students scientific literacy in aspects of knowledge and competence. While, with the students' scientific attitude N-Gain of $sig. 0,000 < (\alpha) 0,05$, it accepts H_1 , means there is a difference between experimental and control class. Generally, it can be concluded that the raise of students' scientific literacy in experimental class with PjBL STEM sciences learning is better than control class with CTL. Similar study was done by Afriana, et al. (2015) which revealed that students scientific literacy skill in experimental class with greenhouse miniatur project was significantly different to control class.

Students of experimental class and control class which compared here are all female. Experimental class and control class are the matching class based on gender and pretest of scientific literacy. Learning model in both class is assumed can enhance students' scientific literacy, where PjBL STEM was implemented in experimental class and CTL in control class. Research of Dewaters & Powers (2006), revealed that PjBL can enhance scientific literacy by active involvement of K-12 students as well as students' interest and competences in STEM concept. While, CTL approach with its seventh's stages applied in sciences learning can build students' scientific literacy (Toharudin, et al., 2011).

Learning applied in this study combined other scientific field to teach sciences. Integration of technology, engineering and mathematics were learned in air pollution topic. STEM aspects are already integrated in learning so it needed to be measured to know the raise of STEM aspects cohesiveness. In order to measure STEM aspects raise, the scientific literacy questions developed were related to STEM indicator. The cohesiveness of the questions included sciences aspect (S), sciences – technology (S-T), science – mathematics (S – M), sciences – technology – engineering (S-T-E). The raises of STEM aspects of each question' indicator are represented by Figure 2.

Figure 2 describes the raise of STEM aspects combined with students' scientific literacy questions. Experimental class was superior in indicator of S, S-T and S-T-E, while control class was superior in S-M indicator. It showed that sciences learning generally had combined mathematics in doing calculation as well as associating experimental data. Result of an experiment in sciences always use mathematic either in analyzing or presenting data.

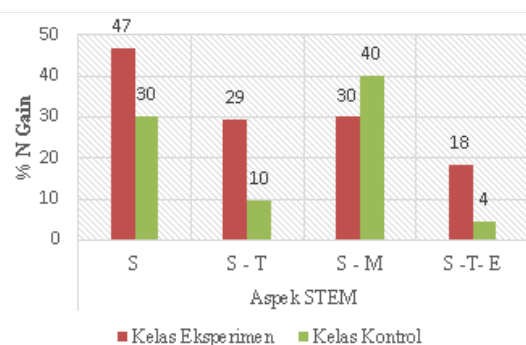


Figure 2. Graphic of average N-Gain for each STEM aspects indicator

The lowest achievement of experimental class and control class was at S-T-E indicator with each raise respectively 18% for experimental class and 4% for control class. In experimental class, this indicated that technology and engineering were in very initial stage of introduction to students through PjBL STEM learning. Students are not used to get it and it was their first experience to have a different learning model. Morgan, et al. (2013), stated that engineering serves a good context to represent other concepts because it discusses about real world problems, but it could be also hard for students to visualize it. In addition, *the way pupils commence, progress, and complete their project demonstrates that creative thinking in technology is a combination of vertical and lateral thinking* (Waks; Barak & Doppelt; dalam Doppelt, 2005). Thereby, PjBL STEM learning in this study was a way to train students think critically. Compared to control class, learning stage in CTL approach had not integrated STEM. As stated by Dwivedi (2014), PjBL for STEM education is an interesting and effective way to learn about sciences, technology, and mathematics. So that, PjBL STEM could be an alternative learning model for teachers to conceive implementation of technology and engineering in the classroom.

Questionnaire of attitude scale was used to know students' response to PjBL STEM learning implementation in air pollution topic. Students' response questionnaire was given after PjBL STEM learning step fully done. Distribution of students response questionnaire in this topic was divided into four indicators; fun and more motivate students by implementing model; helping to understand the concept, building creativity and awareness to save environment; enjoy working in a group; having intention to implement the learning model in other topics. Questionnaire was given to collect data of students' responses to the learning to get a tendency of students' attitude

after learning in the experimental class. Attitude scale used was composed by 10 positive statements. Recapitulation of Students' attitude scale to the learning is represented in Table 4.

Table 4. Recapitulation of Students' attitude scale analysis of PjBL STEM implementation

Indicator	% Average
Students enjoy and motivate to learn air pollution with PjBL STEM	79,31
Students had na notion that PjBL STEM implementation can help understanding air pollution theme, build creativity, and more aware to save the environment	81,68
Students enjoy ctivities in their group	81,03
Students wants to have PjBL STEM learning in other topics	81,03
Average	80,77

Based on general analysis of the instruments, it is known that almost all students is agree with implementation of PjBL STEM model in learning air pollution. Other studies support this by stating that PjBL is an interesting and joyful learning (Yalçin *et al.*, 2009; Kemdikbud, 2014). Thereby, by implementing PjBL STEM it is expected to give students a new learning experience so that improve students motivation in learning air pollution

CONCLUSION

Project based learning integrated with STEM in experimental class was significantly enhance students' scientific literacy skill in air pollution concept. The raise basen on N-Gain average score for experimental class and control class were respectively 0.31 an 0.2. Aspect of knowledge, competence, and scientific attitude in experimental class was in medium category and control class was in low category. The raise of scientific literacy which accmodated by STEM aspects in experimental class is superior in indicators of sciences (S), sciences-technology (S-T), and sciences-technology-engineering (S-T-E). While control class, was superior in sciences-mathematic indicator (S-M). The findings of students' response questionnaire for PjBL STEM implementation in air pollution concept showed that percentage average in all categories are positive and agree with the PjBL implementation. It revealed that

the learning applied was interesting and motivated the students, help topic comprehension, buid creativity, make students more aware about the importance of saving environment, and have a will to reuse PjBL STEM learning model.

PjVL STEM can be implemented in sciences concept which related to technology and engineering to solve real lifeproblems. PjBL STEM stage starting from planning to making project which lets the studets to use material and tool (techological aspect), arranging solution (engineering aspect), and communicating the result in a table/graphic (mathematics) gives a direct meaningful sciences learning. Direct and meaningful learning in acquiring knowledge will influnce students scientific literacy. Moreover, findings in this study also support previous findings and research on PjBL as well as PjBL STEM to enhance stundents scientific literacy.

Not maximal achievement of students' scientific literacy indicated that learnig process quality was not opmtimal yet because students were not used to get through each stgsge of PjBL STEM. Students were more focused on final product to finished at time given. So, the further implementation needs a better time managemnet. This study can be advanced by other methods or other topic which is appropriate to STEM characteristic. Subject in this study is all female, so the gender difference needs to be explored in further PjBL STEM learning implementation.

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THE ANALYSIS OF STUDENTS' CREATIVE THINKING ABILITY USING MIND MAP IN BIOTECHNOLOGY COURSE

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ABSTRACT

Process of learning which generally practiced nowadays is mostly in the form of face-to-face (lecturing) and one way communication. Sometimes the students are given tasks to fulfill the material target in one semester such as papers, internet-based summary, and/or other articles. Such things cause learners accustomed to convergent thinking and not to divergent thinking. Mind map is one of creative products which conducted by learners in learning process. Learning with mind map focuses more on the activeness and creative activity of the students. It will improve their ability to memorize and strengthen concept understanding of the student, and improve their creative thinking ability. This research was focused to analysis the creative thinking skills students using mind mapping in biotechnology course. The participant was students of Biology Education (N=55) consisting of two team that was team A (N=25) and team B (N=30). The result showed gain value of each team of creative thinking skills which were: team A (0.62) with three category: low (8%), average (40%), and high (52%). Team B (0,04) with three category: low (80%), average (10%) and high (10%).

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Keywords: mind map, creative thinking, biotechnology

INTRODUCTION

Education is a process of two-way communication which teaching is done by teachers as educators while learning is done by learners. In this case, the role of the teachers are not only providing information, but also directing and accommodating the learner with educational facility therefore the teaching-learning process become more adequate (facilitator). Education as a learning process is established by the teacher to develop creative thinking which can improve the ability to think and reconstruct of the learner towards new knowledge as an effort to improve good mastery of subject (Syamsudin & Budiman, 2007). Discussing a problem in group will trigger students to cooperate, helping each other to

integrate new knowledge with their basic knowledge. (Wulandari, 2014). However, in practice the learner experience difficulties such as difficulty in concentrating and remembering, which leads to lower learning outcome. For to learn something well, we need to hear it, see it, ask question about it, and discuss it with others. In addition, the learner needs to work with it that means describing things in their own way, showing examples, practicing skill, and doing task that requires their basic knowledge. (Silberman, 2009).

The pattern of this learning process with an active teacher and passive learner has low effectiveness and cannot grow and develop active participation in the learning process (Dikti, 2008).

According to Dewey (Joyce, et al., 2009), the core of the teaching process is the arrangement of the environments within which the students can interact and study how to learn. The same thing was stated by Rutherford & Ahlgren

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(1990), the learning process of science, mathematics, and technology should take place effectively. Effective learning means learners learn how to build their own knowledge, learn through direct experience in concrete way, and learn how to solve problem in group. Teacher should be the one who is creative in classroom, not only employing the proper content but also developing the creativity of the learners in learning process. A study conducted by Temur (2012) shows that it needs an instructional model that involves students working together in groups to share ideas during the process of creative thinking.

The creativity of students and teachers are important factors that affect the learning process. This means teachers have sufficient knowledge about creativity in order to develop creativity in an appropriate manner (Trnova & Josef, 2014). In observation of the course learning biotechnology, the course learning process tends to be taught using the direct method of instruction and paper presentation. Evaluation is conducted by asking some questions on the cognitive level of C1 and C2.

On perspective of the students, they will irregularly answer the questions and find difficulties to start with it, be confused with the model/method of how to answer thus their creativity does not appear. For instance, creating answer such a diary will be looked ineffective and cause boredom to correct it. Therefore, one way to overcome that problem is applying a mind map since it can help students in summarizing the subject material they learn, so that it becomes easier to understand, in addition mind map is also a creative writing method which allows students to memorize a lot of information. According to Ramadhani, *et al.* (2015), the ability of creative thinking also can be developed with a proper method in learning process. One of the methods that can be used to develop the creative thinking ability of the students is mid map method.

Mind map method is one of the learning methods which helps students to dig into their creative ideas and be active in teaching and learning process. Mind map is a best method for teachers to improve memory and strengthen concept understanding of the student, and students also can improve their creative thinking ability. Weinstein (2014) said that learning through mind map can stimulate the visual ability of the learners. This art technique takes 10 minutes to study and can be applied in all of education aspects. For example, showing how students benefit innovative methods and creative techniques to encourage introspection, record, reflect experiences,

brainstorm, and decide goals. Mind map is a solution for classroom problems which cause sleepiness, boredom and frustration. This technique can change students, regardless their age, learning style, and ability and disability. The research question in this study is whether students can develop their creative ideas towards biotechnology material using mind map.

METHOD

This study uses descriptive statistic. By using this method, the writer will describe or give a description about object of the study through sample data or population as it is, without making any general analysis and conclusion (Sugiyono, 2014). The research sample is six semester students of STKIP Hamzanwadi in the 2012/2013 school year. The amount are 55 students in total and divided into two major classes which are class A (N=25) and class B (N=30). Analysis of creative thinking utilizes creative thinking indicator consisting of fluency, flexibility, and originality that are connected to each other by lines. The indicators and scores are described in the table below (Table 1).

A similar mind map scoring model was also employed by Gebya & Dian (2012) by scoring in each mind map branches that are connected. The difference between the writer and Gebya & Dian is in controlled variable and scoring method for each branches which correlated in mind map model.

RESULT AND DISCUSSION

Creativity is a complex mental activity, but it is very important for human life. To have the skills of creative thinking, one must know the basic methods of creative thinking that he really understood, so they can get interesting results. Creative thinking is an important aspect in generating new holistic knowledge and encompassing all development aspects. Creative learning strategy can help students creating new ideas and exploring area of the study deeper. Besides, with a proper technique in developing creative ideas students can also develop their skill and ability (Daud, *et al.*, 2011).

A study about the effectiveness of mind map technique in learning process was proposed by Evrekli, dkk., and Goodnough, dkk., their research finding showed that mind map provides an effective technique in improving long term memory towards factual information of science, which is 10%. The study stated that teachers en-

Table 1. Creative Thinking Indicators and Score using Mind Map

Indicator	Answer Criteria	Score
Fluency: Thinking fluently and creating many ideas	The answers are more than 2, related, pictures and symbols are included	5
	The answers are more than 2, related, pictures and symbols are not included	4
	Giving 2 answers, related, pictures and symbols are included	3
	Giving 2 answers, related, pictures and symbols are not included	2
	Giving 1 answer, pictures and symbols are not included	1
Flexibility: Creating new different idea or seeing from another point of view	The answer idea varies (more than 2), related, pictures and symbols are included	5
	The answer idea varies (more than 2), related, pictures and symbols are not included	4
	The answer idea varies (2 ideas), related, pictures and symbols are included	3
	The answer idea varies (2 ideas), related, pictures and symbols are not included	2
	1 ideas, pictures and symbols are not included	1
Originality: Creating unusual/never existed kind	The answer gives a new idea, related, pictures and symbols are included	5
	The answer gives a new idea, related, pictures and symbols are not included	4
	The answer gives a general idea, related, pictures and symbols are included	3
	The answer gives a general idea, related, pictures and symbols are not included	2
	The answer is wrong	1

Source: Fatmawati, Baiq. (2015)^b. A Study About Student's Creative Thinking Skill Using Mind Map In Biotechnology Subject

joy the utility of mind map and technique in motivating students in science (in Mani, 2012). Learning strategy with mind map focuses more on students' active role and creative activity which will improve and strengthen their memorizing and understanding ability, and the students become more creative. Beside the teaching-learning process will be more interesting, students will also be more diligent to study and do homework, not give up easily, be fond of solving varied problems, be independent and can maintain their opinion (Pandley, *et al.*, 1994). Cathy and Azim (2013) proposed that mind map is an appropriate way towards learning observation that is constructive for technical science. Making mind map habitually in group will positively influence the quality of learning process.

The form of question on tests of creative thinking was conducted by providing a "clue" about creating a mind map. After that the mind

maps were corrected by scoring according to the pattern, and then these maps were analyzed to find N-gain for each students. This method was to determine whether the creative thinking ability of students is improving after applying the mind map method. The analysis of the answer of the students that utilizing mind mapping was conducted by finding the relationship between lines includes flexibility of expressing ideas of their mind, fluency in expressing their opinion and originality that appears in the answer, and all of which was manifested in the main map. According to the results of their pretest and posttest, there were difference scores of creative thinking in fluency, flexibility and originality.

Originality indicator showed that the students had not been able to demonstrate the originality that was proposed. The gain score was lower than either fluency or flexibility. The analysis of creative thinking ability still refers to creative

thinking indicator, but it is adapted to mind mapping principle.

The average of creative thinking value of the students had difference in experiment class and controlled class (results presented in graphical form 1). Jones (2012) with his findings showed that there is no difference in the average value of the perception among three components in mind mapping activity which is mediated socially towards the components of music model. But when forced to sort mapping, report and learning preference of the students were varies, which makes it possible to examine differences in some subgroups of students. Overall, it can be concluded that although the average rank of the three activities of mind mapping is similar, students have various beliefs in what activity and what subject they can learn. After N-gain creative thinking of both classes was determined, it was grouped into three categories of low, medium and high creative thinking ability (result is presented on the Figure 2).

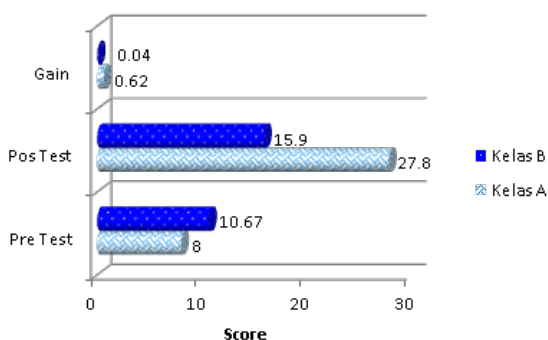


Figure 1. Creative thinking score gain using Mind Map in biotechnology subject

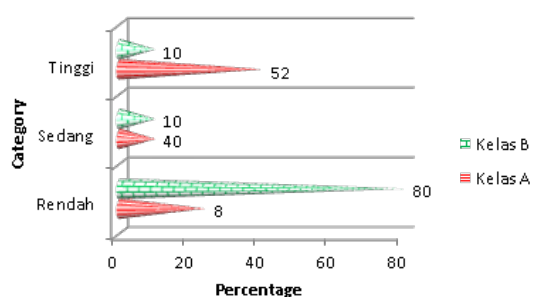


Figure 2. Creative thinking criteria using Mind Map in biotechnology subject

Figure 2 showed that class VI A gets high and medium score more dominantly than class VI B, since during the learning process, students of VI A on their spare time asking more detail about the mind map. A concept focused on the implementation of biotechnology in various field

such as food, environment, health, forestry, animal husbandry, plant breeding, mining, and biodiversity. Based on this, students were asked to describe the application of biotechnology to the fields. Gebya & Dian (2012) found that mind mapping that can fulfill all of the aspect required with percentage (41,7%) for very good, (41,7%) for good and (16,6%) for enough. Fatmawati (2015) stated that students can express and develop their ideas of mind by forming a pattern of ideas interconnected with the main topic in the middle while the sub topic and its detail are formed into its branches, using colors and pictures towards fermentation material. The result of gain value for each creative thinking indicators using mind map are fluency (1.50), flexibility (1.58), and originality (2.58).

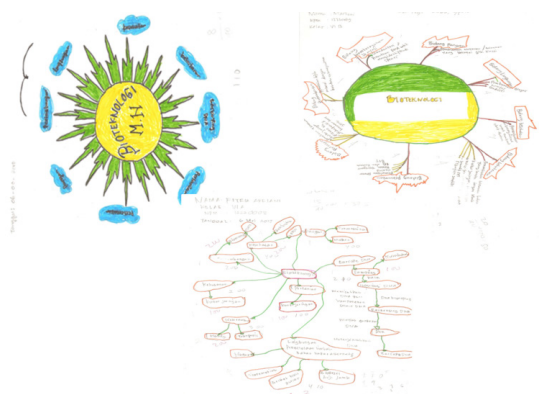


Figure 3. Examples of mind map in biotechnology course before applying the mind map technique.

Before creating a mind map, teachers provided technical illustration mind map and asked the students to find references on the internet about how to create a mind map. The students only used one or two colors to connect branches, but the desired pattern of the mind map had not been formed yet. Fatmawati (2014), according to her study about mind mapping the fermentation process in microbiology class, found that the mind map created by students before applying mind mapping method looked incomplete. It is because the students start knowing mind map in learning process, their answer are convergent and do not show any creative thinking ability.

Based on that study, the teachers asked the students about difficulties related to mind mapping. They stated that the hardest part was making the connections that relates to each other and drawing the mind map pattern and the confusion of how to start writing. After knowing the problem, teachers explained it in detail and showed the example of mind map.



Figure 4. Mind map in biotechnology course after understanding the mind map technique.

An effective strategy for mind mapping is explaining it in detail all possible applications of mind mapping, utilizing different colors, words and pictures and encouraging the students to use mind map in their group activity. In fact, these research findings provide a framework in spreading mind map technique to mechanical engineering students. Framework proposal tries to create a better creativity development program (Zampekakis & Tsironis, 2007). Mind map is a creative and effective way of writing, and literally will mapping the minds. Mind map is one of creative learning media that reflects how brain works. Mind map is a learning method which activates both sides of the brain and issues all of the potential and capacity of the brain that are still hidden. Mind map provides many beneficial aspect for student in studying, thinking, planning their daily activity, recording, summarizing, writing and even exploring creative thinking ability.

Figure 2 indicates that students have already understood mind mapping technique by applying symbols, pictures, and colored text to connect a series of words in the mind map. Fatmawati (2015) stated that after applying the mind mapping method, students improve their answers and develop their ideas of mind by utilizing various colors and pictures forming a pattern of ideas that are related to the main topic in the middle with subtopic and its detail as the branches. Creative thinking skill and learning achievement that learned using mind mapping method is better than creative thinking skills and learning achievement of Social students who take the conventional learning (Priantini, *et al.*, 2013). Riswanto & Pebri (2012) suggested that there is a significant difference towards the students' writing achievement which taught through mind mapping strategy. Mind mapping strategy improves students' writing achievement, most of them are more interested in writing provided topics about social

organizations and news items.

During the mind mapping process, students enjoy designing their works in form of mind map. They get pleasure. They express it like a child by drawing, but this is a way to memorize and write their creative ideas in developing the given material. A thing that should be remembered in making a mind map is not all learners can use symbols and images to clarify the meaning of the mind map, as influenced by internal factors of a person, such as "the soul of art".

Mind map helps students to learn information by making them organize and add pictures and colors. It is proven that mind map reduces the extrinsic cognitive burden since students create their own two-dimensional space to tie the related ideas and concepts (Nesbit & Adesope, 2006). Mind map allows students to make visual pictures to improve their learning (Budd, 2004) and can be used as Meta cognitive media which allows them to create a connection with material meaningfully. Ozgul (2012) stated that the application of mind mapping in learning process helps teacher to improve their teaching method, lesson plan and evaluation, and make teachers happier in teaching and learning process.

Mind map consists of a network that connects a corresponding concept, connects ideas with others. The form is free. Spontaneous thinking is needed when making a mind map, the goal of mind map is to find a link between creative ideas (Mani, 2012). Mind maps can be employed in many fields, such as those which used by Radix&Azim (2013) in technical engineering who argued mind map is a proper way to an observation of constructivist learning in knik tea science. Some of the benefits of mind map are: a) understanding the material, b) planning, c) communicating, d) being creative, e) saving time, f) resolving problem, g) concentrating, h) arranging and explaining ideas, i) memorizing, j) learning more quickly and efficiently, and k) seeing the whole picture. Mind Map aims to make the subject material patterned visually and graphically that can help to record, strengthen, and recall the information that has been learned (Buzan, 2004).

CONCLUSION

Students are able to express their creative ideas using mind map in biotechnology class, this can be identified from gain value obtained by VI A class 0.62 with low (8%), medium (40%) and high (52%) category. While class VI B only varies in 2 points (0.04) from class A with low (80%), medium (10%) and high category (10%). Class

VI A is more active in asking/discussing outside the lecturing hours about how to make mind map. Not all learners can employ symbol, and or picture in process of mind mapping to complete their answer.

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ANALYSIS OF MENTAL MODEL OF STUDENTS USING ISOMORPHIC PROBLEMS IN DYNAMICS OF ROTATIONAL MOTION TOPIC

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ABSTRACT

The analysis of mental models is a part of the identification of students' thoughts on the concept. Mental models analysis is conducted by conditioning the complex problems such as the isomorphic issues. The research objective is to analyze the development of students' mental models on the topic rotational motion dynamics. The study was designed with the mixed method. The design phase of the research was conducted in both quantitative and qualitative approach. The quantitative phase was performed by providing pre-test, learning, and post-test containing isomorphic problems; while qualitative phase was implemented by interview and quiz. The data were analyzed quantitatively and qualitatively. The results of the study categorizes mental models into three types, i.e. Low Mental Model (LMM), Moderate Mental Model (MMM), and High Mental Model (HMM). Based on the pre-test results, it was proved that all students used Low mental model in resolving the isomorphic problems. Using the Low Mental Model, it was found that students have misconceptions on the moment of force and moment of inertia. Mental models developed gradually from Low mental model to Moderate Mental Model and then reached the High Mental Model Mental. It was observed from the results of pre-test, quizzes, and post-test. The quiz and post-test results showed the students who used Mental Model and High Mental Model.

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Keywords: analysis, mental models, isomorphic problems, the dynamics of rotational motion.

INTRODUCTION

Diagnosis in learning is a form of assessment. One objective of the assessment is to determine the ability and learning difficulties experienced by students (Kusairi, 2012: 6). The ability and students' learning difficulties can be identified through a description of students' way of thinking. When a person is trying to solve a problem, the person will create a model in his mind about how is the way to conquer the problem. Model that describes a person's mind in solving the problems, a form of the response to the phenomenon and the situation can be defined as a mental model (Greca and Moreira, 2002, Coll

& Treagust, 2003, Engelhandt et al, 2003, Ornek, 2008). Fazio et al (2013) defines more specifically about mental model of physics that includes the student's ability to determine a reason when constructing a knowledge and explicitly explain the allegations of knowledge. Mental models are not easy to identify a person's mental model which represents a different thought on everyone (Coll & Tragust, 2003). However, the students' mental models need to be known by educators as an initial diagnosis in learning (Chiou, 2013). Mental models are not easy because of the nature of mental models that are tend to be unstable, inconsistent, and always changing as more information is obtained or recalled (McClary & Talanquer, 2011). Mental model developments would gradually become better as the mental models of experts

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in a particular domain (Seel, 2006, Darabi et al, 2009). Therefore, mental models can evolve where to diagnose the development of mental models require eight principles that must be observed (Seel et al, 2008), namely: 1. It is embedded in complex problem situations; 2. It is applied in different subject domains; 3. It allows the construction, modification, and reorganization of mental models; 4. Data collection on mental models is in a longitudinal design; 5. Able to demonstrate the construction of mental models in a row until it was perfect from beginner to expert; 6. Referring to the expert model characteristics; 7. It provides the quantitative data which are valid and reliable; 8. It allows direct methodological analysis and interpretation of data collected.

Eight principles which were established by Seel et al (2008) form the basis for this study. Complex problem to diagnose mental models can be presented in the form of isomorphic problems and longitudinal research design to do several times diagnosis. The material in different situations or contexts that make researchers used varies categories of mental model type (Bao & Warnakulasooriya, 2001, Fazio et al, 2013).

In fact, isomorphic problems are the problem that have different features but use the same physics concepts to solve problems (De Cock, 2012). Isomorphic problems can be presented in several forms of matter. In research by Singh (2008), the isomorphic problems presented in the form of open-ended. The open-ended items have some advantages and disadvantages. The advantages of open-ended instrument can reveal the students' mental models without restricting the expression of the students' thinking way.

The isomorphic problems are given to students through physics learning. The physics subject covers the complex problems to diagnose the students' ability to solve the problem. One of mental models among the items that need to be overcome by the physics students is the concept of the dynamics of rotational motion. The research results suggest that there are some students of various classes with the same difficulties in understanding the concept of rotational motion and the rolling material (Rimoldini & Singh, 2005, Close et al, 2013). The learning process given to students is oriented to the everyday life problems. There are some researches to identify the mental model using the various instruments (Didișet al, 2014). The methods and instruments are used to achieve the certain results. This study aims to diagnose the development of students' ability in the topic of dynamics of rotational motion using mental models.

METHOD

This study employed a mixed method research design (Cresswell, 2007). The study consisted of two phases which quantitative and qualitative. In the quantitative phase began with the provision of pre-test before learning, intervention with problem-based learning, and post-test after the lesson. Qualitative phase following each stage of the quantitative phase. Qualitative phase was conducted by interview after the pre-test and post-test, as well as the provision of a quiz question in each lesson. The results of the interview can clarify answers written by students. Results of interviews used to support a deeper analysis of the mental model of students' thinking way. Interviews were conducted because not all students could express the answer through written language. The subject of this research was 19 students of class XI IPA at SMAN Jenangan, Ponorogo. Questions used to diagnose mental models in the form of 10 questions with the open-ended isomorphic shaped.

The data analysis was performed by using qualitative and quantitative approaches. The quantitative analysis was performed by counting the percentage of students on each type of mental models in pre-test, quizzes and post-test. The qualitative data was obtained by coding the students' answer to categorize the students in three mental models, i.e High mental model (HMM), Moderate mental model (MMM), and Low Mental Model (LMM). The categorization of dominant mental model was performed by analysis of mental models which were used by students to answer 10 questions. If students used 40% type of mental model in answering 10 questions, then that models are dominating the student's mind. The classification of students in three types of mental models is adapted from the research of Wang & Barrow (2010). Students are categorized as LMM if they get 0-3 points on their mental model characteristics to answer the question. Next, if they get 4-6 point, that means they are classified as LMM. Finally, if the students obtain 7-10 points, they could be use the HMM. Those classifications are set according to the stage and it depends on the analysis of the characteristics of problems solving.

RESULT AND DISCUSSION

The results of the analysis is presented in the form of column-chart as shown in Figure 1. Figure 1 shows the percentage change in the number of students in pre-tests, quizzes, and post-test.

The pre-test result showed 100% students using Low Mental Model to answer questions. After students obtained complete information through learning, Moderate and High mental model were starting to be seen on their answers to the quiz and post-test.

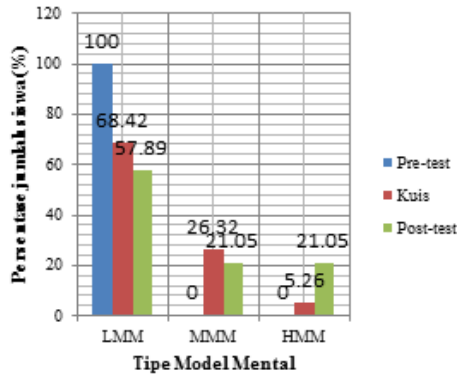


Figure 1. Percentage of Students in Each Type of Mental Model.

Students experienced a gradual development of mental models. This mental model changes were caused by the influence of the information obtained. The nature of mental models of the students tend to be unstable, inconsistent, and it is always changing as more information is obtained or recalled (McClary & Talanquer, 2011). Description of students' mental models is shown as follows.

Low Mental Model (LMM)

The number of students who use the LMM in pre-test was 100%, quizzes was 64.42%, and the post-test was 57.89%. In pre-test, students answered question number 2, 4, 5, 10 using LMM as much as 100%. The response of students in problem solving using LMM is shown in Figure 2.

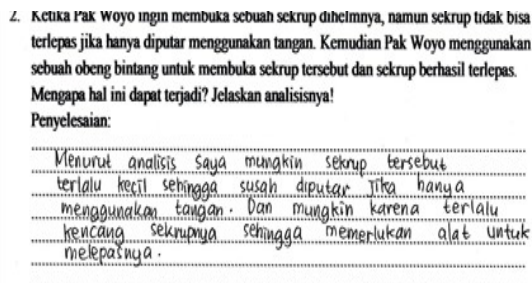


Figure 2. An example of student's answer in the pre-test which is categorized as LMM

Students who used the LMM tend to respond by providing an explanation. However,

their explanation was not based on the concept of physics. The explanation given to answer the question were based on the observations or experiences encountered by students everyday. Based on Figure 2, further interview was conducted and the results of interviews with students showed that the student's assumption was based on their experience that has ever happened. When using a screwdriver that fits to the place, it will be easier to detach/attach the screws. The question states that the screwdriver shape is paired. For example, star screwdriver is used to unscrew a hollow star, whereas strip screwdriver is applied to unscrew the strip. The LMM mental models have similar characteristics to the practical mental model of research Fazio et al (2013).

Number of students with LMM on the quiz and post-test were reduced, it was because of students were able to process the information obtained when learning. At LMM stage, it was found that some students had the misconceptions. Misconceptions experienced tend to be resistant because of the student's answers did not change from pre-test to post-test. Misconceptions are resistant in accordance with the finding of Wang (2007) which stated that individual misconceptions and understanding lead to the development of mental models with features that are not true, making the mental models produced will provide feedback erroneous and reinforce misconceptions. Answer of students who have misconceptions can be seen in Figure 3. The misconception experienced by students in line with the results of research Rimoldini & Singh (2005).

The students' answer as shown in Figure 3 shows that they have not used the moment of force concept to explain the screw rotation. They thought that the force influences the difference on power to open the screw with screwdriver and with hands. They did not know that the screwdriver can form the torque; therefore it influences the moment of force value that can rotate the screw.

The student's answer in Figure 3 indicates that students have misconceptions. The students assumed that the objects can roll faster because of the mass, weight, and shape of the surface of objects. Twelve students in pre-test and two students in post-test showed their assumption that solid ball have the higher mass; therefore, it can roll faster. Moreover, the solid texture influences the ball movement.

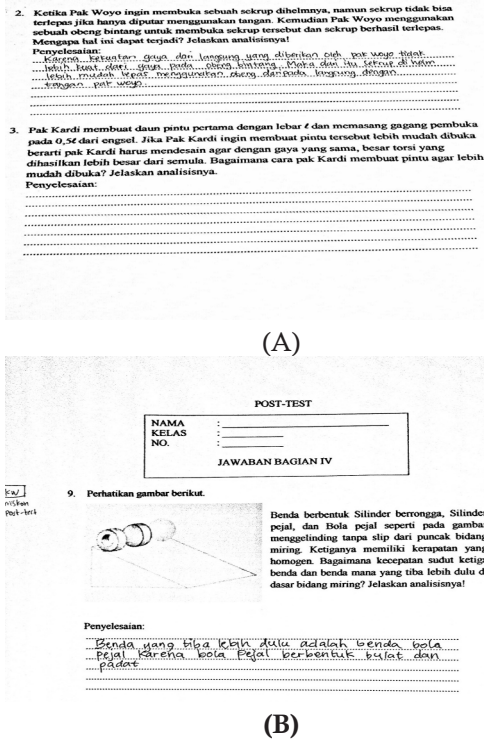


Figure 3. (a) The student's answers in the misconception on moment of force (b) The student's answer in the misconception on inertia moment.

Moderate mental model (MMM)

The number of students using the type of MMM was 37% in solving the quizzes, and 21.05% when they worked on the problems of post-test. In pre-test, there were no students who predominantly used the MMM to solve problems. The answer of students who used MMM can be seen in Figure 4.

Students who used MMM could analyze the concept, although their analysis on concepts were less precisely. Moreover, other students could use the concept in solving equations. MMM has characteristics that similar to the type of mental models in the descriptive research by Fazio et al (2013).

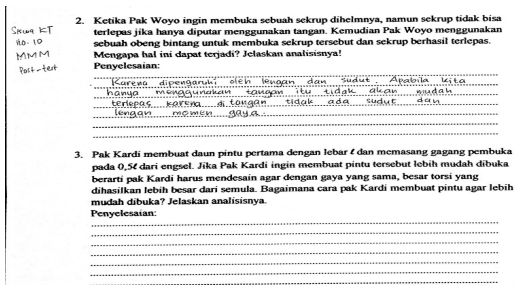


Figure 4. The students' answers in the post-test with the type of MMM.

The pattern of responses as in Figure 4 illustrates that the student is able to analyze the moment of force but has not been able to connect the influence of moment arm force against force. Students have not been able to link the relationships between concepts, the concept used less precisely.

High Mental Model (HMM)

There was small number of students who were included in this type of HMM in this study. The number of students answered the problem in quiz using HMM was 5.26% and in the post-test was 21.05%. Students who used the HMM to answer the problems in question by providing the correct analysis of the concept, although it has not perfect yet.

The characteristics of HMM type are similar to the type of mental models in explicative research by Fazio et al (2013). Students who used HMM provided information through interviews where they answered that they can understand the material studied which ranged from 75% -85%. The student's level of understanding on the material affects the mental models built. Seel (2006) stated that the relationship with the conception of mental models such as cause and effect is because of students build a mental model of the concepts, rules, and associations of potential students. The example of the student's answer with high mental model can be seen in Figure 5.

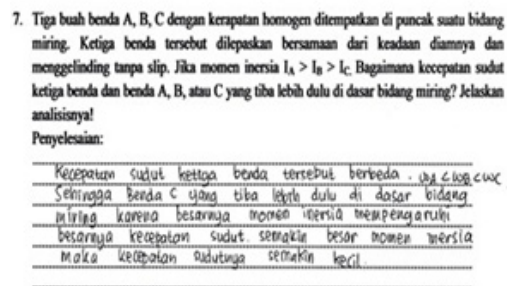


Figure 5. The students' answers in the post-test with HMM.

The pattern of responses as in Figure 5 shows that students can analyze the problem properly, without knowing the value of the moment of inertia of solid ball. The results of the interviews showed that the students said that they can predict that the moment of inertia of the small solid ball. It is because they can memorize the learning material about the moment of inertia of cooked eggs which are smaller than the moment of inertia of raw eggs and also the movement of two different eggs. Students with HMM were able

to connect the observations and the underlying concept.

Mental models of students is experiencing a gradual shift by phase. At the beginning before the learning, students only have Low Mental Model, but after learning there are some students who experience changes in mental models become Moderate or High Mental Models Mental Model. Changes in such mental models is not uncommon. Students' mental models can be developed near the mental model of an expert when it obtained the full information (Seel, 2006, Darabiet al, 2009). Isomorphic to the problem presented can affect students' mental model changes because a student can use different mental models in response to a set of circumstances or issues deemed equivalent by an expert (Fazio et al, 2013).

CONCLUSION

The conclusion of this study is based on the results and discussion as much as two points. First, there are misconceptions in students with mental model of the type Low Mental Model. The student with misconceptions has a Low Mental Model which is a thing that needs to be known by educators in the learning plan. Misconceptions can be reduced by providing learning that focuses on the concept. Second, mental models can evolve gradually into such an experts mental model. Mental model of a person may change because of the nature of mental models are unstable, inconsistent, which is caused by the development of the information obtained. The development of mental models starts from Low to High Mental Models. The development of the low mental model in pre-test can be reduced when resolving the existing problems in the quiz and post-test.

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STUDENTS ARGUMENTATION IN SCIENCE LESSONS: A STORY OF TWO RESEARCH PROJECTS

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ABSTRACT

The study analysed profiles of students' argumentation and how lessons may develop students' argumentation skills. The study was conducted at two Indonesian progressive private schools and a school located in Australian low socio-economic community. This study explored possibilities to draw together results from two different research approaches typical to each country. The Indonesian research project used paper and pencil tests and interviews to investigate students' argumentation skills, while the Australian research project analysed videos of the lessons. The Indonesian study finds that there is no significant difference between two types of schools and gender. The Australian classroom showed shifts in creative dispositions that include the argumentation processes but not a consistent pattern between classes. The Australian teachers actively required students to make claims, explore the robustness of these claims, transferred these claims to new settings and to think of alternative explanations that encouraged students to construct more coherent arguments. This study finds that interpreting and re-interpreting two different research approaches can produce insights that benefit both sides as it can account for the context and needs of each country. In addition, combining of two different methodologies provided perspectives often not collected through single methodologies.

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Keywords: argumentation skills, Australia, Indonesia, science education

INTRODUCTION

Internationally, governments are concerned about the outcomes of international comparative studies on students' achievement in science, such as TIMSS and PISA that involved both Australia and Indonesia. A number of educational policies are formulated in response to the findings, such as programs to improve teachers' qualification that are expected to give impact on the improvement of students' achievement. In both Australia and Indonesia, there were similarities in terms of strategy to improve the quality of education. While Indonesia introduces teacher certification (Jalal, Samani, Chang, Stevenson, Ragatz, & Negara, 2009; Republik Indonesia,

2005), researchers and government organizations in Australia have conducted numerous national surveys and reviews on teacher education programs in relation to the competency levels of teachers, certification procedures, and their employment status (Australian Institute for Teaching and School Leadership, 2013; Harris, Jenz & Baldwin, 2005). There is a relatively common perception in both countries that changing the teacher education programs will improve learning. In both Australia and Indonesia, the focus is on changing the quality of teachers rather than how the students learn. While focusing on improving teachers' competencies that can be important, however, it should not be ignored how the students learn since education is about students' learning rather than teachers' teaching. Comparatively, approaches to improve education put much more

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emphasis on what the teacher do, not on what and how the students achieve.

Some researchers (Osborne, 2010; Hand, Norton-Meier, Staker, & Bintz, 2009) claim that reasoning skills can contribute to the quality of student learning. This paper will describe two studies in Australia and Indonesia that attempt to address some of the issues around the students' argumentation and reasoning. Kuhn (2010) argues, "Skills of argument are fundamental intellectual skills, worthy of attention in their own right." Argumentation requires students to think clearly and critically as well as provide evidence to support claims. Hornikx & Hahn (2012) identify the notion "argument" as refers to reason, a structured sequence of reasons and claims, and a social exchange. All these three are integral to understand the human reasoning and cognition. These suggest that argumentation skills are closely related to reasoning and in this paper; the two terms are used interchangeably.

Hammer & Sikorski (2015) argue that a student learning is complex and that it needs to take into account the complexity reasoning of the learners. In addition, students learning can often be lack a degree of coherency in their reasoning processes and it is important to address this. Student learning is enhanced when they are actively involved in the learning process. Engagement in learning can be facilitated when students develop good reasoning skills that can be achieved by demanding students to make a claim and to support their claim by giving strong evidences. Students achieve better conceptual understanding and reasoning skills when they are supported to generate their own representations and justify their understanding.

This process of utilizing representations provides insights into how students reason. As Lehrer & Schauble (2015) said, learning is a coordinated, on-going enterprise of working together to build coherent accounts and not a kind of static hypothesis to be tested, affirmed, and reified. There are students who cannot develop coherent accounts and to address the different ways that they endeavor to reason and understand the concepts. There are two possible ways for students to make meaning of science concepts (Zemba-Saul, 2008). In the first pathway, students may start with scientific phenomena and pursue it with formulating testable questions and followed by collecting and analyzing data. Alternatively, students may also make meaning by looking at the existing scientific knowledge and scrutinizing the knowledge in terms of the evidence and the justification. Toulmin's (1958) formal model of argumen-

tation processes has been the dominant model in studies on student argumentation in science. According to Toulmin, a strong argument consists of a claim (a statement of position), data/ground (facts and evidence to prove the claim), warrant (logical statements that serve as bridges between the claim and the data), backing (statements to support the warrants), qualifier (statements that limit the strength of the argument), and rebuttal (statements indicating circumstances when the argument does not apply).

As suggested by Nielsen (2013), one of the advantages of Toulmin's model is the applicability to analyze large-scale quantitative data. It focuses on the identification of claims, assertions, connecting evidence or data, warrants for claims, and backings for warrants (Brown, Nagashima, Fu, Timms, & Wilson, 2010; Osborne, 2010). Toulmin's models allow researchers to analyze an argument into its component and conduct quantitative analyses.

While we see the value in Toulmin's taxonomy, we also believe that the actual process is not so reductive as Toulmin's model suggests. Dolan & Grady (2010) who claimed that the highest level of reasoning in inquiry entailed students thoughtfully representing data in multiple ways including tables, drawings, graphs, or statistical representations note the complexity of reasoning processes. The different nature of Indonesia and Australia in terms of the methods to teach science at schools as well as research methods employed by science education researchers, it is interesting to see how Indonesian and Australian schools facilitate students reasoning. The following are questions that guide this research: How is the profile of students' argumentation?; How do lessons facilitate students' argumentation?; How is the significance of the research design?

METHODS

This study was designed to explore possibilities to integrate findings from two different research traditions of two countries (quantitative in Indonesia and qualitative in Australia). Although traditionally both countries have a long history of bilateral relationship, however, the number of educational research collaboration is very limited. It seems that different research traditions in both countries have been shaping research-funding bodies to favor different research approach. As a result, researchers in both countries adjusted their research approach to the preference of the awarding bodies.

In this study, we attempt to collaborate at

data analyses and interpretation level (Figure 1). We believe that interpreting and re-interpreting two different research approaches can produce insights that benefit both sides as it can account for the context and needs of each country.

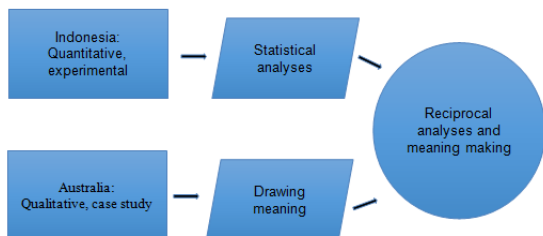


Figure 1. Research design

For the Indonesian setting, a pre and post intervention of the data collection using written tests and interviews were conducted to measure students' reasoning. Interviews to the school principal were conducted to collect data about the school philosophy and policies. Teachers' views about how lessons may contribute to students' argumentation skills were collected through interviews to the science teachers. At the Australian setting, data were collected through interpretive analyses of the videos and interviews to the teachers and the students. The Australian study focuses on instances where argumentation appears in class and deeply analyzes them to draw meanings from such instances. Based on the data collected at each country, we conduct reciprocal analyses and draw meanings from the data. We tried to understand and draw meanings of findings from both countries. Finally, we tried to draw common and more general accounts from both studies.

The study was conducted at two Indonesian schools and an Australian school. The Indonesian schools are two readily accessible private schools. For the purpose of anonymity, the Indonesian schools are identified as School A and School B. The schools were purposely selected since they were considered as progressive schools that ready to adopt innovation. Both schools implemented the national curriculum but they also modified it to fit the philosophy of the schools. Unlike most schools, enrolment rate at both schools was relatively low as they were relatively expensive schools. All students in School A and School B participated in the study.

The Australian school consists of a school whose teachers have been involved in our work on student-generated representations (Prain & Waldrip, 2006; Sutopo, Liliyasi, Waldrip, 2013; Waldrip & Prain, 2012; Waldrip, Prain, & Sellings, 2013). The school was a high school loca-

ted in low socio economic community. The number of the students in the classroom was about 25 students. A science topic on genetics taught by a science teacher was chosen as an exemplary lesson. Students were accustomed to traditional classes that were didactic and teacher focused. We focused on a teacher (Wendy) who was perceived as excellent by their peers. The teacher was committed to improving the student learning and took risks to try new approaches that were likely to improve learning for students. One would identify the teacher as a 'risk taker'.

The levels of students' argument were analyzed based on a modified rubric based on Toulmin's framework. Based on Toulmin's framework Choi, Notebaert, Diaz, & Hand (2010) developed a matrix to the analyzed argumentation. The matrix, however, is a bit complicated that we decided to simplify for the purpose of our study (Table 1).

Secondly, the students' responses were analyzed based on the coherence and comprehensiveness of the components of their answers (Table 2). We felt that it was important to examine whether the students related components of arguments together to build a coherent argument. We were interested if the students' answers provided and related data, evidences or warrant that in meaningful and logically made sense. To analyze the coherence of the reasoning, we developed the following rubric. Students' interviews were used to clarify the students' answers and to explore the students' deeper reasoning.

Analyses of the Australian data were mainly based on the videos of the lessons. All videos were carefully watched to find incidents of argumentations. We initially analyzed the videos based on Lucas, Claxton and Spencer's (2012) creative disposition including inquisitiveness, persistence, imaginativeness, collaborativeness and disciplined. When there were parts of lessons that showed such incidents, we carefully analyzed them to see how argumentation was used to develop the students' thinking. In addition, the teacher – student interaction and the student-student interactions were examined to explore their reasoning processes.

RESULTS AND DISCUSSION

Level of the arguments

In general, both schools (Figure 2) show similar patterns of Toulmin's levels. Most of the students are predominantly at level 2. This means that students are able to make a claim and present some data or warrant to support the claim

Table 1. Level of students' argument

Level	Description
1	Present a claim only. Example: I am going to use pesticide (claim). Present a claim and data and/or warrant.
2	Example: I am going to use pesticide (claim) because pesticide contains chemicals that will kill the insects (data), so that the number of the pests will decrease (warrant). Present <i>claim, data, warrant, and backing/ qualifier/ rebuttal</i> .
3	Example: I am going to use pesticide (claim), but I will choose only natural pesticide (qualifier) because pesticide contains chemicals that kills pests (data) The number of the pests will decrease (warrant). Presents <i>claim, data, warrant, backing, and qualifier/ rebuttal</i> .
4	Example: I am going to use pesticide (claim), but I will choose only natural pesticide (qualifier) It is because pesticide contains chemicals that kills pests (data) The number of the pests will decrease (warrant) because pesticides kills pests (backing). Presents all components of argumentations: <i>claim, data, warrant, backing, qualifier, and rebuttal</i> .
5	Example: I am going to use pesticide (claim) although I know that pesticide is not good for the environment (rebuttal) It is better to use natural pesticide (qualifier) because pesticide contains chemicals that kills pests (data) The number of the pests will decrease (warrant) because pesticides kills pests (backing).

Table 2. Level of coherency and relationship between components in the examination scripts

Category	Description of the rubric
Higher Coherency	<i>Claim is logic and is supported by a correct and relevant grounds (data, warrant, backing)</i> Example: To fights rice pests we can use controlled insecticide and natural predators of the insect Insecticide works by affecting the physiology of the insects while predators prey the insects
Reasonable coherency	<i>Claim is logically make sense and is supported by a sound ground.</i> Example: I am going to use insecticide because it will kill pests
Limited coherency	<i>Claim logically make sense but no supporting grounds or the ground is incorrect or irrelevant</i> <i>Claim doesn't logically make sense and provides no supporting grounds</i> Example: Building a wooden fence around the rice field to protect rice field from pests.

but only few of them can provide rebuttal. A study conducted by Garcia-Mila, Gilabert, Erduran and Felton (2013) suggests that giving students tasks that required them to reach consensus led them to produce rebuttals in their discourse. Since rebuttals represent an acknowledgment of the limitations to one's own claim, higher number of rebuttals indicates that the students are learn to look issues from different perspectives.

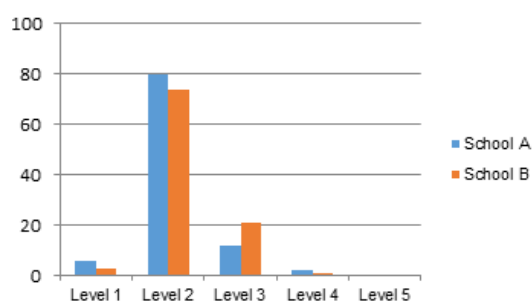
**Figure 2.** Percentage of students' argumentation

Figure 2 shows that neither Indonesian school's perspective resulted in higher levels of students' reasoning as compared to the other school. Although both schools adopted a very different philosophy, however, the results indicates that schools' philosophy does not reflected in the students' argumentation skills. It suggests that argumentation is not a product of the type of school. It is possible that the development of the students' argumentation seems to rely on the teaching-learning process, which reflects Hattie's (2012) claims that the teacher has much more impact on learning than does the school. This indicates that lessons do not significantly reflected school philosophy.

Indonesian teachers' interviews suggest that they did not completely aware of strategies to facilitate students' learning using argumentation and inquiry, such as Argument Driven Inquiry (Sampson & Gleim, 2009), or give tasks that require students to come to a justified agreement of other students and propose a consensus solution to the problem (Garcia-Mila et al., 2013). They described some strategies perceived that could promote students' reasoning. Some of these reasons were trivial, such as asking questions that do not require the students to think or asking the students to present an idea, that is, recall questions. Some teachers required their students to conduct field study that could appear to provide opportunities for reasoning. However, these experiences were designed more on giving students direct experience with the objects or nature rather than asking the students to collect and analyze data to support their ideas.

Results from the students' questionnaires show that teachers (43%) rarely present problems or issues that require the students to provide evidence to support their answers. The Students (58%) also report that laboratory classes are not aimed at collecting evidence to support the students' ideas. These suggest that laboratory classes are not designed to promote the students' reasoning. It is possible that students rely on their common sense rather than reflecting on laboratory evidence to support their claims.

Coherence of the arguments

Figure 3 shows that students at School A tend to be able to formulate more coherent arguments compare to School B. Our observation finds that lessons rarely demanded the students to formulate coherence arguments, such as by asking the students to provide more detail explanation and supporting evidence for their answers. Indeed, there were situations where teachers pre-

sented issues that required the students expressed their ideas, however, students were not demanded to provide more elaboration. To facilitate students' argumentation skills, teachers should involve the students in an argumentative situation that required them to think and justify their arguments (McDonald, 2014).

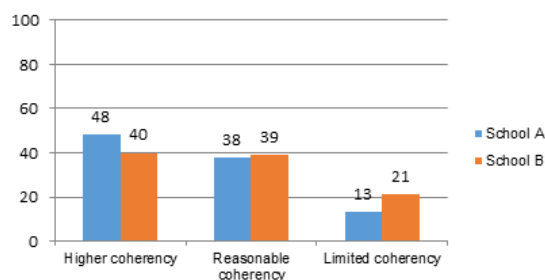


Figure 3. Coherence of students' argumentation

From grade 7 to grade 9, there is a shift (Figure 4) toward a more coherent reasoning but the gain is not significant. This result confirms the tendency for gaining over time (Choi, *et al.*, 2010; Kuhn, Katz & Dean, 2004). It is possible that this shift was due to the students' maturity or personal experience rather than the learning experience. Indeed, maturity may play important roles in facilitating the students' learning as people grow up they can argue better.

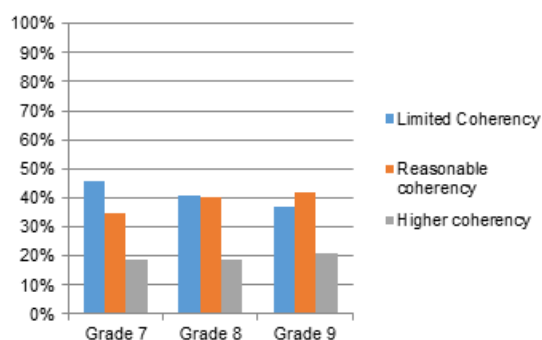


Figure 4. The development of students' arguments

As suggested by Choi *et al.*'s (2010) simple maturation is not sufficient for learning how to reason or to argue. This suggests that there are other factors affecting the students' ability to reason and they do not necessarily relate to the lessons in the classrooms. The survey results also show that the students made use of information from the news (25%) and their daily life experience (35%) as sources of evidence to support their claims. This data could suggest that the development of the students' reasoning depend more on students' individual efforts rather than the school programs.

Gender comparison

A comparison between boys and girls shows that girls tend to reach higher levels of reasoning as well as a more coherency in reasoning skills (Figure 5) but the difference was not statistically significant. Since schools and teachers seem to play very minimum roles in developing the students' reasoning, girls' achievement may relate to maturity or personal efforts. Teachers suggest that girls tend to be more focus in the lessons compare to boys.

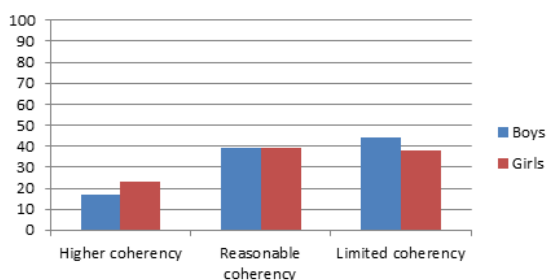


Figure 5. Comparison between boys' and girls' argumentation.

Statistical analyses of the levels and the coherence of the structure of the students' argumentation show that there is no significant difference in terms of types of schools, the grade levels,

and gender. These suggest that difference philosophical backgrounds and school arrangement, give little contribution to the development of the students' argumentation skills. The fact that different grade levels did not lead to improvement of students' argumentation suggest that argumentation has not been given sufficient attention at both schools. In the interviews, the teachers said that their teaching strategies were predominantly lecturing. Here, the students are passive audiences with little opportunities to practice their argumentation skills. The interview suggests that the teachers did not value argumentation because their main focus was delivering that contents of the curriculum and practicing for examinations.

Argumentation in the classroom

Data on argumentation process in the classroom were taken from the Australian context. The initial analyses of the video recordings were based on Lucas, *et al.* (2012) Creative Dispositions (Table 3). It measures the extent lessons provide learning environments that allow the students to develop their argumentation and reasoning skills. Table 3 presents the time in the lessons that indicate creative dispositions.

Table 3 shows that there was no consistent pattern in the use of creative dispositions. Wendy

Table 3. Percentage of time on Creative Dispositions observed in Wendy's class

Aspect	Class 1	Class 2	Class 3
Inquisitive			
Wondering & questioning	11.1	6.3	7.8
Exploring & investigating	7.9	9.1	8.3
Challenging assumptions	5.5	4.4	7.7
Persistent			
Sticking with difficult	6.1	4.2	5.5
Daring to be different	3.1	4.1	4.3
Tolerating uncertainty	2.3	1.3	3.7
Imaginative			
Playing with possibilities	12.0	14.1	9.1
Making connections	8.0	8.8	8.7
Using intuition	4.3	2.9	2.5
Collaborative			
Sharing the product	3.9	7.9	8.7
Giving & receiving feedback	8.0	11.8	5.2
Cooperating appropriately	3.0	7.2	7.2
Disciplined			
Developed techniques	2.4	6.0	7.1
Reflecting critically	5.7	3.8	2.9
Crafting & improving	2.5	5.7	3.1

Student/ teacher	Conversation	Aspect of argument
Wendy:	We are going to look at the chances of inheriting a particular trait. When meiosis occurs, the breakup can be random. If we have two parents who can roll their tongue and they are heterozygous. We want to find out what is the chance of them having a child that cannot roll their tongue.	Invitation to make a claim
Ken:	Which one can't? Two big 'RR's can, two 'rr's cant.	Making a claim
Susan	1 in 4.	Making a claim
Steve:	50 : 50.	Making a claim
Kay:	It is 1 in 4 because the big 'R's dominate.	Justifying a claim
Ken:	Mothers give half the information, 'R', or 'r'. Dad's give 'R' or 'r'.	Justifying a claim
Wendy:	When the sperm with 'R' meets egg with 'r', it means they can roll their tongue. When the sperm with 'r' meets egg with 'R', it means they can roll their tongue. The Big 'R' dominates. Can 'r' and 'r' roll their tongue?	Asking for clarification
Susan:	Yes.	Making a claim
Steve:	What about your kids?	Asking for clarification
Kay:	It depends.	Refining a claim
Wendy:	Is it really important to know this? Not really. For some people, this stuff matters. Say you want a child who is over 2.2 meters tall, have brilliant sporting ability, dark hair, green eyes.	Refining a claim
Ken:	That is like cheating. If they go to basketball as they were - designed that way.	
Wendy:	What happens if a teacher who influences the child not to like basketball and want to do something else?	Invitation to make a claim
Ellen:	What if the parents didn't want them to understand science?	Invitation to make a claim
Wendy:	They don't do one thing in tests, you choose what test you want. Women only have a certain number of eggs and so there is a limit to how many combinations of genes that one can have.	Refining a claim

often used collaborative group work to build understandings and this class had a high degree of observed the student- teacher and the student-student interactions. Wendy's classes were characterized by reasonably high levels of persistency, imaginative and discipline dispositions.

To understand how lessons may contribute to the students' argumentation, we analyzed classroom conversations that require the students to make claims, justifying claims, and refining claims. The following is an example of such conversation.

The excerpt shows that in the nature, arguments there is no sequence of making claim, providing data (evidence) warrant, backing, qualifier, and rebuttal. Rather argumentation flows

in a random sequence that certain component of argument may appear more frequent than the others may do. In Wendy's class, the learning environment was good that the students did feel comfortable in making suggestions and challenging other comments. She did express the view that, even though these students normally avoided science, in this class they were heavily involved in the discussion and challenging other claims.

At the same time, Wendy had planned and led a particular line of questioning. Her teaching was focused on the group as a whole but she responded to individual responses and interests. Her initial approach was to teach them as a group but in practice, she modified her lesson according to student responses and to address the

students' interests and understandings. She had developed an environment in which the students felt free to express their views and felt that it was important to allow the students to express their understanding in ways that reflected their interests. A feature of her teaching was the ability to coordinate the students' explanations (8%) and used their evidence to explain and clarify their understanding (8-9%). Wendy had the most consistent use of each creative disposition and this could be reflected in that the reasoning processes had a higher level of making claims, coordinating explanations and justifying and communicating ideas than most of the other classes. She felt that what was possible for the students in checking and refining claims resulted in a lower need for them to communicate their ideas publicly.

After the topic had been taught, both the teacher and the students were interviewed. The majority of the students, three months later, were able to recall their learning and explain their current understanding with more detail to the researchers than what the teacher reported were typical responses from the students. The students were asked whether their experience with this approach affected their understanding, ability to explain, and their perception of the class. The majority of the students reported that compared to traditional classes: The classes were more interesting and engaging resulting in more class engagement and more involvement in discussions, making claims, explaining and clarify that improved their learning; They felt that the necessity to explain their viewpoint enhanced their ability to communicate understanding to be more convincing; The need to explain their thinking helped many students to clarify their understanding; and The group and classroom discussions assisted in developing, clarifying and evaluating understanding of concepts.

Discussion

This study reported on argumentation using two studies that utilized quite different samples and methodology. We suggest that valuable lessons can be drawn from using different methods and different classes. Firstly, the Indonesian case study that used surveys and examination of the student script showed that most of the students' argumentation skills were relatively immature in that most students were at the level 2 (of five levels) while only a small proportion of the students developed coherent arguments. While the shifts in the Indonesian sample were not significant, they did occur in the direction of more coherent argument as the students progressed through their schooling. We argue that

teaching for reasoning requires more than just explaining the concepts, but letting the students develop claims, find supporting evidence, and identify possible counter arguments. The students reported that Indonesian teachers rarely asked the students to give evidence for their thinking or collect evidence for their views. Osborne (2010) states that teachers need to explicitly develop the reasoning skills with their students. In our view, there is a need for teachers to plan lessons that facilitate the students' ability to construct coherent arguments. These Australian teachers who were 'risk takers' planned lessons that required the students to make claims, explore the robustness of these claims, transferred these claims to new settings and to think of alternative explanations, which encouraged the students to construct more coherent arguments.

In Indonesia, it is very often believed that a smaller size of class would allow students to have more quality discourse between teacher – students and student-students. This study shows that the size of the class does not necessarily lead to quality discourse unless the teacher is competent and in the position to do it. The larger Indonesian class is only slightly larger than the Australian classrooms indicating that class size is not a major issue in developing reasoning. This confirms that the class size is not the determinant factor (Berliner & Glass, 2014).

In 2013, Indonesia introduced a new curriculum that put more emphasis on scientific process and scientific reasoning. The curriculum prescribes that teachers should teach lessons based on "scientific approach" model that requires teachers to give the students more opportunities to find evidence and to reason. Although the curriculum guides provide detailed guidance on how to teach, improvement of the teachers' understanding of the curriculum and other additional supports are needed to ensure that teachers are competent to implement the curriculum. As documented in earlier research (Widodo & Riandi, 2013), previous Professional Development (PD) resulted in few changes to classroom teaching practice. Therefore, it seems reasonable to suggest that future PD about the implementation of the new curriculum should adopt new PD models to enhance the teaching and learning processes. In Australian classrooms, teachers are required to undertake a minimal amount of PD to maintain teacher registration but are less directed as to what PD is appropriate for them.

In the Australian cases, the students were asked to represent a claim, provide evidence for it, then after further representational manipulations

on, refinement, discussion, and critical thought, to reflect on and confirm or modify their original case. In this context, analogous to Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff (2011) views of reasoning processes, the students were invited to be assessors of their own learning (mediators), and to function as an audience and sounding board for the other students, thereby co-operatively fostering scientific reasoning and literacy development aligned to scientific practice on a micro learning-community scale. As noted by Ford & Forman (2006), unless school students learn to construct and interpret accounts of their observations and reasoning, and become active in the learning process, then their learning can become constrained and superficial. The Indonesian students were asked to make a claim, justify their claim and to provide a rebuttal in their examination scripts but rarely in classroom practice. It is possible that students utilize reasons in classroom activities but do not do this in examinations, as they might not be able to provide coherent justification nor do they educated to see this as an essential a criteria for examination marking.

We suggest, like previous studies, the teaching process has the most impact on reasoning. Hence, the quality of the teacher does matter (Berliner & Glass, 2014). Teachers who have clear expectations as to what they want the students to develop and how to achieve this, can make a difference. The extent that the teachers' value reasoning and they know how to develop it can have an influence on students' learning.

Indonesian students reported that in their view, teachers rarely required them to make a claim, justify, and rebut challenges. The Australian case study focused on the pattern of creative dispositions and found that they varied from lesson to lesson but some components were more dominant. It also examined the class discussion and noted that students moved between ranges of creative dispositions (Tytler & Prain, 2010). It did not appear that any particular dispositions were precursors to other dispositions. The students engaged with dispositions as a tool to explore their understandings and the teacher could facilitate this process. The Indonesian sample indicated that the type of school was not a major factor in improving the student reasoning. It did suggest that there was an improvement over time in the level of coherency in reasoning. These results examined the analysis of examination scripts and students' perceptions of the process.

We argue that looking at the student reasoning from a range of perspectives, improved our understanding as to how reasoning was facilitat-

ed. The teachers played a critical role in helping the students explored their understanding and developed confidence to expose their views (Tytler, Prain, Hubber, & Waldrup, 2013). Sharing of understanding assisted students to explore their own personal views (Kuhn, 2015). It provided teachers with the opportunity to monitor the students understanding and to facilitate opportunities to check robust of understanding, and to plan the next crucial step in developing the students' understandings of topics. We do suggest that Indonesian teachers need to use classroom talk as a means of monitoring student understanding. We did not find evidence in Indonesian classrooms that this was prevalent.

CONCLUSION

This study combined researches from two different education cultures. The Indonesian sample investigated largely the quantitative data and did not find significant change in outcomes. Since the students appear to perceive that they were not taught how to reason very often in class, there is a need to re-conceptualize how this is achieved. The Australian data, largely qualitative, described the reasoning process and interviews revealed greater retention of learning compared to other classes. The teachers reported some subjective outcomes like perceived stress and improved the students' engagement.

The outcomes of this research can inform teacher education candidates in these countries. We recognize that there is a need to continue this study to investigate reasoning and describe learning in both countries. We recognize that it is not easy to combine data from different countries but it is definitely not impossible. It is important to recognize the limitations of doing this. We suggest that this research can produce insights that benefit both sides as it can account for the context and needs of each country. We recognize that culture can have an impact on the results, but in this case, the results are not largely explained by culture. This study appears to be the first investigation of reasoning that examines two quite different countries, that are, Indonesia and Australia. Indonesia has a very centralized education system while Australia is moving towards a more centralized system. Hence, the implications of this research are important for both countries.

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DEVELOPING MATERIALS FOR ACTIVE LEARNING OF GUIDED INQUIRY-INTEGRATED BOWLING CAMPUS ON THE TOPIC OF SENSE OF HEARING AND SONAR SYSTEM OF LIVING ORGANISM

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ABSTRACT

This study is categorized as developmental research since it puts to its core the developing materials process for active learning of guided inquiry-integrated bowling campus. This research aims to construct adequate learning materials that are based on the criteria of validity, practicality, and effectiveness. The developed learning materials are lesson plan, teaching material, student worksheet, and posttest which were validated by experts to perceive information on materials' validity and were tested to 25 eight graders of Junior High School on even semester of academic year 2015/2016 by using One-Group Pretest and Posttest Design. Data analysis was undertaken in quantitatively-qualitatively descriptive way resulting: 1) Valid categorized material validity (score 3.39); 2) Student worksheet legibility shows 100% for its interesting and understandable contents, 96% for its interesting appearance and its readable and adequate student book legibility for Junior High School students displaying the average sum of sentences the researcher took from sample text which was 5.69 sentences within 100 words under average sum of 145.8 syllables; 3) Very good execution rate (average score of 3.53); 4) Students responded very positively (98.58%); 5) Student centered learning activity; 6) Increase of students' learning outcome (N-gain 0.88 and $t = 23.04 > t_{0.05;24} = 1.711$). This research concludes that materials for active learning of guided inquiry-integrated bowling campus which were developed have been proved valid, practical, and effective to enhance learning outcome of Junior High School students.

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Keywords: Bowling Campus, Guided Inquiry

INTRODUCTION

National education has the function to develop skill and to create character as well as dignified national civilization in order to educate its people. This national education aims to expand students' potentials in order to become God serving individuals having noble, healthy, bookish, competent, creative, independent characters and to perform democratic way of citizenship as well as being responsible ones. The comprehensively intelligent Indonesians are the people with brilliantly spiritual, emotional, intellectual and kinesthetic characters which are embodied in visions

and missions of national education in Strategic Plan of National Education Ministry (2010-2015).

Based on learning outcome of Science in Indonesia, authentically obtained from Science literacy outcome of Indonesia students undertaken by *The Organization for Economic and Development (OECD)* in PISA (*The Programme for International Student Assessment*), it is reported that science ability of Indonesia students is still on lowest ten of the list of all 65 countries achievement. This result signals relatively low achievement of Indonesia students especially in some ability to: 1) comprehend the complex information; 2) understand theory, analyze, and solve problem; 3) utilize tools, their procedures, and problem solving;

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and 4) perform investigation (National Education Ministry, 2013).

Learning outcome can be regarded "pass" if it reaches the criterion of minimum passing standard (In Indonesia commonly abbreviated as KKM which stands for *Kriteria Kelulusan Minimum*) which was determined by teacher of all subjects in every education unit. KKM is a target of education unit in achieving competency in every subject matter. Basically, every learning related stakeholder (education unit and students) hopes to gain maximum learning outcome so that every unit has to put some effort to possibly pass the determined KKM.

Based on the result of interview with the eighth graders of State Junior High School of 1 Larangan Pamekasan of academic year 2015/2016 with determined KKM of 75, it is shown that many students' achievement were still below the KKM. There were 60% of them with achievement below the KKM while the 40% remainings' were above this standard. On the other hand, observation result on teaching and learning activities shows that many students were reluctant to pose question and to deliver opinion, and they paid attention less to the teacher while the teacher performed explanation on material. They would pay attention if the teacher admonish them to. The learning situation was still undertaken in teacher-oriented way. The students were set to listen to their teacher's explanation and demonstration and also were asked to proceed worksheet so that the learning process could not instantly be regarded to be carried in an optimal way.

One of the efforts that can be used to enact students more active in learning process is a refinement on process especially by using active way of learning. Active learning is any learning that enables students to play active role in learning process both in form of student to student interaction and student to teacher interaction.

Active learning model is such a model in organizing learning system through active learning method which leads to independent learning. The ability to learn independently is the end point of active learning. To obtain such situation, learning activities are set so that it can go meaningfully for students. Activities which include students' participation in solving problem are the activities that can trigger mind expansion (Silberman, 2006).

The selected topic in this research is the sense of hearing and sonar system of living organism. This topic was chosen because these two concepts can be found in everyday life by the students. Besides, the topic of sense of hearing

and sonar system entails many derived concepts that need investigation, observation, and experiment conducted by using scientific approach. Nevertheless, students still tend to treat this topic as difficult matter to learn so that the innovation towards learning and learning strategy need to be undertaken to make students more active and engaged.

Gulo (2002) defined inquiry model as learning sequence that includes maximally all the ability of students to investigate and to find systematically, critically, logically, and analytically so that they can formulate by themselves their own discovery confidently. By the use of inquiry activities, teacher's extensive guidance becomes important part. Inquiry approach makes it easier for students to develop independently for its thinking system, investigation, and way to act (Pavelich and Abraham, 1979). Investigation and trial can exercise students to perceive science processing skill. Hence, to exercise this skill, inquiry based model can be utilized. A guided inquiry learning enables students to obtain chance to expand knowledge and helps them to develop conceptual understanding (Pandey, et al., 2011; Banerjee, 2010; Barthlow, 2011; Blanchard, et al., 2009; Wilson, et al., 2010; Brown, 2010; and Wenning, 2011).

Based on this consideration, it is important to develop a learning that can exercise students to build the way of thinking and to find a concept as well as to develop analyzing skill amongst them without any particular student's dominion. This is very in line with what mandated by 2013 curriculum which highlights scientific approach essence. However, students are not used to engage in inquiry based learning, so this research addresses guided inquiry based learning.

METHOD

This research is developmental study which aims to develop teaching and learning materials which base on four D model that is modified based on necessity. The design of developing teaching and learning material in this research is given in this following Figure 1.

Research was undertaken to 25 eight graders of State Junior High School of 1 Larangan, Pamekasan of academic year 2015-2016 by using *One-Group Pretest-Posttest Design*, because this research was applied in one group without any comparison group. This research instrument was then validated by experts.

Observation, test, and questionnaire are the technique used to collect the data. The topic

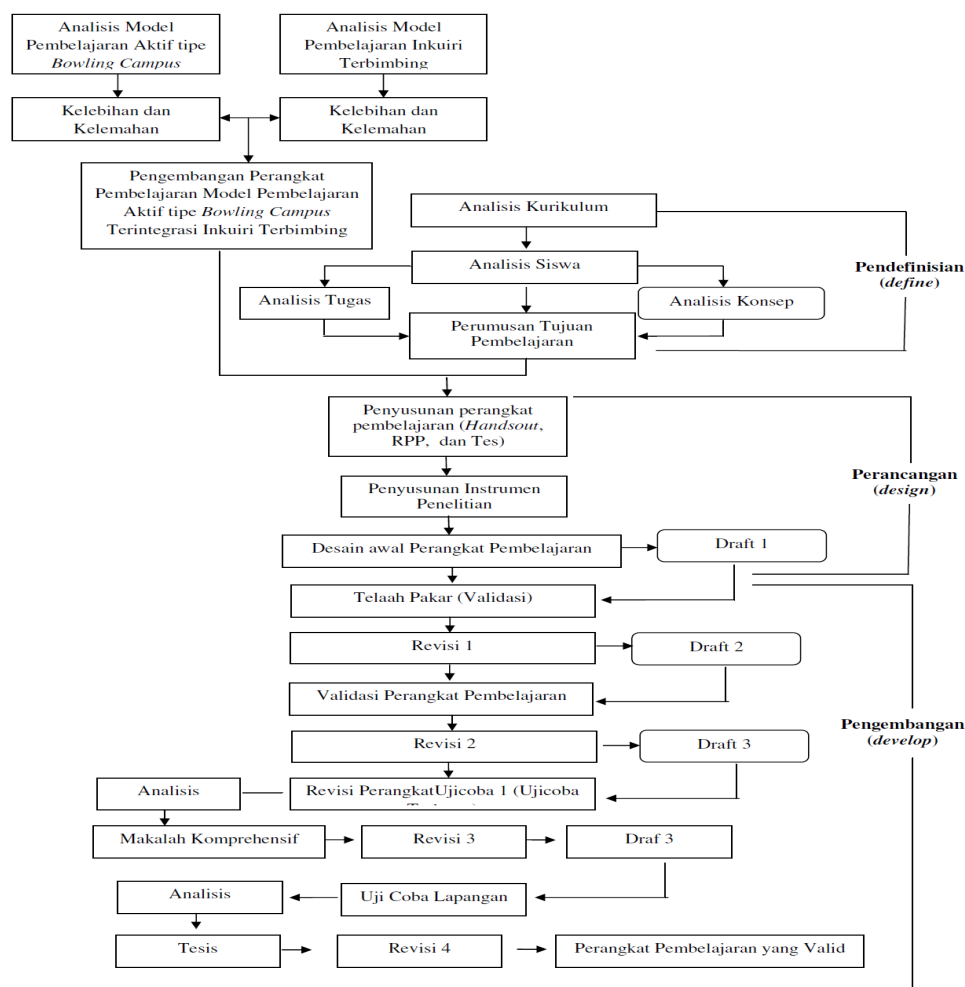


Figure 1. Flow chart on phases of Developing Materials (adapted from Thiagarajan, 1974)

being concerned is sense of hearing and sonar system of living organism.

RESULT AND DISCUSSION

The result of tested materials carried out in State Junior High School of 1 Larangan, Pamekasan which was based on materials validity, materials legibility, learning execution, students' activity, students' learning outcomes, students' responses, is elaborated as follow

Based on the validity of developed materials, it is obtained that: lesson plan validity on every aspect entailed two categories: good and very good. Validity of materials were reported valid. Worksheet validity including instruction aspect, content correctness, procedure, and question was indicated valid. Posttest validity including content, language, and question writing was proved valid and very valid.

The practicality aspect of materials was

indicated by learning execution, legibility of teaching material and student worksheet, and students' responses. Generally, legibility aspect for teaching and learning materials was reportedly good. Teaching material was used as means to support learning activity, content included in teaching material was reportedly relevant and adequate. Cain & Evans (1990), explained that if content included in teaching material is not valid or showcases misconception, that book cannot function as it is supposed to, as learning sources and means (enhance learning quality)

Content included in student worksheet is relevant to the one included in syllabus and lesson plan, so that basic competency can really be achieved. This statement is in line with what Devi et al (2009) explained, content included in student worksheet supported the achievement of basic competency, and that content can be derived from book, paper, internet, and scientific journal. Activity entailed in student worksheet displays

action or activities undertaken by students. Those actions or activity facilitate students to exercise their science processing skill. The determination of learning source was based on learning goals and content which are about to be mastered by students, or in other way, providing an experience to students appropriately to achieve learning goals.

The developed teaching and learning material for active learning of guided inquiry-integrated bowling campus were embodied in research instrument which was developed based on 2013 curriculum, in which science learning in Junior High School is undertaken by using scientific approach including observing, asking, collecting data, associating, and communicating (National Education Ministry, 2013)

The observation result on students' activities during the learning process in meeting 1, 2, and 3 showing the activity the students did the most with highest rate are listening and paying attention to teacher's explanation; doing experiment/observation; as well as posing question or opinion. Meanwhile, the lowest ones are showing irrelevant activity to learning process.

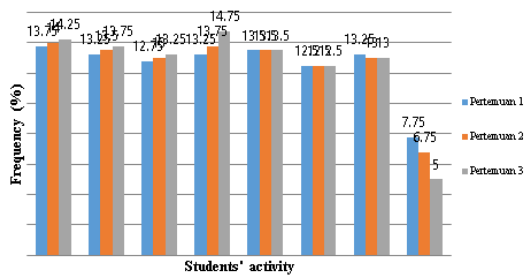


Figure 2. Percentage Diagram of Students' Activity.

Vygotsky argued that the development of life process depending on the social interaction and social learning plays important role to cognitive development (Khulthau & Todd, 2008). Noviwati (2010) stated that active learning of guided inquiry-integrated bowling campus used by the teacher can make students more active in learning process, plan the bases of scientific thinking within the students themselves, so that in this learning process, students can be even more active in solving problem.

Activity in active learning of guided inquiry-integrated bowling campus is one of activities that can be used to increase students' understanding on particular concept they are studying. However, in this research, the obstacles faced are the lack of students' understanding about scientific method and time consuming issue, so that

students cannot perform inquiry activities in an optimal way. The alternative solution conducted to tackle these obstacles are teaching students the scientific method in earlier phase of learning process and providing the appropriate amount of time so that learning process can go well.

There is significant increase on knowledge of students prior to and after learning based on analysis on pretest and posttest for obtaining the outcome of studying knowledge. Passing learning by the students reflects the increase of conceptual understanding of students.

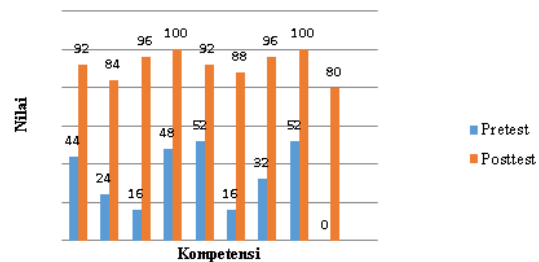


Figure 3. Nilai : Score, Kompetensi : Competency.

This increase of students' conceptual understanding has its connection to students' activities during the learning process, especially in observation and experiment. In those activities, students found themselves their own new knowledge by the use of teacher's guidance.

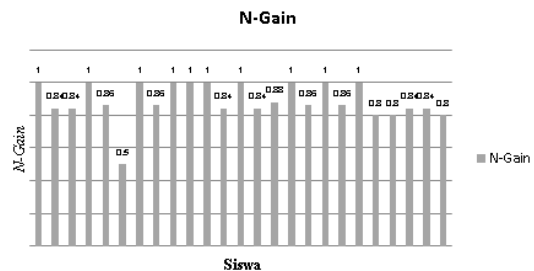


Figure 4. N-Gain Diagram.

The result of calculation by using n-gain and paired t-test also implies the increase on students' learning outcome in knowledge aspect. Every student has different increase score. It is because the cognitive ability of students different to each other. It is in line with Piaget who assumed that students grow through equal intellectual development order, but those growths happen to develop in different progress (Jufri, 2013)

Based on analysis on students' responses towards material development (including; teaching material and student worksheet) as well as learning execution by the use of active learning

of guided inquiry integrated bowling campus, it is obtained that on average there are 98.58% students who responded positively with strong criteria (Riduwan, 2010). Positive response is shown by the students during the learning by using material which was developed based on constructivist theory on good learning which makes students learn, stressing on students' active participation, and put teacher as facilitator (Westwood, 2008)

CONCLUSION

Based on research output, it can be concluded that: materials on active learning of guided inquiry integrated bowling campus are proved to be appropriate: valid, practical (the developed materials can be used in learning process), and effective (the developed materials can enhance students' learning outcome). Teaching and learning materials by using active learning of guided inquiry integrated bowling campus are proved to be able to increase learning outcome of Junior High School students.

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DEVELOPMENT OF STAD COOPERATIVE BASED LEARNING SET ASSISTED WITH ANIMATION MEDIA TO ENHANCE STUDENTS' LEARNING OUTCOME IN MTS

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ABSTRACT

This study aimed to develop a cooperative learning set (lesson plan, students' worksheet, and its evaluation) which is assisted with animation media to enhance students' learning outcome. The development of the learning set used 4D model, which had been tested to 30 students of grade VII at Roudlotun Nasyiin Mojokerto in even semester of academic year 2015/2016. The research was conducted by one group pretest-posttest design. Then, data was descriptive-qualitatively analyzed. The results of this study is as follow 1) Learning set validity is in valid category, 2) Practicability of the learning set is shown by implementatively qualified lesson plan and students' activity, 3) The effectiveness was judged from the raise of learning outcome. Conclusion of this study is that the cooperative based learning set assisted with animation media is proper and can be used to enhance students' learning outcome

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Keywords: animation media, cooperative learning, student's learning outcome

INTRODUCTION

National education which is based on Pancasila and 1945 constitution of Republic Indonesia serves to develop the ability and character development and civilization of the nation's dignity in the context of the intellectual life of the nation, aims to develop students' potentials to become a man of faith and fear of God Almighty, noble, healthy, knowledgeable, skilled, creative, independent, and become citizens of a democratic and accountable.

Learning materials which can support learning set include learning media, learning modul, and students' worksheet. Based on initial school observation, students' worksheet is the most chosen learning material to help students comprehend the concept. Students' worksheet is a set of compulsory learning task for students

(Depdiknas, 2004)

Learning media is a tool to elaborate teaching-learning process. Considering that many learning media can be used in the classrom, teachers have to be able to choose it carefully and precisely (Kustandi, 2011). Sutopo (2003) stated that one of learning media which can give a concrete learning experience through its audiovisual is the flash media. The software has many superiorities because its picture, animation and audio can be very attractive for the students to learn. Learning media animation by Adobe flash helps learning activity by giving students a figure for abstract concepts. The limitation of static pictures as a learning media can be improved by flash in various learning models and one of those is cooperative learning.

Learning media as stated by Gagne (in Ali 1992) is one of teaching-learning components which has a crucial role to support a success teaching-learning success. Media and animation

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using in a learning has many benefits and superiorities. Nowadays, more teachers tend to use animation in conveying information to attract students attention and help their comprehension. Hidayat (2010) stated that, generally, learning media help interaction between the students and the teachers so the learning can be efficiently and effectively done.

It also change the role of the teachers to be more positive and productive. A well media utilization, makes teachers as not the only one learning sources for students. A teacher do not need to explain all the material because media will also takes a part on it. So that the teachers will have more time to pay attention on other educative aspects such as helping students' difficulties, character buliding, and motivating students as well as to stimulate students' enthusiasm to learn. Miarso (2004) agreed that "Media learning is everything used to distribute messages and can stimulate the mind, attention and learning ability of students so as to encourage the process of intended and under-control learning ". According to Hidayat (2010), defined that media included teachers' teaching and messenger of information from the teachers to the students. As a presenter and channeling messages, media learning in certain cases, can represent teachers to give information for students.

As stated by Artawan (2010) the superiorities of animation media in biology learning are as follow. Help teachers to present information on a fairly complex process in life, such as the nitrogen cycle, aerobic respiration, circulatory system and other processes. Minimize the huge object and otherwise, such as animals animals and microbes. Motivating students to pay attention because the present appeal for students, especially animation equipped with a voice. Have more than a convergent, for example cobining the audio and visual.

According Kef, et al. (2006) that the use of animation can increase the speed of comprehension and Ainsworth (2008) stated strategy that students use to learn with animations depending on their cognitive resources, the motivation to strive on effective learning strategies and knowledge on the suitability of a particular strategy. According to Barak, et al. (2010) states that the use of animated films improve students' thinking skills, in terms of understanding, application of knowledge and reasoning ability. Cooperative learning model is a practical classroom techniques that can be used by teachers to help students learn skills ranging from basic to solving complex problems. Cooperative learning model, students work in small groups to help each other

learn from each other. The groups consisted of students with high learning results, average, and low; boy and girl; students with different ethnic backgrounds in the classroom. (Nur, 2008).

Based on research conducted by Lindarti (2010), showed that learning outcome quality was improved after applying the cooperative learning model STAD,. Moreover, according to research conducted by Nina (2013), show that the implementation of cooperative learning model STAD gave a positive effect and improved student learning outcomes, and according to research conducted by Armstrong (1998), that the coeprative learning type STAD can make a fun learing activity and provide positive effects.

METHOD

This research is *Development research* which is divided into two procedural stages. This stage was conducted by 4D (*four D models*). Development of this model set is composed of 4 steps as follow; *define, design, development, and disseminate*. This study only used three of those, until development stage. This stage was done by *one group pretest posttest design* (Sugiyono, 2011). The first step is measuring the students as *pretests*, then it was treated within a specific time duration, then finally had *posttest*. *One group pretest posttest design* can be visualized as follow :

O_1 : *Pretest* (Learning outcome measurement before the treatment)

O_2 : *Posttest* (Learning outcome measurement after the treatment)

X: treatment (Cooperative learning assisted with animation media).

RESULT AND DISCUSSION

Table 1. Result of Developed Learning Set Feasibility

Learning Set	Average	Category
Lesson plan	3.41	Valid
Students worksheet	3.37	Valid
BAS	3.33	Valid
Animation media	3.36	Valid

The following explanation is the result of learning set practibility. Result of Lesson Plan implementation.

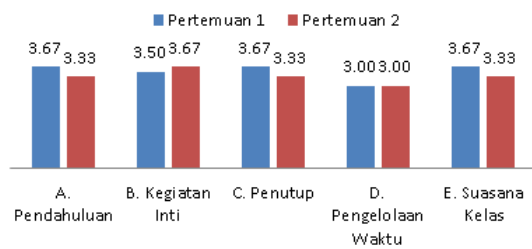
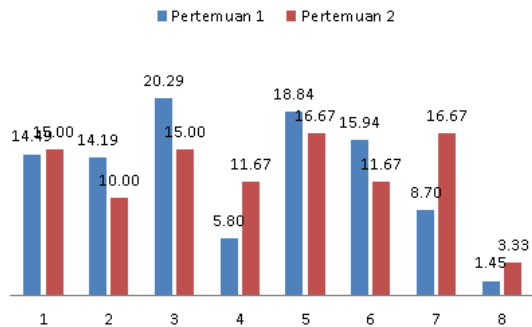


Figure 1. Diagram of Cooperative learning assisted with Animation Media Implementation.



Note

1. Reading (Modul and worksheet),
2. Doing experiments
3. Doing observation,
4. Taking note on observatio result,
5. Doing group collaboration,
6. Mendiskusikan tugas,
7. Communicating observation result,
8. Irrelevant action

Figure 2. Diagram of students activities in animation media assisted learning.

Questions’s sensitivity was derived from total of the right answer minus total the wrong answer the divided by test pasrticipants. As in Table 4.7, there are 10 questions has sensitivity ≥ 0.3 in a good sensitivity category.

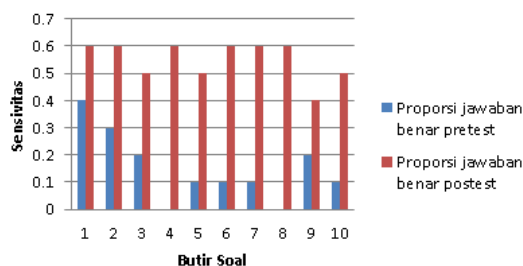


Figure 3. Diagram of Pretest and posttest sensitivity in cooperative learning assisted by animation media.

Test of learning outcome tested to 30 students as 10 items of multiple choices. Complete-

ness was measured from a student’s achievement to reach or exceed minimal completeness criteria (KKM) = 75%.

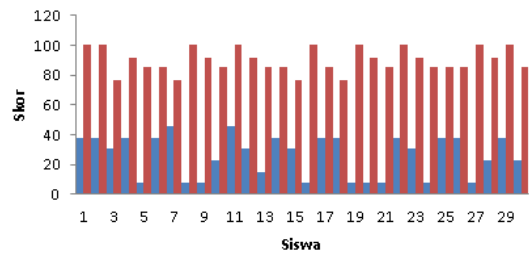


Figure 4 . Diagram of Learning Outcome Completeness.

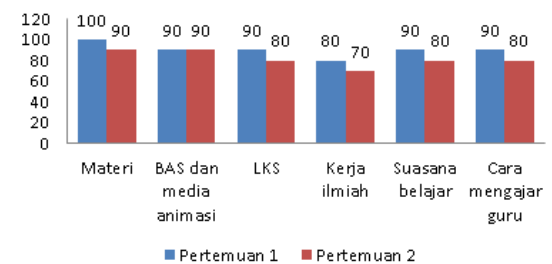


Figure 5. Diagram of Students’s Interest in Cooperative Learning assisted with Animation Media.

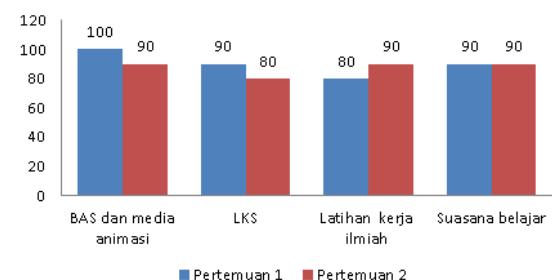


Figure 6. Diagram of Students’ New Experiences in Learning assisted with animation media.

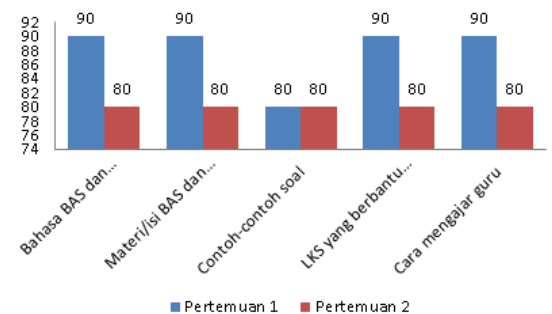


Figure 7. Diagram of facility given to Students in Learning assisted Animation Media.

This research results a cooperative learning set assisted with animation media to enhance seventh graders learning outcome in human circulatory system. The set was comprised of

lesson plan, students' worksheet, students learning modul, and animation media. First criteria of learning set feasibility was expert validation which showed that it is valid with $2,6 \leq P < 3,5$ and reliabel as it exceeds the minimal value given $(r) \geq 0.75$.

Based on validator assesment, lesson plan learning modul and animation media is valid and can be used with minor revision. Lesson plan was developed according to cooperative learning syntaks as follow (1) inform learning golas and motivate student, 2) presenting / conveying information, 3) organizing students in a learning group, 4) guiding group of working and learning, 5) evaluation, 6) rewarding (Arends, 1997)

Stages in learning stress on students' centered active involvement. The teacher is only as fasilitator who provides guidance to students. This is in accordance with the opinion of the Nur Bruner (2000) and a similar statement by Raturmanan (2004) stated that the importance of students active involvement in learning and believe that the actual learning that occurs through discovery. The group shared learning gives students the opportunity to study, joint a discussion, read the instructions in the students' worksheet. In addition to the principle of direct involvement of student learning will remain longer in memory and be more meaningful if they experience, observe, try and practice.

Based on the assessment worksheets developed according to (Depdiknas, 2004) includes the students' worksheet contents, title, basic competence, completion time, brief information, equipment / material needed, a task that must be done, procedures, and the report should be done. According Darmodjo et al. (2009) requirements that must be met to be qualified worksheets include didactic requirements, construction standards and technical requirements. Terms of didactic worksheets contain the principle of learning effectively which has several provisions, namely 1) pay attention to their individual differences, so that worksheets can be used by students who are good at, which is being, or slow, 2) emphasis on the process of concept discovery so that students get driving directions to search know by LKS, 3) has a variety of stimulus through various media and student activities, 4) develop students' communication skills of social, moral, emotional, and aesthetic, and 5) learning experiences is not determined by the material lesson material but is determined by the focus of development includes intellectual, emotional, and so on. Terms construction includes 1) use language appropriate to the students' maturity level, 2) using clear sen-

tences structure, 3) the sort order of the lessons that are presented in accordance with the abilities of students, 4) avoid questions that are too open, 5) the book references is not beyond the students' legibility, 6) use simple sentences and short, 7) provide enough space for the students to write and illustrate the worksheet, 8) use more illustration than the words that will ease in capturing implied worksheet, and 9) contains a source of motivation through the clear learning objectives and benefit from that lesson. Technical requirements relating to 1) A good worksheet should have identity to facilitate its administration, topics use big bold letters, not regular underlined letters, using no more than ten words in one line, using frames to distinguish the command line with the answers, and try to get a great comparison with the case of the pictures match, 2) good image for a worksheet is the image that corresponds to the learning objectives, it can declare the message of the picture effectively. 3) A good worksheet appearance is it with interesting combination of images and text. Developed students' worksheet has superiorities of using colored images, communicative language, have clear instructions making it easier for students to work on the problems and the observation instructions. Students' worksheet activities are done in groups in order to create a well learning interaction between the teacher and the students, learning media and tools used have been provided by the researchers.

A goodof quality students' learning module based on Akbar (Akbar 2013), can be used as 1) a source of teaching material, 2) a reference book on the subject, 3) are arranged in a systematic structure and simple, 4) equipped by learning guide. The superiority of the developed textbook ie BAS equipped with extra media animation as a medium of learning that helps show the material abstract about the mechanism of action of the heart and blood function as transporters of oxygen and carbon dioxide on the circulatory system in humans, the images in BAS has a color display for easy study the material, especially the organs of the circulatory system, their concept maps, a summary of the material and a glossary of terms to help explain the meaning of the term in the material circulatory system.

Media animation developed can be an alternative learning tool. As the opinion Miarso (2004) "Media learning everything used to distribute messages and can stimulate the mind, attention and learning ability of students so as to encourage the process of learning a deliberate, aimed and controlled and animation media can stimulate students 'motivation'. According to

according to Gagne (in Ali, 1992) instructional media is one component of the learning process has an important role in supporting the success of the learning process. The use of learning media can also provide a stimulus for students to the spirit of the learning process. Another opinion, according to Rusman (2012) medium was used as: 1) as a tool in the learning process, learning media is a tool that can clarify, simplify, accelerate the delivery of the message or subject matter to students, 2) as a component of the sub-systems of learning. Learning is a system in which there has sub-components which are components of learning, 3) directing the learning, instructional media as messages or materials to be delivered, or what competencies are developed to have students, 4) as a game or arouse the attention and student motivation, learning media can raise awareness and motivation in learning, because the media can accommodate all skills students in learning, learning media can provide some help understanding of the students who lack proficiency heard or seen in the concentrations studied, 5) improve outcomes and learning process, In quality and quantity of learning media greatly contributed to the results and the process pembelajaran. Berdasarkan description above, it may be said learning device that was developed based on the individual assessment by the validator, the average belongs to the category valid making it feasible to use in the classroom.

The second criterion, the feasibility of a good device that is practical, practical learning tools can be analyzed through keterlaksanaan RPP for learning and student activity during learning. Based on Table 4.5 it can be seen that the coefficient of reliability of observation enforceability of learning and teaching to the test II exceeded 0.75 or 75%. According Borich (1994), an instrument well categorized and can be used to observe activities when reliability is greater than or equal to 75%.

Accomplishment of cooperative learning model is a practical classroom technique that can be used by teachers to help students learn skills ranging from basic to solving complex problems. Cooperative learning model, students work in small groups to help each other learn from each other. The groups consisted of students with high learning results, average, and low; male and female; students with different ethnic backgrounds in the classroom; and students with disabilities if any. Membered heterogeneous group stayed together for several weeks, until they can learn to work well together as a team (Nur, 2008). STAD, students are grouped in a group of 4-6 students'

learning. The students were combined in terms of performance levels, and gender. Teachers presented a lesson, and then students work in his teams to ensure that all team members have completed the lesson. After that, all students are subject to individual quiz about instructional materials, at that time they were not allowed to help each other (Nur, 2008).

Analysis of the students' activities observations in cooperative learning activities assisted animation media obtained first meeting and the meeting of two high activity most students to work together and make observations 17.76% 17.65%. Lowest student activity was behaviors that are relevant tidak 2.39% ie activities carried out outside learning. Activities of students in a group had very active role. It is the student's activity is in accordance with cooperative learning. The group shared learning gives students the opportunity to study a joint discussion, read the instructions in the LKS. In addition to the principle of direct involvement of student learning will be more meaningful to do last longer in memory if experiencing, observing, trying and practicing yourself (Raturmanan, 2004). Cooperative learning provides the opportunity for students to interact with other students and learn from other students. It encourages students' conceptual growth of growing student at a higher way of thinking or way of thinking that is more complex (Eggen & Kauchak, 2012).

Constructivist theory by Vygotsky (in Slavin, 2000), stated that there are four modern constructivist ideas that plays an important role in learning. 1) an emphasis on the social nature of learning is that students learn through interaction with adults or peers who are more capable. In the project cooperatively, students are exposed to the thought process of peers, this method does not make learning outcomes is open to all students, but also make the process of thinking of other students is open to all students, 2) development zone nearby (Zone of Proximal Development) who emphasized that the students learn best when the concept of it being in their nearest development zone. The tasks in the development zone nearby are tasks that can not be done by the students, but it needs help from peers or adults, 3) apprenticeship cognitive (Cognitive Apprenticeship), which outlines the process by which a person who is learning gradually by step acquire expertise in interaction with an expert in the form of an adult or an older person or a peer who control the problem, 4) Scaffolding, which emphasizes the support step by step to learn and solve problems. Students should be given the

tasks of complex, difficult and realistic and then given enough assistance to complete these tasks.

Based on the description above can be said that the media-assisted cooperative learning animation also had met the criteria of practicality, proven by a good category of lesson plan, and high students activities is cooperating in learning as the highest event. It is proved that the learning set had met the criteria of practicality.

The third criterion is the effectiveness of learning can be analyzed through the results of student learning, and student responses. Analysis of student learning outcomes was divided into two, namely the cognitive learning. The result of student learning is one indicator of the feasibility study was developed. Completeness of individuals in achieving learning goals can be undone by a well. If all serving the purpose of learning the magnitude of ≥ 75 in accordance with the standards of completeness in MTs Roudlotun Nasyiin Mojokerto. The completeness of learning outcomes individually exceeded 80 of the overall proportion of students reach the learning objectives magnitude of ≥ 75 .

Furthermore, pottest was given after the assisted cooperative learning animation conducted, completeness individually of 30 students has increased, with an average of 88. The raise / N-Gain of pretest and posttest score was in high category with an average of 0.70 (Hake, 1999). It is clear that the cooperative learning media-assisted animation has a positive effect on media-assisted cooperative learning animation. Furthermore, after being granted an assisted cooperative learning animation is done posttest, completeness individually of 30 students has increased, with an average of 88. The amount peningkatakan / N-Gain score pretest and posttest was done high category with an average of 0.70 (Hake, 1999). It is clear that the cooperative learning media-assisted animation has a positive effect on media-assisted cooperative learning animation.

Result students' cognitive learning outcomes analysis can be seen in Table 4.9, namely pretest of 30 students, no thorough investigation of the standard completeness set is 75, which is proof of the value of the average completeness class pretest only reached 27 Furthermore, after being given a cooperative learning-assisted animation, completeness individually of 30 students has increased and completed all, with an average 89 and the percentage of completeness 100% obtained show that the learning outcomes of the individual has been completed. The amount of the increase / N-gain scores on a pretest-posttest was done that cooperative learning media-assisted

animation has a positive effect on cognitive abilities of students. The completeness of students indicated that cooperative learning media-assisted animation to increased learning outcomes in the blood circulation system materials. Some research that samayas it Lindarti (2010), showed that after applying the cooperative learning model STAD, quality further improved learning outcomes. Nina (2013), show that the implementation of cooperative learning model STAD positive effect can improve student learning outcomes, Zaki, et al. (2013) showed an increase in science process skills and social skills of students through the implementation of cooperative learning STAD type-Based Experiments.

The analysis of student's response to learning can be seen in Table 4.11 The analysis was done by giving a questionnaire composed by 15 items declaration in accordance with a response rate of each student. Students' response to the learning obtained an average of 100 keen on materials developed, format of student textbook and media of 90%, students' worksheet of 90%, 80% of scientific work, the learning atmosphere of 90%. Based on those percentage, it can be categorized that students gave very good and positive response rate on media-assisted cooperative learning animation. Piaget cited by Nur (2004) stated that the process of cognitive development was also formed by the students' learning environment. If the student environment is an active environment, the students' cognitive will be patterned to be able to master the concepts and solve problems quickly. Implementation of cooperative learning media-assisted animation helps teaching and learning activities, as mentioned above also help the students to achieve mastery of learning outcomes. It is obtained as a cooperative learning model-assisted animation media appropriate research by Ainsworth (2008) which suggested a strategy that students use to learn with animated media depending on their cognitive resources, the motivation for trying on a particular strategy. Rusman (2012) stated that one of the functions of instructional media is as a game or encourage students' learning attention and motivation. Learning media can increase student motivation in learning, because the media can accommodate all students' skill in learning. Learning media can provide assistance understanding of students who lack proficiency to listen and observe in the concentrations studied. Students' interest about the content of learning material was different between the first (100%) and second meeting (90%), due to the learning material of the first meeting were more interesting because the observations

were made with the animation media. In the second meeting the observation were done by an experiment of influence of activity through the application of scientific work where some students were still had difficulties in determining the hypotheses and variables.

The Ease of students to understand the language component of learning modul and animation media in first meeting was 90% and second meeting was 80%, content of learning module and animation media in first meeting was 90% and second meeting was 80% showed one of the functions of media learning which can facilitate understanding by reducing the occurrence of verbal material. During the learning often found students experiencing verbal because what is explained or described more teachers are abstract, there is no real illustration. Therefore, instructional media play an important role, effective and efficient in clarifying the message delivered (Rusman, 2012). Based on the description above, it is known that cognitive learning outcomes and process skills the student has achieved completeness 100% interest in students' responses to the media-assisted cooperative learning animation 90% and 90% of high student interest materials developed by pemebelajaran cooperative. This shows that the cooperative learning device-assisted animation has fulfilled effectiveness. So it's worth and improve learning outcomes especially on the material circulatory system.

The findings showed that cooperative learning device meets the eligibility animation media can be used to improve learning outcomes at the MTS on the circulatory system concept. It is supported by the validity and reliability of the learning media. Animation media can help explain the abstract material and motivate students to learn. The media is said to be practical learning, as supported by the accomplishment of lesson plan that both categories, student activities during the implementation of learning is very active. Learning tools are developed is said to be effective, because it is supported by cognitive achievement of students who have increased as well as the responses of students towards learning is very positive and the response of students interested in learning the material content circulatory system with assisted animation media and students can easily understand the content of the material from the textbook and media animation in learning circulatory system.

Results of students' responses analysis to the learning is shown by Table 4.11. Analysis was done by giving questionnaire with 15 questions appropriate to the response level of each student.

Averages of students responses were 100% interested to the material, students' learning modul and media 90%, students worksheet 90%, scientific wor 80%, learning atmosphere 90%. Based on the percentage, it was considered that the students' response rates were very good and positive impact on media-assisted cooperative learning animation. Piaget cited by Nur (2004) stated that the process of cognitive development was also formed by the students' learning environment. If the student environment is an active environment, the cognitive students will be patterned to be able to master the concepts and solve problems quickly. Implementation of cooperative learning media-assisted animation helps in the process of teaching and learning activities, as mentioned above also help the students to achieve mastery of learning outcomes. It is obtained as a cooperative learning model-assisted animation media appropriate research Ainsworth (2008) suggested a strategy that students use to learn with animated media depending on their cognitive resources, the motivation for trying on a particular strategy. Rusman (2012) claimed that one of the functions of instructional media is as a game or arouse the attention and motivation of students. Media attention and learning can increase student motivation in learning, because the media can accommodate all students in learning skills. Learning media can provide assistance in the understanding of students who lack proficiency heard or seen in the concentrations studied. Interest in response to the students about the material content of different subjects on the outcome of the meeting to 1 (100%) and meetings to 2 (90%), due to the meeting of the first material that discuss rated more manarik because the observations were made with the aided animation media and meetings to two more downhill because at the meeting to two learning experiments conducted with melakungan influence activity through the application of scientific work that some students are still difficulties in determining the hypotheses and variables.

Students' easiness in understanding language component of learning modul and animation media in the first meeting was 90%, and second meeting was 80%, learning modul material and animation media was 90% and second meeting was 80%. It is shown that learning media help concept comprehension and reduce verbalism. During learning, verbalism was commonly happened because teachers tend to explain abstract concept without a real illustration. Therefore, the learning media has an effective, and efficient role to clarify information (Rusman, 2012). Based

on explanation above, it is known that students' cognitive outcome and scientific process have reached 100% completeness, students' anxiety responses to learning set assisted with animation media was 90% and student, students motivation is high with 90%. This findings shows that cooperative based learning set have met effectiveness criteria, feasible and enhance learning outcome especially in circulatory system topic.

This research finds that cooperative based learning set assisted with animation media had met the feasibility and can be used to enhance MTs students' learning outcome in circulatory system concept. This is supported by learning set validity and reliability. Animation media helps to explain abstract concept and motivate students to learn. The developed learning set is practical because it is supported by good category lesson plan implementation and active participation of the students in the classroom. The developed learning is said effective as it is supported by the raise of students' cognitive learning outcome and students' positive responses to the learning. Students were also interested to learn human circulatory system. Animation media helps students to comprehend the content of learning modul and animation media itself.

CONCLUSION

Based on the research has been done, it can be concluded that development of STAD cooperative learning set assisted with animation media is proper to use and can enhance students' learning outcome.

Based on the discussion and findings, it is suggested that teachers have to do a preparation to use developed media so they will fully understand learning steps to be done, and also can consider time allocation to get the best result.

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CONCEPT ENHANCEMENT OF JUNIOR HIGH SCHOOL STUDENTS IN HYDROSTATIC PRESSURE AND ARCHIMEDES LAW BY PREDICT-OBSERVE-EXPLAIN STRATEGY

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ABSTRACT

This study explored effectiveness of Predict-Observe-Explain (POE) strategy to enhance concept comprehension of junior high school students in hydrostatic pressure and Archimedes law concepts. Subjects of this study were 31 students of a private junior high school in East Flores in even semester year 2015/2016. By mixed-method design, this study concluded that (1) average score of concept comprehension was significantly increase ($p = 0.000$) from pre-test (36.77) to post-test (63.26) with strong category of effect size (1.62), and moderate category of N-gain (0.40); (2) learning was also succeed identifying some misconceptions and remedied it. Those misconceptions were: (a) hydrostatic pressure was influenced by liquid volume and or the shape of the container, (b) an object was floated for there was air within, (c) a sunken object had no buoyant force, and (d) the magnitude of buoyant force was equal to liquid volume; (3) some of common problems around the students in applying hydrostatics concept and buoyant force were as follow (a) related to mathematical representation of hydrostatic force $P_h = P_0 + \rho gh$, most all students interpreted h as the depth measured from the bottom of the liquid column (not from the surface of the liquid as it should be), (b) related to buoyant force, the problem depended on the context where the question given. In context of immovable objects in a certain fluid, almost all student was hard comparing buoyant force magnitude to the weight. In context of sliding object in liquid, almost all students failed to explain the object position to its buoyant force.

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Keywords: POE Strategy, Misconception, Hydrostatics pressure, Archimedes Law

INTRODUCTION

Learning sciences is not merely for mastering knowledge which composed by facts, concepts or laws, but it is also the process to find it out (Rule of Educational and Cultural Ministry of Indonesia Number 22 Year 2006). In consequence, Sciences learning should be able to facilitate students in identifying objects and phenomenon, describing phenomenon, purposing question related to the phenomenon, constructing explanation, testing explanation by other

different ways and communicating their arguments (NRC, 2012). By this series of process, it is expected that students would get the knowledge meaningfully (Mayer & Moreno, 2003; Akinbobola, 2015). In order to let the students learn meaningfully, teachers need to use a phenomenon to trigger their active thinking (Longfield, 2009).

There are Many everyday phenomena around student-related topics and the principle of hydrostatic pressure and Archimedes law. Based on the constructivism learning theory, naturally the students tend to make of his own explanation when dealing with the observed phenomena, and

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often the resulting explanation was inconsistent with the principles of science that should (Docktor & Mestre, 2014). It is usually due to limited observations and their science knowledge (Yin et al., 2008; Wonget al., 2010; Radovanovic & Slisko, 2013). The misconception which was established by the students often are stable, difficult to change, and disturbing the students in understanding new scientific knowledge better (NRC 2001; Docktor & Mestre, 2014). Therefore, it is important for teachers to know students' misconceptions brought and making it an important input in designing learning.

Previous studies showed that many students had misconception in hydrostatic pressure and Archimedes law phenomenon. (Loverude et al., 2003; Heronet al., 2003; Unal & Costu, 2005; Hardy et al., 2006; Yin et al., 2008; Skoumios, 2009; Cepni et al., 2010; Cepni & Sahin, 2012; Wonget al., 2010; Chen et al., 2013; Radovanovic & Slisko, 2013; Ozkan & Selcuk, 2015). Loverude et al. (2003) dan Heronet al. (2003) reported students' difficulties in solving problems related to Archimedes laws. Yin et al. (2008) was succeed identifying 10 common misconceptions in students when observing sinked and floated objects. While Wonget al. (2010) reported that misconception in bouyant force was not only happened in middle school students but also in teachers.

Some researchers had done to apply learning to remedy misconception by 5E learning (Cepni et al., 2010; Cepni & Sahin, 2012). The result was not satisfying. It needs other effort more effective.

One effort can be done to remedy students' misconception is by POE strategy and its variances (White & Gunstone, 1992; Yin et al., 2008; Costu, 2008; Costu et al., 2012; Kala et al., 2012; Radovanovic, & Slisko, 2013; Kibirige et al., 2014). The main point of the learning is giving chances for students to be involved in observation, proposing questions, constructing hypothesis of proposed question, making prediction based on the constructed hypothesis, testing prediction,

and repair hypothesis to get a valid explanation related to learned phenomenon. The learning is appropriate to essence of learning science as a process (NRC, 2012) and it is believed can enhance students' critical hinking skills (Riveros, 2012; Etkina & Planinsic, 2015)

Some studies had reported the effectiveness of learning based POE in remediating students' misconceptions, For example, Costu (2008) and Costu et al. (2012) was succeed remediating students' misconception in condensation process, Kala et al. (2012) was succeed remediating senior high school students' missconception in pH and pOH. Kibirige et al. (2014) was succeed remediating students' misconception in salt dissolving process in water. Related to hydrostatic, Radovanovic & Slisko(2013) reported effectiveness of POE learning to remediate junior high school students' misconception in bouyant force.

By this study, we constructed and applied POE learning strategy in hydrostatic pressure and Archimedes law. Generally, the learning sequence is shown by Figure 1. The core of the learning was to give a broad chance to the students to observe the phenomenon, describe it concenterely, proposing questions, making hypothesis on the proposed question, making a prediction based on constructed hypothesis, testing validity of the prediction by experiments, and reconstruct the hypothesis to get a valid explanation about related phenomenon.

As a concrete representation of the learning implementation, here is shown a learning sequence in hydrostatic pressure concept, especially related to the principle at any point is proportional to the depth of the point. Peristiwa-learning events that arise at each stage are also presented. Learning events appeared at each stage are shown bellow.

The teacher presented the phenomenon of water gushing through the holes in the bottle (Figure 2), and then asked students to describe the phenomenon. One description of the student was "water has increasingly distant glow when the

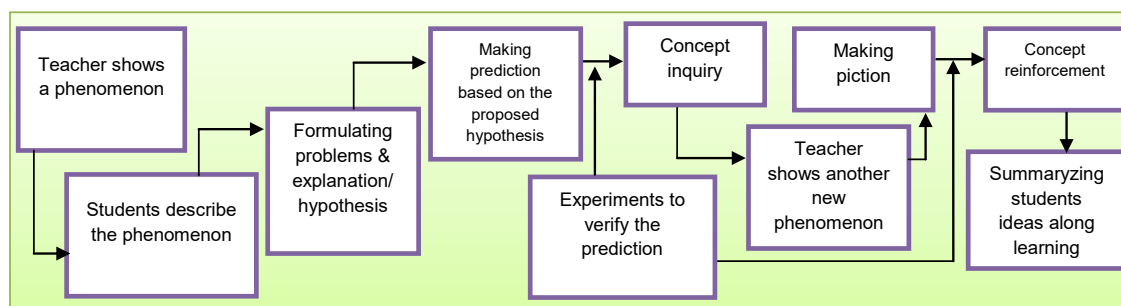


Figure 1. General Sequence of Learning by POE Strategy

hole in the bottle is deeper.

The teacher asked the students to formulate the problem based on the phenomenon that has been described. One formulation of the problem that the students were “why the water that comes out through the bottom holes have jets farthest?”



Figure 2. Water gushing Phenomenon from a Bottle

Teacher asked students to make hypotheses regarding the formulation of the problem created. Most students left the hypothesis: “the difference jets of water due to differences in the volume of water that is on every hole.” Others proposed: “difference jets of water due to differences in water pressure at every hole”.

Teachers guided students test his hypothesis by measuring the water pressure using the Hartl tool. (Previous teachers demonstrated the functions and workings of the tool) After experimentation, the students agreed that the difference jets of water coming out through the holes in the bottle due to differences in water pressure.

Teachers guided students to evaluate the accuracy of other hypotheses that have been raised student. Through FAQ student eventually concluded that “the difference jets of water not due to differences in the amount of volume that is on every hole, but due to the difference in pressure in the water”.

Teachers guided students to formulate its findings in the form of mathematical models. Through interactive discussions, the students formulated the principle that the water pressure at any point is proportional to the depth ($P_h \sim h$).

The teacher asked the students to predict pressure ratios in the bottom of the water in several different columns as shown in Figure 3. In Figure 3 (a), all columns filled with water so that the water surface just as high. In Figure 3 (b), all columns filled with water at the same volume. Both problems are presented sequentially, first Figure 3 (a) and Figure 3 (b). Related to the situation in Figure 3 (a), all of the students thought that the biggest pressure in the container A, while

the smallest in container B. They reasoned because the water in the container A container at most and at least Bs. Related to the situation in Figure 3 (b), the students said that the pressure in the container A most for its widest cross-section.

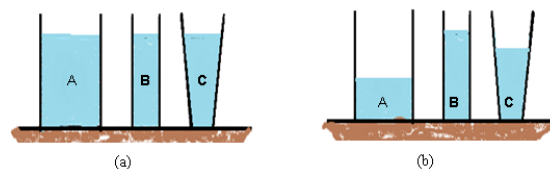


Figure 3. The Design Problem to Check Students' Understanding

The teacher asked the students to test their predictions with experiments using the Hartl tool. After experimentation, all students agreed that the pressure in the third bottom of the housing in Figure 3 (a) equal, whereas in Figure 3 (b) the greatest pressure occurs in the column B, followed by C and A. Based on these experiments, teachers emphasized once again that which determines the amount of pressure is the depth of the water, not the shape of the column and the amount or volume of water.

Learning sequence in other topics is generally similar. However, the activities depend on classroom environment and characteristic of the topic. Learning applied to all topics in concept of hydrostatic pressure and Archimedes law. The learning was conducted during even semester of academic year 2015/2016 (January – February 2016) at SMP Mater Inviolata, Larantuka, East Flores Regency, East Nusa Tenggara Province. This school is one of most favourite schools in this regency.

This article is mainly focused on (1) how far POE strategy can enhance students concept understanding in concept of hydrostatic pressure and archimedes law? (2) what misconception revealed during learning, and how far the learning can overcome it? (3) what is the common difficulty of the students and can not be solved yet by this learning (if it is exist)?

The research subject was 31 students of VIIIA SMP Mater Inviolata Larantuka. This class is the best class among others. POE learning strategy or something similar had never been applied in this classroom. So far, science learning was mostly conducted by conventional approach. All students live at coastal area, eventhough their parents are not fishermen. Generally, the parents works at govermental offices and the small parts are entrepreneurs. The first author in this article is the teacher.

Table 1. Description of Measured Competences for Each question

Number	Measured Competence
1	Explaining the reason why a certain point in an aquarium has the biggest hydrostatic pressure
2	Explaining reason why points in horizontal line in some containers have different hydrostatic pressures
3	Counting hydrostatic pressure at fish's mouth
4	Explaining sequence of hydrostatic pressures of points in horizontal line under the can
5	Explaining bouyant force of static object in water
6	Explaining why an object is lighter when we put it underwater
7	Counting bouyant force of sinked object in the water
8	Comparing height of a ship above marine and freshwater
9	Explaining effect of object's position underwater to its bouyant force work on it

The research design used to response the proposed research questions is *mixed method-embedded experimental design* which is adapted from Creswell & Cark (2007). Quantitative data included students' pre-test and post-test score (multiple choices test), and the qualitative data included students' reasoning on their pre-test-and post-test answer, as well as events appeared during learning process, Pre-test was done a week before learning and post-test was a week after learning. Learning was conducted in four weeks with three hours learning in each week. The pre-test and post-test used the same instrument which is composed of nine multiple choice questions. Students' competence measured is described by Table 1. First until fourth questions were related to hydrostatic pressure, while questions number 5 until 9 were related to Archimedes law (Table 1)

Research instrumen were validated by sciences educational expert to observe its conformity with the construct of measured competences. It is also had been tested to 114 students with the results as follow. One question is in difficult category (Number 9), six questions are in middle category (number 1,3,4,5,6,and 8), and two questions are in easy category (number 2 and 7). Generally, the instrument had Alpha Cronbach value of 0,20 and could be categorized in low reability category (Everitt & Skrondal, 2010).

The first research question, answered through the analysis of quantitative data with a different test for paired samples (score pretest and posttest) followed by analysis of the level of learning effectiveness to use parameternormalized gain ($N\text{-gain}$): $\langle g \rangle =$ (Hake, 1998) and Cohen's d-effect size (Cohen et al., 2007; Morganet al., 2004; Ellis, 2010). The use of N-gain and d-effect size commonly used to assess the effectiveness of a lesson (see for example, Sutopo & Waldrip,

2014; Sinaga & Suhandi, 2015; Kleinet al., 2015; Finkelstein & Pollock, 2005; Colettaet al., 2007; Pursitasariet al., 2015).

The third research question to be answered qualitatively based on data obtained during the learning process and by students' reasoning test. Analisis directed to identify miskonsespsi that appears during learning and especially that still exist today postes. Selain it, also qualitative analysis to understand more deeply quantitative findings as directed by the first research question.

RESULT AND DISCUSSION

Enhancement of students' scientific concept understanding

Descriptive statistic of pre-test and post test scores is summarized in Table 2. It seems that the average of post-test score is far higher than the pre-test. To test its significancy need to do difference test to both data set. Considering that skewness distribution of the pre-test and the post-test is in interval of [-1,1], we referred to Morganet et al (2004) to use paired sample t-test.

Table 2. Statistical description of Pre-test and Post-test Score

	Pretest	Posttest
Number of Data (N)	31	31
Average	36.77	63.26
Standart of Deviation	16.231	15.942
Skewness	0.342	-0.095
Lowest Score	11	33
Highest Score	78	89

Note: Score interval is 0-100

By using SPSS, obtained $t(df = 30) = - 7.73$

with $p = 0.000$ (two-sided). This analysis showed that the difference between pretest and posttest scores is statistically significant. Karena average post-test score (63.26) was higher than the average pretest score (36.77) it can be concluded that the learning is applied in this study effectively improve student mastery of topics hydrostatic pressure and Archimedes' law.

The result of the calculation of Cohen's d-effect of 1.62, was categorized in the category of strong or very high (Morgan et al., 2004; Ellis, 2010). The calculation of the average value of the N-gain gave average of 40; included in the medium category (Hake, 1998) or the lower middle (Sutopo & Waldrip, 2014) It can be concluded that the POE strategy applied in this study provided strong positive impact of improving students' understanding.

Based on the record of learning, it is revealed indications of misconceptions that can then be remedied through the learning. Indication of the misconception related to hydrostatic pressure had appeared since the beginning of the learning when the teacher presents the phenomenon of water gushing from the holes in the bottle wall. As explained in the introduction, some of the students thought that the difference jets water was caused by differences in the volume of water on each hole, the more water over the hole faster and faster jets of water through the hole. This thought delivered students on the misconception that the hydrostatic pressure is influenced by the amount of water and not the water level in over a point to consider. The other misconceptions revealed during learning is that the water pressure is also influenced by the shape of the container. Misconceptions that have been improved through the experiment to measure the water pressure by using the Hartl tool.

Indications of misconceptions related to the buoyant force was revealed when the teacher presents the phenomenon of forced and encouraged balloon into the water. Most of the students thought that the balloon pushed up because there was air in the balon. The misconception had been successfully repaired with the demonstration of an empty balloon float (not blown) in water. Another misconception arised during the course are (1) objects which has no bouyant force will sink, and (2) the amount of water in the container affects the magnitude of the buoyant force: the more water in the container the greater the buoyancy experienced by the object. The misconception has been successfully removed by experiments measuring the buoyancy experienced by objects in the container contains a lot of water

and a container containing a small volume of water.

Unresolved students' difficulties by the end of learning

The low N-gain value indicates there are still some concepts that have not been well understood until the end of the learning. Therefore, in order to further improvements, needs to be seen where the capabilities that have not been raised by optimal. Therefore, first of all needs to be a shift in the distribution of students' responses of the pretest to posttest for each item. The results are summarized in the Figure 4. In topic of hydrostatic pressure (Figure 4a), students seemed that they still had not mastered the skills tested on question 3. In Archimedes Law topic, many students who have not mastered the skills tested on question 5 and 9. Therefore, it is still need to be deeply explored how students' thinking when answering such questions.

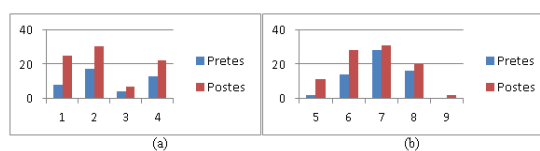


Figure 4. Distribution of correct answer for each question in pre-test and post-test (a) in topic of hydrostatic pressure, (b) in topic of Archimedes principle

Difficulties related to Hydrostatic pressure

Question number 3 aimed to explore students' ability in determining hydrostatic pressure at certain point inside of a container (Figure 5) o answer this question correctly, students must understand the formula of $P_h = P_0 + \rho gh$ well. If there are no errors in the counting operations (algebra), students who answered A used the formula $P_h = \rho gh$ with $h = 60$ cm; students who answered B used the formula $P_h = P_0 + \rho gh$ with $h = 60$ cm; students who answered C used the formula $P_h = \rho gh$ with $h = 80$ cm; and students who answered D used the formula $P_h = P_0 + \rho gh$ with $h = 80$ cm, means it has been able to use the formula correctly. Shifting the students' answers from pretest to posttest are presented in Table 3.

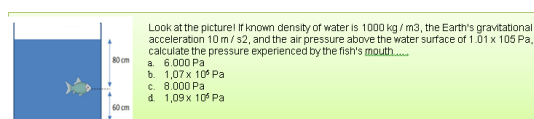


Figure 5. Question number 3

As shown in Table 3, the distribution of students' answers are not so changed from pretest to postes. Students who answered correctly only increased slightly, from 4 to 7 of students. On post-test, most students (11 of 31) chose the wrong answer B with 7 students of whom chose A when the pretest. The data shows that students do not yet understand well the meaning of the quantities that appear in the equation $P_h = P_0 + \rho gh$. Most students (16 of 31), who chose either A or B, interpreted the h as the height of the bottom of the vessel and not on the surface of the water (Figure 6).

Table 3. Crosstabulation of students' response in pretest and posttest for item number 3

A	Postest			Total	Pretest
	B	C	D*		
Pretest A	2	7	1	2	12
B	2	3	2	0	7
C	1	1	4	2	8
D*	0	0	1	3	4
Total Posttest	5	11	8	7	31

NB : * = correct answer

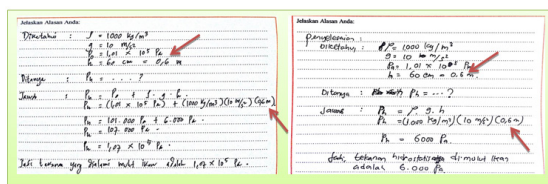


Figure 6. Example of Students Misconception in Understanding Depth Concept

This mistake indication was revealed during learning where students tend to understand depth concept as hight. Actually, the teacher had been doing an effort to repair it through questions example with pictures. Another weakness appeared is P_0 definition. Almost all student (who chose A and C), did not involve P_0 in their calculation. Many students who had those difficulties showed that the learning was not helpful enough for the students to understand formula $P_h = P_0 + \rho gh$ well.

Difficulties related to buoyant force

Students' difficulties related to buoyant force were indicated by many students who got wrong in answering question number 5 and 9. Question number 5 aimed to explore students' understanding about buoyant force of static objects underwater (Figure 7)

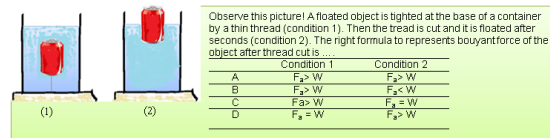


Figure 7. Question number 5

To answer this question correctly, students should apply Newton Law about movement, mainly in analysing forces in both conditions. Students who chose A, B or D are most likely did not put Newton law in solving the problem. They only used buoyant force principle with inappropriate understanding. For instance, students who chose A thought that buoyant force at floated object is always bigger than its weight, whereas students who chose D found that during the objects do not float nor sink to the bottom, the magnitude of the buoyant force is equal to the weight. On the other hand, students who choose B thought that the magnitude of the buoyancy of floating objects experienced less than its weight. Distribution and shift students' answers from pretest to posttest presented in Table 4.

Table 4. Crosstabulation Students' Answer on Pretest and Posttest for Question Number 5

	Postest				Total	
	A	B	C*	D		
Pretest	B	1	9	6	4	20
C*	0	0	2	0	0	2
D	0	3	3	3	0	9
Total Posttest	1	12	11	7	0	31

Note: * = All answer is correct

As shown by Table 4, distribution of students' answer is significantly changed, from 2 students to 11 students. This increase came from six students who choose B plus 3 students who choose D when pretest. Data indicate that the number of students who had a right understanding increased after the learning. However, most students (12 of 31) chose the wrong answer B where 9 of them also chose B in pretest. Other students (7 of 31) chose the wrong answer D where 4 of them also chose D in pretest. Data showed that most students had not been able to solve the problem correctly. Some of them even stand on at the wrong initial understanding despite they had the learning process.

The possibility to get the difficulties had been predicted, because during learning process, students and teacher never relate the Newton law. It was intentionally done in order to see how far

students are able to apply Physics concepts or law which have been learned before when solving problems. Data showed that students were failed to do that. We have suggested the importance of involving Newton law in learning Archimedes principle (Berek et al, 2016)

Question number 9 aimed to explore students' understanding about effect of object position underwater to buoyant force worked on it (Figure 8)

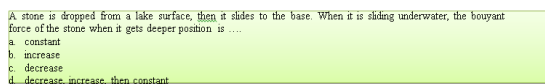


Figure 8. Question Number 9

To correctly answer this question, students should understand that the power of buoyant force of an object is equal to weight of fluid moved by the object; as long as there is no change in liquid volume moved by the object, the buoyant force is also constant. Students who chose B, C, or D may simply did not use the principle in answering the questions. The distribution of students' answers from pre-test to post-test is shown by Table 5. When pre-test, there was no one could answer it correctly, whereas in post-test there were only 3 students correctly answered the question. Generally, students chose C both in pre-test and post test.

Table 5. Crosstabulation of Students' Answer on Pre-test and post-test for question number 9

		Post-test				Total Pretest
		A*	B	C	D	
Pre-test	B	0	0	1	1	2
	C	3	5	18	1	27
	D	0	1	1	0	2
Total Post-test		3	6	20	2	31

Note: * = Right Answer

Least students who could correctly answer this question, both in pre-test and post-test, indicated that students had had wrong prior knowledge and the learning were not able to repair it yet. Many students who consistently chose C, indicated that students had misconception related to buoyant force in context of slidedown object in homogeneous liquid. They thought that the deeper object position the smaller its buoyant force. Furthermore, the learning even added a number of students who think that the deeper object position the bigger its buoyant force, from 2 students become 6 students (Table 5)

Based on the previous explanation, we found some students' difficulties in applying buoyant force principle into contexts. In static context object in liquid (Figure 6), almost all students were not able to compare the magnitude of buoyant force of the object with its weight. In slide object context in liquid (figure 7), almost all students (3 of 31 students) got difficulty to explain the effect of object position to its buoyant force. Those difficulties can not be solved by learning strategy used in this study.

CONCLUSION

Based on the results and discussion above, it can be concluded that; The applied POE strategy in this study could significantly increase students' understanding in concept of hydrostatic pressure and buoyant force ($p = 0.000$) with effect size of 1.62 (strong or very high category) and N-gain of 0.40 (medium or low medium category)

The learning also could identify some misconception and repair it. Misconceptions which could be repaired are: (a) hydrostatic pressure is influenced by liquid volume and or shape of the container, (b) an object can be floated because there is air within, (c) sinked objects have no buoyant force, and (d) buoyant force is equal to liquid volume.

The common students' difficulties in applying concept of hydrostatic pressure and buoyant force are: (a) mathematical representation of hydrostatic pressure $P_h = P_0 + \rho gh$, most students interpret h as the depth measured from the bottom of the column (not on the surface of the liquid as it should be), others did not take into P_0 to determine the pressure at a point in the liquid, (b) related to the buoyancy, the difficulty of students depends on the context in question which are given. In the context of stationary objects in a liquid, most students had not been able to compare the magnitude of the buoyancy experienced by the object with a heavy object. In the context of the sliding object in a liquid substance, almost all students had difficulty in describing the position of objects on the magnitude of the buoyancy experienced.

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THE EFFECTIVENESS OF CTL MODEL GUIDED INQUIRY-BASED IN THE TOPIC OF CHEMICALS IN DAILY LIFE TO IMPROVE STUDENTS' LEARNING OUTCOMES AND ACTIVENSNESS

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ABSTRACT

Science learning in school can be applied by connecting the material in the learning with real life. However in fact science learning process in SMP Negeri 10 Magelang has not emphasized students' activity to relate science to real life. Learning science using CTL guided inquiry-based model implement the learning in where teacher provides initial questions related issues or events in everyday life, then students do experiments to prove concepts of science guided by teacher. The purpose of this research is to determine the effectiveness the model in topic of learning of chemicals in life to improve students' learning outcomes and activity. This research was a quasi-experimental research. The research was conducted in SMP Negeri 10 Magelang with 8th grade students as research subjects. The sample in this study was taken using purposive sampling technique then resulting VIII A as experiment group and VIII C as control group. The result shows that experiment group's learning outcomes increased with N-gain value of 0.62 in the medium criteria. Experiment group's average of learning outcomes is higher than control group based on the calculation t test with $t_{count} \geq t_{table}$ ($5.42 \geq 1.67$). Experiment group's activity also increased every meeting, first meeting was 36.9% in less active criteria, the second meeting increased to be quite active of 60.5%, the third meeting was in the active criteria of 78.2%, and the fourth meeting was 81.4% in very active criteria. It can be concluded that the CTL guided inquiry-based model is effective to improve students' learning outcomes and activity.

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Keywords: Make a match, guided inquiry

INTRODUCTION

Well ordered education system can create intelligent, adaptive, and civilized generation. To achieve those objectives, the government implements education unit level curriculum (SBC). This curriculum refers to a student-centered learning where students do not only treat as objects but they tend to play an active role in learning process. They play some active roles in constructing knowledge instead of only memorizing the knowledge. To optimize the role of students, it

was developed developed the instructional strategies, methods, and media related to student centered learning system (Rahardiana et al, 2015).

Science learning process in SMP Negeri 10 Magelang has not applied student centered learning meaning that students has not been trained to actively seek out their own knowledge of science closely related to daily life and but rather to get their acquisition of knowledge from science textbooks. The process of learning strategy is still dominated by memorizing the course material with the direct instruction, question-answer and discussion.

Science learning at school is also not pre-

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sented integratedly but separatedly for example physics and biology. Based on the principle elaboration of curriculum development in SBC, science learning process in junior high school has been suggested to be presented integratedly. Presenting science content integratedly is interpreted as an effort to integrate the various studies that can create integrated learning (Parmin & Sudarmin, 2013).

In Indonesia, the science content taught integratedly is physics, biology, chemistry and astronomy. Science education students are expected to teach integratedly science in junior high school level. Students should be able to combine these integrated sciences into a single topic or theme (Widiyatmoko & Nurmasitah, 2014).

Students feel difficult to understand the material because they do not experience for themselves what is learned, so the learning outcomes and students' activity is in the unpotimized level. This is proven by the final test score in odd semester that shows around 85% of eighth graders score is still below the minimum completeness criteria of 75 and the average is about 63. The material delivery should use the fun method to help students to comprehend the material, one of them is using contextual learning model.

Khusniati (2012) states that the example of using a contextual approach in science learning is by doing experiment frequently used and performed in daily life. Selection of topics is closely related to student life, it will make students enthusiastic to the learning process.

Learning in school should emphasize to involve the learning experience related to the actual problems that occur in the environment rather than only focusing on theoretical knowledge, so that the contextual learning model is needed. Contextual teaching learning (CTL) is a strategy to connect material or topic of learning with real life. Thus, the learning process will be more interesting and is needed by students because they directly perceived benefits of what they have learned (Rusman, 2012).

Contextual learning has seven principles to be developed by teachers, they are: (1) constructivism, it is a knowledge built by a person step by step and the result is shared through a limited context. Knowledge is not a set of facts, concepts or rules that are ready to take and remember, (2) discovering, it is an activity that will provide confirmation that the knowledge and skills and other abilities needed is not the result of a given set of facts, but is the result of discovering independently, (3) questioning is a main key strategy in the CTL. Its implementation in the CTL should be

facilitated by teacher, the students' habit to ask or teachers' ability to use good questions will lead the increasing of quality and productivity of learning, (4) learning community will familiarize students to cooperate and use learning resources from their partner, (5) modeling is to develop the learning process in order to meet whole expectations of students and help to overcome the limitations of teachers, (6) reflection is a way of thinking about what has happened or have just learned, and (7) assesment is actually the process of collecting a variety of data and information that could provide clues to the student learning experience.

Science learning process in SMP Negeri 10 Magelang does not actively emphasize material and real life. Teachers always encourage students to gather and provide information by applying the direct or explanation method. The process of learning science was limited to delivery of material contained in the book so students simply memorize material. Thus, the CTL model is expected to make students being able to understand the meaning of the material taught by the teacher, so that students have the knowledge that can be applied in real life. They do experiments to prove abstract concept and material that is difficult to be theoretically taught by the teacher, so that learning science should use guided inquiry approach.

Guided inquiry learning requires teachers to design learning process that involves students actively. At the beginning of teachers give a lot of guidance then regularly reduce its frequency in order to result a good investigator and their scientific knowledge can be improved. The advantages of guided inquiry-based learning for students emphasize in presenting their experiment results. Students will be actively involved in discussions based on their learning style (Jonah et al, 2013).

Bruner quoted by Setiani and Priansa (2015) states that the stages in the implementation of learning guided inquiry are: (1) the stimulus is asking questions or encouraging students to observe the pictures and read books about the material, (2) the problem statement is associated with providing opportunities for students to identify as many issues that are relevant to learning materials, then select and formulate a hypothesis, (3) data collection is related to the giving opportunities for students to gather information, (4) processing of data is related to data processing which has been obtained by the students, (4) verification is a careful examination to prove the truth of the hypothesis, and (5) generalization is drawing conclusions from the learning process that has been done.

Dewi et al (2013) shows that results for students' learning outcomes who learn with guided inquiry model is better than students learning with conventional learning models. This is because the guided inquiry learning model can provide opportunities for students to participate actively in the learning process. Students find concepts that are studied independently based on the problems that exist in the environment. Students will gain more meaningful experience and keep it in their minds then it will certainly have an impact on the acquisition of students' learning outcomes. It is also in line with research from Pamelasari & Khusniati (2014), which states that Schoolyard inquiry is proven as effective method to improve the understanding of science vocabulary. Giving variations on learning activities can enhance learning motivation, achievement in understanding the material and the motivation.

Learning science through CTL model guided inquiry-based in this study used the topic of learning of chemicals in life. It consists of materials frequently encountered and its effect occurs in everyday life. The topic is appropriate to combine with CTL model by doing experiment based on guided inquiry. CTL model guided inquiry-based aims to make students to be more active in the classroom and is expected to improve students' learning outcomes.

The purposes of this research are to determine the effectiveness of CTL model guided inquiry -based with the topic of chemicals in life to improve students' learning outcomes and activeness.

METHOD

The research is an experimental research conducted at SMP Negeri 10 Magelang in second semester of the academic year 2015/2016. The sampling technique used in this study is purposive sampling, it was obtained class VIII A and VIII C as samples. The methods used in this study are (1) the test is used to get the data of students' learning outcomes consisting of pretest and posttest, (2) the observation is used to obtain data on students' activity, and (3) the questionnaire is used to determine the students' response to the effectiveness of CTL model guided inquiry -based

RESULT AND DISCUSSION

This study aims to determine the effectiveness of CTL model guided inquiry -based with the topic of chemicals in life to improve students' learning outcomes and activeness. Both of exper-

iment and control groups were given the same material in 7 hours of lessons. However, models and teaching materials are used differently, experiment group used CTL model guided inquiry-based with students' worksheet (LKS) CTL model guided inquiry-based which was validated by expert and judged to be feasible to be used, while the control group used direct instruction and with LKS verification.

The data in the research consist of the pretest and posttest scores and the observation of students' in both groups. The analysis was performed by t test to find out the differences of their averages, mastery test, and students' activity that is descriptively analyzed in every meeting.

Learning outcomes data were obtained from posttest score then analyzed by using two average difference, of one sided t test. It was used to determine differences in learning outcomes of both groups. The data can be seen in Table 1.

Table 1. Posttest Score

	Experiment Group	Control Group
Number of students	31	32
Highest score	95	90
Lowest score	55	40
Average	77,7	65,3

Table 1 shows that the average score of posttest in experiment group is higher than the control group. Posttest data were analyzed using the 5% significance level and $df = 31 + 32 - 2 = 61$. Based on the analysis of the t test, it was obtained $t_{count} = 5.42$ and $t_{table} = 1.67$, because $t_{count} \geq t_{table}$, then it can be said that there is a significant difference between the posttest of both groups. Thus, the hypothesis is proven that the application of the model-based guided inquiry CTL can improve students' learning outcomes significantly. Improvement of students' learning outcomes was analyzed using N-gain, which is used to determine the improvement of their achievement by comparing pretest and posttest between both groups. The improvement of learning outcomes is presented in Table 2.

Table 2 shows that the experiment group gains higher scores than the control group, with the moderate category. Thus, the hypothesis is proven that the application of the model can improve students' learning outcomes.

Based on the N-gain test, the gain score of experiment group is 0.62 higher than the control group of 0.42 in the criteria of moderate. This is in line with Ciptasari, et al (2015) research that

states science learning using CTL model fulfills successful indicator with gain score of more than 0.3 and said to be effective in terms of cognitive learning outcomes of students.

Table 2. The Improvement of the Learning Outcomes

Score	Average		Gain Score	Category
	Pretest	Posttest		
Experiment group	41,3	77,7	0,62	moderate
Control group	37	65,3	0,42	moderate

CTL guided inquiry-based learning with the experiment will encourage students to build knowledge through discovering facts independently instead of memorizing. This is in line with the CTL component of constructivism. The discovery is done through experiment activities undertaken by group discussion. Learning community in the classroom encourages students in a group that have a higher ability to teach other members who do not comprehend the material. After doing the experiment, every student is preparing to present answers from LKS and presenting it in front of the class. They must have a responsibility to themselves and to the group. The other groups paid attention to and required then ask what is not clear and students can learn and understand the material in the group.

Suryawati et al (2010) states that solving problems in the experiment activities done in groups on contextual strategy will encourage students to learn from the environment, work in groups, cooperate with friends, and apply learning material through real experience. Contextual learning is successful to improve students' skills in problem solving because students do not memorize their lessons but find their own knowledge in the material.

Science learning by involving students to discover themselves and connect with real-life material results learning experience to be more meaningful and powerfully kept in the minds of students. It is affected on improving students' learning outcomes. This is consistent with Rahayu & Herman (2015) research that states the experiment activity can encourage students to find their own information on the material taught in guided inquiry guided by the teacher, then the students can relate the information obtained with life. The experiment is designed to be concrete and easily found in everyday life so that students understand the material and easily involved in

learning process

The improvement of students' activeness obtained from description of every meeting is presented in Figure 1.

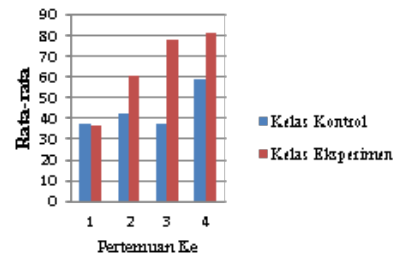


Figure 1. The improvement of students' activeness

The students' activeness indicators are 1) participating in carrying out the task, 2) engaging in problem solving, 3) asking, 4) conducting group discussions, and 5) training themselves in solving problems or issues.

Implementation of the research at the first meeting in the experiment group by applying the model resulted the gain of 36.9% in the criteria of less active. This is due to students do not get used to do the experiment based on the instructions on the LKS. Students difficultly understand and do the experiment based on the problems provided in the LKS, so it runs slowly and requires a long time.

In the second meeting of the percentage of student activity increased from 36.9% to 60.48% with the criteria moderately active. Students have started to understand the activities that should be done. The teacher asks them to observe the instruction as in the first meeting and give the opportunity to express their opinions in a discussion with their friends of the group about activities that should be conducted in the LKS. Students are beginning to understand and getting used to do the activities.

Implementation of the research in the third meeting obtained a percentage of student activity increased from the second meeting of 60.48% to 78.2% in the active criteria. Students are beginning to understand and getting used to do the experiment. The teacher gives students the opportunity to discuss with friends in the group activity that must be carried out. Students performed experiment properly so they could explain the results obtained in a presentation to the class confidently.

In the fourth meeting, students obtained a percentage of 78.2% to 81.4% in the very active criteria. It can be seen from a very enjoyable

learning process, students are able to write the title, formulate the problem and the purpose of the existing problems. They already actively involved in discussing, composing and performing work steps in the experiment activities. Students worked together in conducting experiment and writing the results and discussion on LKS. Students were also not awkward to express their opinion in summing up the results of the activities. The presentation was fluent and they did not feel shy to deliver the experiment results and afraid to be wrong. Other groups paid attention and did not reluctant to question and refute the results from other groups. The teacher guided them to summarize the conclusions delivered from each group and encourage students to be able to provide answers to questions that are difficult to be answered in the presentation.

Control group used direct instruction with experiment, in the first meeting students' activeness percentage obtained 37.5% with less active criteria. The process consisted of giving an explanation on the material made students tend to get bored and did not pay attention, then did an experiment. The experiment was done ineffective because students simply wrote the results, answered questions, and did not encourage students to conduct their own activity but did the steps based on the LKS. The presentation was performed ineffectively because students tended to be passive and did not willing to express opinions.

In the second meeting, students gained from 37.5% to 43.1%, but still in the same criteria of less active, it is because the experiment did not encourage students to conduct a discussion about formulating the problems, objectives, how to work for doing experiment, so students tended to do practicum and wrote the result individually in answering the questions and concluding the experiment.

The students' activeness decreased from 43.1% to 37.5% in the third meeting, this was because they felt bored and reluctant to do experiment. It was only done by a few students in one group, the other students simply watched and waited to write the results of the experiment.

Students' activeness increased from 37.5% to 58.9% in the fourth meeting, but in the same criteria of moderately active. Control group has been quite active in doing experiment with friends in the group, they presented and expressed their idea on the results of experiment and ask the group to discuss in front of the class.

Students' activeness in the experiment group improves every meeting compared to control group, this is because the application of CTL

model requires students to participate actively in discussing with the members of their group and they are required to find the concept of the material independently. Khusniati (2014) states science learning model leads students to do observation or direct observation in their environment. It is very suitable to deepen the concepts of science. Students will learn related to what has been known to either the activities or events occurring around them, and real-world application is an effective strategy for teaching science as a process, so students will easily understand the material when he was doing an activity to learn it, it will make them enjoy the learning process

Science learning with CTL model guided inquiry-based can help students to interpret the material that is learned with the appropriate learning style. Because learning is not just always about learning outcomes, so this research analyzes the process of change. The process of change is students do not only learn but find the concept independently. Thus, students can learn to understand the material according to their learning styles or fun learning so they can be actively engaged in learning process. This is consistent with the results of Neka et al (2015) research that states guided inquiry learning model can provide opportunities for students in the learning process to find the concepts independently through surrounding environment. Student involvement will lead to highly motivated feeling and actively learning.

Students' activeness improves every meeting. In the experiment group, students were initially less active, then improved to be moderately active, active, and in the fourth meeting they were very active.

Students' feedback through a questionnaire distributed in the experiment group was performed to find out their response of the model. The questionnaire is also used as a reflection of the research that has been carried out. Questionnaire responses have levels ranging from strongly agree, agree, disagree, and strongly disagree. The questionnaire was given in the last meeting after posttest.

The result of students' response on the application of CTL model guided inquiry -based shows that students stated strongly agree learning with the model to be exciting and fun, this is proved by the reason that are expressing excited with practice and discussion and not to be boring lesson. Students feel highly motivated by doing the experiment because they can try out the tools in the laboratory and discuss during those activities. Students also agree with CTL model to make them more understand and memorize the

material. Students prove the theory through practice, so they can interpret their learning result in everyday life and store the information in their mind. Students found learning science through experiment can facilitate the material to be remembered, not just memorize by doing the right practice. It makes students to be more active in the learning process because through experiment activity students become more curious to try and also performing question and answer in the learning process.

CONCLUSION

Based on the research, it can be concluded that the CTL model guided inquiry -based with the topic of chemicals in daily life is effective to improve learning outcomes and students' activeness with the following results:

The results of the experiment group learning outcomes has increased by 0.62 with the moderate category and different significantly between posttest score of experiment and control group found out through t test, with t count (5.42) > t table (1.67).

Students' activeness in the experiment group increases every meeting, 36.9% of the less category, 60.5% of moderately active, 78.2% of active and 81.4% of very active

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THE DEVELOPMENT OF AUDIO-VISUAL STUDENT PORTFOLIOS (LKS) CONTEXTUAL TEACHING AND LEARNING-BASED (CTL) ON SOUND CHAPTER OF SCIENCE SUBJECT FOR DEAF STUDENTS

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ABSTRACT

The results of observation from several SLBs (Special School) showed that there was no LKS that accommodated Audio-Visual. So far, the LKS only available in the form of a handout that could be visualized, so that in science subject, the deaf students had difficulty in understanding sound chapter. In order to help deaf students understand sound chapter, the writer developed Audio-Visual LKS. The general purpose of this study was to develop the Audio-Visual LKS CTL-based on sound chapter of science subject for deaf students. The special purposes were (a) to produce Audio-Visual LKS CTL-based, (b) to describe the feasibility of the product of Audio-Visual LKS CTL-based from the experts' valuations as well as the users with the rating instruments available, and (c) the effectiveness of Audio-Visual LKS CTL-based application to the understanding of sound chapter for deaf students at Grade IV. The development procedure used 4-D model which consists of stages of define, design, develop, and disseminate. This study performed limited test to five deaf students, and extensive test to 33 deaf students from several SLBs in Surabaya and Yogyakarta. The product resulted from this development was the Audio-Visual LKS CTL-based on sound chapter of science subject with the results of the feasibility from matter experts, media experts, and users that could be categorized as good/proper. The result of effectiveness analysis from all subjects obtained t count (7.510) > t table (1.694). Thus, it can be concluded that there is an effectiveness of application of Audio-Visual LKS CTL-based to the level of sound chapter understanding on science subject for deaf students at Grade IV.

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Keywords: Audio-Visual, Contextual Teaching and Learning (CTL), Student's Fortfolios (LKS), Sound Chapter

INTRODUCTION

LKS was a guide in studying especially in test method. According to Arsyad (2004), he said that LKS as a study source could be used as a learning media alternative and was one of print media as a product of the print technology development in the form of books and contain visual materials. Supported by Anggaryani (2006), LKS was a handout that contained lesson materials arranged step by step systematically and orderly that needed to be understood by the students. There-

fore, LKS was a handout which contained guides for students to do some programmed activities and made separately from students' books.

LKS as a lesson material in supporting teaching and learning process (PBM) could be implemented by the deaf students themselves. LKS that was needed in studying science in order to be going well, should be keyed to students' daily lives. Contextual teaching and learning was a learning concept that could help teachers to connect between materials taught with real life situation and encouraged students to connect the knowledges they had with their application in their lives as the members of family and society (Nur-

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hadi, 2002). CTL enabled students to connect the content of academic courses with the context of daily lives to find purposes. CTL expanded students' private context further by means of giving fresh experiences that would stimulate the brains in order to make a new connection to find new purposes (Johmson, 2002).

A book entitled "Phonics Guidance for The Teaching of Phonics to Deaf Children," studied about realising voice/sound and discriminating voice/sound that used surrounding areas (inviting students to take a walk in nearby areas), realising voice/sound and discriminating voice/sound of musical instruments (song or instrument), realising voice/sound and discriminating voice/sound from our own bodies (clap hands), rhythm and voice/sound. According to (SYC Lim, J Simser, 2005: 309), they described that the methods in hearing started from the exercise to detect voice or sound and it emphasized that the teachers would cover their mouths either with their hands or a piece of paper to make students were able to hear it. One of learning approaches that could be used to bridge the discrepancy between the knowledges the students gained with their daily lives was Contextual Teaching and Learning.

Based on the result of the observations from several special schools with fourth grade teachers, there were some obstacles teachers faced when teaching science, one of which was the lack of props. The teachers had difficulty in bringing in the natural sound that akin with the original sound, for example the sound of natures, animals, or musical instruments. That was why the students could not get enough chances to know some sounds which resemble with the original, and also not each basic competencies (KD) were supported by props. Therefore, there some with props and some were not. Without the interesting props, teaching and learning process would also be less interesting. The student were usually very excited and energetic when studying science, because it involved with their daily lives.

In accordance with the thoughts of some figures above and reality, it showed the importance of teachers in preparing lesson materials in the form of Audio-Visual LKS CTL-based on science subject that appropriate with the needs of deaf students. Therefore, the writer had the initiative to develop the Audio-Visual Student Portfolios (LKS) Contextual Teaching and Learning-based (CTL) on sound chapter of science subject for deaf students.

METHODS

This study was a development study because its purpose was to develop the Audio-Visual LKS CTL-based on sound chapter of science subject for deaf students at Grade IV. It used the 4-D development model as a reference, they were Define, Design, Develop, and Disseminate. The experiment was done in SLB-B Karnnamanohara, Yogyakarta, located on Pandean 2 Street, Gang Wulung Condong, Depok Sub-District, Sleman, Yogyakarta.

The subjects of this study were the deaf students of Grade IV. There were two steps to test the Audio-Visual LKS CTL-based, limited test and extensive test. The limited test used 5 students which consisted of 4 female students and 1 male students with the level of hearing of 90 dB – 110 dB between the age of 10 – 15. Meanwhile the extensive test used 33 students from several SLBs in Surabaya and Yogyakarta. These tests aimed to examine the Audio-Visual LKS CTL-based that was developed. The experiments was held on the second semester of academic year 2016/2017.

The method of collecting data validation of Audio-Visual LKS using Audio-Visual LKS' validation sheet. The validation data of Audio-Visual LKS were collected by validator's valuation used Audio-Visual LKS' validation sheet. The methods of collecting data on Audio-Visual LKS' experiment were: (1) Questionnaire, (2) Test.

The data collected during the experiment would be analysed quantitatively and quantitative descriptively. The research data, matter expert, and media expert were analysed by considering the inputs, comments, and suggestions from the validator. The result of the analysis was used as a reference in revising the Audio-Visual LKS CTL-based. The data of student's and teacher's response which were collected from questionnaire were analysed using descriptive analysis with percentage.

This effectiveness analysis used one group pretest-posttest design. According to Wahyudi, dkk (2014:52) stated that on this design, there was a test before giving treatment (T1) so that the comparison of T1 and T2 to find out the effectiveness of treatment X could be done. If $T2 > T1$ significantly, it could be concluded that the difference was caused by the treatment (X). The formula to analyse the level of the achievement of effectiveness from overall subjects was **T-Test** statistics formula, from the result data of before and after studying using Audio-Visual LKS CTL-based on science subject sound chapter.

The physical specification of the software was packed in the form of DVD-R with 3,5 GB capacity. For the Audio-Visual LKS, the E-Module science form could be opened using GOM Media File (swf) with 1335 x 750 pixel capacity. There already included Preface, Table of Contents, Introduction, Core Competencies (KI), Basic Competencies (KD), Indicator, Lesson Materials, and also Exercises in accordance with the sound chapter.

The display of the Audio-Visual LKS with the content of lesson materials of sound related to surrounding environment such as nature's sound, pets' sound, vehicles' sound, musical sound, and household appliances' sound.

The software would be displayed a video which consisted of Figures, sounds, and captions that related to some kind of sounds such as nature's sound, pets' sound, vehicles' sound, musical sound, and household appliances' sound. There were objects that could be operated by students or teachers in accordance with their movements.

There was also a navigation button that could repeat the materials presented and useful in interactive question and answer session. The students' answers would be responded directly by the program of the Audio-Visual LKS.

RESULTS AND DISCUSSIONS

The products of this study consisted of two products, they were handout in the form of LKS sheets and Audio-Visual LKS that was packed on CDs that contained several Audio-Visual of Figures and videos CTL-based. The handout of Audio-Visual LKS was clipped with spiral wires on it's edges. This helped deaf students made the Audio-Visual LKS CTL-based more effective (stronger, long-lasting, easy to carry). Meanwhile the Audio-Visual LKS on CDs could be carried out easily so that it made students study easier.

The LKS that was used had different meaning of each colour, for students the colour of the cover was orange (combination of red and yellow) which symbolized happiness, warmth, friendship, optimism. This colour had a strong attractiveness because it could stimulate eyesight (Mangkoko.com. 2016). With the positive-meaning colour, the writer wanted the deaf students to be happy, be optimistic, and also to stimulate students' eyesight so that they could be more focus on Audio-Visual LKS CTL-based.



Physical Aspects of Audio-Visual LKS CTL-based Audio-Visual LKS CTL-based (for students) :

- Paper type : HVS
- Paper colour : white
- Paper size : A5
- Font : Tekton
- Pages : 45

The colour of the paper in the LKS was white with green stripes on the sides. White symbolized peace and innocence, while green represented natures, leaves, freshness, relaxation, harmony, natural, cool, soothing (Mangkoko.com. 2016). With positive-meaning colours, the writer hoped that the deaf students would be peaceful in learning Audio-Visual LKS CTL-based.

Audio-Visual LKS CTL-based (for teachers):

- Paper type : HVS
- Paper colour : white
- Paper size : A5
- Font : Tekton
- Pages : 63

The LKS for teachers was blue which symbolized the colour of sky and ocean. It gave a broad impression of a room, freshness, cool, peaceful, and ease of mind (Mangkoko.com. 2016). For the colour of the papers, they were white with blue stripes on the sides. White symbolized peace and innocence.

With the colours that had positive meaning, the writer hoped that the teachers who taught the deaf students would have peaceful souls and at ease minds when teaching deaf students in class (Teaching and Learning Process/PMB)

Accompanying Maerials:

Paper type : HVS
 Paper colour : white
 Paper size : A5
 Font : Tekton
 Pages : 11

The CD:

CD type : DVD-R
 Capacity : 3,5 GB
 Player : GOM Media File
 GOM Media File (swf) Capacity : 1335 x 750 pixel

Matter Experts Validation

The results of analysis from the instruments given to the matter experts were used to revise the product of Audio-Visual LKS CTL-based which has been produced to gain the better product of Audio-Visual CTL-based in accordance to the materials studied. The average value of overall indicators was the total amount of value from validator's answers divided with the number of indicators. The total value of matter experts validator's answers was 59. The number of indicators was 14. The average value was $59 : 14 = 4.21$. The average value of overall indicators from matter experts' valuation indicated that the Audio-Visual LKS was **good/proper** to be tested.

Media Experts Validation

The results of analysis of the instruments given to the media experts were used to revise the product of Audio-Visual LKS CTL-based which has been produced to gain the better product of Audio-Visual LKS CTL-based in accordance to the materials studied. The average value of overall indicators was the total amount of value from validator's answers divided with the number of indicators. The total value of matter experts validator's answers was 63. The number of indicators was 16. The average value was $63 : 16 = 3.94$. The average value of overall indicators from media experts' valuation indicated that the Audio-Visual LKS was **good/proper** to be tested.

Table 1. Validator Valuation of Audio-Visual LKS CTL-based on Science Subject Sound Chapter for Deaf Students.

Result of Validation	Average	Criteria
Matter Experts	4.21	Good
Media Experts	3.94	Good
Total Average	4.08	Good

Table 2. The Criteria of Validator Valuation of Audio-Visual LKS CTL-based on Science Subject Sound Chapter for Deaf Students.

Number	Average Value from Validator	Explanation
1	$1 \leq Va < 1,50$	Bad
2	$1,50 = Va < 2,50$	Poor
3	$2,50 = Va < 3,50$	Fair
4	$3,50 = Va < 4,50$	Good
5	$4,50 = Va < 5,0$	Excellent

Explanation:

Va = the level of validity

The test of Audio-Visual LKS CTL-based was done in Grade IV Class. The Audio-Visual LKS CTL-based was tested to students with hearing disorders in SLB-B Karnnamanohara Yogyakarta which amounts to five students at the ages of 10-15 years and the level of hearing of mild and moderate between 90dB – 110 dB. The experiment was done to test the feasibility of Audio-Visual LKS CTL-based on sound chapter of science subject. The test was done three times. At the end of the test, the questionnaires of student responses were distributed to students to be filled.

After each teaching and learning activity using Audio-Visual LKS CTL-based, the five deaf students were given questionnaires about their opinions about the using of Audio-Visual LKS CTL-based. The average students response for the third meeting was 96.83%. According to the percentage of student response on meeting I, II, and III which gave positive response to the Audio-Visual CTL-based, it could be concluded that the Audio-Visual LKS CTL-based was **proper** to use.

The questionnaires of teacher response about Audio-Visual LKS CTL-based aimed to get the input from teachers about the Audio-Visual LKS CTL-based that was used. The teacher response of the using of Audio-Visual LKS CTL-based were answered after they used the LKS on each meeting. The average of teacher response on meeting I, II, and III was 96.30%. Based on the value range, it could be said that the teacher response about Audio-Visual LKS CTL-based was **positive**. Because of the said response, it could be concluded that the Audio-Visual LKS CTL-based was **proper** to use.

The formula to analyse the level of achievement of effectiveness from overall subjects was statistical formula of **T-Test**, from the test result data before and after studying using Audio-Visual LKS CTL-based on sound chapter of science

subject. The **T-Test** formula was as follows (Djarwanto, 2000:158):

$$t = \frac{\bar{d}}{S_d/\sqrt{n}}$$

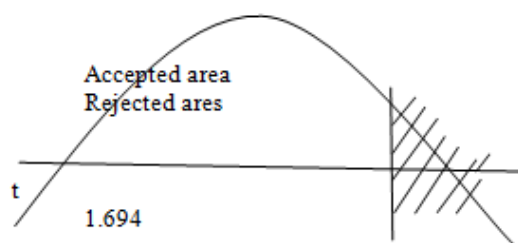
$H_0 : \mu_d = 0$ ($= 0$)

$H_1 : \mu_d > 0$ (> 0)

Value of $t_{0.05;32} = 1.645$

H_0 accepted if: $t \leq 1.645$

H_0 rejected if: $t > 1.645$



$$t = \frac{\bar{d}}{S_d/\sqrt{n}}$$

$$= 7.510$$

Because the degree of freedom was not included on the table, the writer then interpolated to get the value of t-table.

t count (7.510) > t table (1.694), H_0 rejected. It could be concluded that there was an effectiveness viewed by the level of understanding sound chapter for deaf students Grade IV using Audio-Visual Student Portfolios (LKS) Contextual Teaching and Learning-Based (CTL) on Science Subject.

CONCLUSION

There are two products of this study, they are handout in the form of LKS sheets and Audio-Visual LKS in the form of CD that contains some Audio-Visuals such as Figures and videos CTL-based.

The product of Audio-Visual LKS has been declared as proper by matter experts, media experts, and users (teachers and students)

The effectiveness can be viewed from the level of understanding of sound chapter for deaf students at Grade IV using Audio-Visual Student Portfolios (LKS) Contextual Teaching and Learning-based (CTL) on science subject.

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PROPORTION: CLAIM, REBUTTAL AND BACKING DATA BASED ON TEACHER QUESTIONS AS REASONING INDICATOR OF PROBLEM BASED LEARNING IN HIGHSCHOOL SYSTEM REPRODUCTIONS

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ABSTRACT

The reseach purpose is to compare learning proportion of the students based on arguments to learners Claim which is supported by facts, data and theories between conventional learning and PBL as the answers for teacher questions. Research Procedure began with 4 times biology teachers discussion workshops to compile PBL learning plan to be used on treatment class. 61 participants with 30 in control class and 31 in treatment class. Reasoning calculation based on arguments during communication in form of the answers to teacher questions. Basic Grouping of Learning is : Claim Rebuttal (CR), Claim Data (CD), Claim Backing (CB) and Claim (C). Results indicates that: C decreases during PBL learning; CB increases during PBL; CD doesn't exhibit real change during PBL. PBL utilization needs the readiness and competence of the teachers which influences the reasoning quality of the learners.

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Keywords: Claim, Claim rebuttal, Claim Backing, PBL, arguments, reasoning

INTRODUCTION

Knowledge construction through learning, one of its success indicator is the identified ability of reasoning that function as problem solver. (Özgelen, 2012). Scientific reasoning developed through arguments that appeared from communication inside the class (Acar *et al.*, 2015) through various science which one of them is human reproduction materials in Highschool. Reproduction material constitute a study full of problems which haven't been structured and happened in daily lives such as: the outbreak of various diseases connected with reproduction structures and organs like LGBT, the world population boom, which analysis needs various sciences. These unstructured problems are called

ill structure. (Tawfik, Trueman, & Lorz, 2013). The unstructured problems have 5 unclear parameters (intransparency) heterogeneity of interpretation, interdisciplinary, dynamic, and legitimacy to be done with various solutions (Hung, 2016). The problems that have not been structured on the reproduction material were began in the case of an effort to address the world population boom which is shown by the graph of the fast growth of world population. The almost similiar argument to the reasoning is seen as the center in constructing an explanation as scientists were using arguments or reasoning as Claim followed by evidence of Warrant or Backing which is very important to be noted during learning in the class (Simonneaux, 2007), so it can be interpreted as an argument which is basic reasoning to construct scientific knowledge.

Based on the dynamic of the effort to control the population boom that interacted with the

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dynamic change of culture, then learning with the problems of “How businesses cope with the population boom” is an issue that has not been structured, so it becomes a problem to be used as to learn human reproduction material through PBL. Learning using the unstructured problems to be analyzed further until knowledge in a structured manner were obtained and connected to each is the problem based learning (PBL). PBL is a learning that begins with a problem that ill or have not been structured with the main stage is meeting the problem (Tan, 2007), but not all problems can be used as the unstructured problems in PBL learning (Jonassen & Hung, 2015). Expectations on the learning with the unstructured problems, allows plenty of interdisciplinary knowledge to arrange the discourse and efforts of students that serves to organize the material and application on reproduction knowledge in life. Ultimately becoming into meaningful knowledge for the benefits of themselves and solve more complex problems.

The amount of knowledge that interdisciplinary and the amount of effort to organize significant knowledge associated with meaningful communication capability to participate in the form of ideas or delivering of opinions in the form of discourse. Discourse is a statement and answer for teachers question is a logical dialogue that was built during the learning in the form of ideas or criticism that became the basis of the establishment of the arguments. The structure of scientific arguments to control variables such as the components of Toulmin Model: Claim, evidence, warrants and disclaimers are an attempt to support the scientific contextual process. (Ford, 012). Claim proportion based on evidence, data or theory, which became the basis for the reasoning arguments on learning problem based learning on the human reproductive material is the purpose of this study. Arguments or reasoning is the way to show the meaningfulness and meaninglessness through a claim supported by facts, events and reasons are rarely done because of the many obstacles and difficulties of learning the classroom (Berland & Hammer, 2012), among them is a reason to answers as well the connection between the answers and the facts are studied. Supporting research results were conducted by Acar et al., (2015) shows that the arguments relating to the difficulty of the studied material, the harder the material the smaller the reasoning of students.

METHODS

The Research would be qualitative research which calculate the percentage of Claim and Claim which based on facts, backing data or theories, also Claim rebuttal. The number participants involved were 61 which consist of 30 in control class and 31 in treatment class. Control class used conventional learning conducted daily by the teachers while treatment class used PBL learning.

PBL learning plan were compiled by the teachers through 4 times in biology teachers discussion workshops or “ musyawarah guru mata pelajaran biologi” (MGMP) by following the steps of *meeting the problem, problem analysis and generation learning issues, discovery and reporting, presentation and reflection and overview integration and evaluation* (Tan, 2007). Learning plan was needed as the conducting scenario of the learning according to the stages of PBL. Learning plan constitute the teacher preparation to construct and express science in form of activities or attitudes. (Harris & Hofer, 2016). Learning plan organization was compiled by the teacher based on constextual investigation experiences which oriented to build students knowledge (Argote & Miron-Spektor, 2011)

Reasoning calculation was based on arguments delivered during logical dialogue between teacher and students (Kim & Roth, 2014). Reasoning calculation was focused on students answers to all teachers questions. Analysis result of students answers was studied based on argumentation components according to Toulmin models which consists of: Claim, (C), Claim Backing (CB), Claim Data (CD), Claim Warrant (CW) dan Claim Refusal or Rebuttal (CR). The answers consist of the students statement during learning process, be it in control or treatment class. (Reed & Rowe, 2005).

Data collecting in control and treatment classes was done before and after treatment class conducted PBL learning. Learners statement and answer were analyzed following Garcia-Mila, Gilabert, Erduran, & Felton, (2013). Percentage was calculated based on statement and answer numbers categorized in C, CB, CD, and CR. Scores in Claim were not considered, the one which is considered and calculated was Claim type frequency divided by total Claim then times 100.

RESULTS AND DISCUSSIONS

Based on communication between learners and teacher on the answers for teacher questions : C, CB and CR were obtained (Table 1).

Percentage of Claim in the early and end of the learning in control class does not change the percentage, but in the treatment class showed a decrease. Claim relates to the statement, the percentage decrease shows that through PBL statement that is not supported by facts or the theory experience a decrease, means that learners who express their opinions are more considering the knowledge acquired during the learning process. Based on a bigger decrease than the control class, then PBL had an effect on the numbers of answers and statements of the learners. PBL has the effect to declare C is more careful to give an answer. Contrary to the CB and CD which has an obvious increase. CB and CD is learners Claim based on the theory and the data obtained through solving the unstructured problems. CR is a refusal of a Claim that is not found in either the conventional or treatment class. Through conventional learning or PBL, learners do not indicate a refusal of any statement, so only C, CB and CD were detected. More detailed analysis for percentage of Claim backing is shown in Figure below.

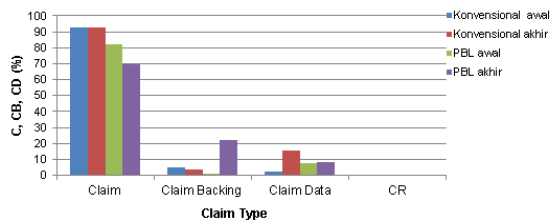


Figure 1. Percentage of Claim, Claim Backing dan Claim Data on conventional class and PBL class.

The percentage shown in the Figure above shows Claim in the control class did not experience any change while in treatment classes, it has decreased. The relatively fixed percentage of C in the control class while decreased in PBL classes

are: 1) the manifestation of interdisciplinary knowledge required in PBL learning cause changes to the statements of learners in constructing knowledge; 2) the differences of the learners in appreciating learning through ill structure problem solving which requires the scientific solution that needs data and theories so Claim on PBL learning decreased while Claim and Claim Data Backing increased. The complex problems which requires the support of many scientific knowledge become a difficult effort for all students to answer teachers questions or the submitted answers have the smae quality, as the following example;

The almost similiar answers by 4 students showed the students desire just to participate in all the questions, but unfortunately the clarification was not carried out by teachers with the follow-up question about the reasons of the given answers. Teachers were asked to examine the books used, without continuing answers given by the students who need clarification. The answers written in the book or reference is the end of discussion. In the case of teachers who do not perform the follow-up questions to discover arguments or reasoning given from the answers, closes the possibilities of the students reasoning. Teachers question are often become a trigger for learners to use more of their thought processes (Turiman, Omar, David, & Osman, 2012). Teachers question become sparks of an answer that leads to reasoning, so looking for the learners answer with continuing teachers question are able to improve the skills of teachers and learners to think more.

Teachers clarification oriented to the corresponding facts began with events that happened to all female students is an interesting discussion, because it happened in real life. With looking for the answers and questions that continues to be the basis for understanding the assessment of a wide range of knowledge that is used to solve problems in tackling the population boom. Thinking of fact to be applied in a larger problem that requires analogy and logic in the form of C, CB, and CD and CR. C is the student answer that is not an argument, and further testing is needed

Table 1. Percentage of C, CB dan CR learners based on teacher questions in kontrol and treatment class learning

	C, CB, CD dan CR (%)			
	Claim (C)	Claim Backing (CB)	Claim backing data (CD)	CR
First Control	92,85	4,76	2,38	0
Last Control	92,85	3,57	15,47	0
First Treatment	81,91	1,12	7,86	0
Last Treatment	69,67	22,13	8,19	0

to assess the reasons to obtain reasoning. Gouvier, (2013) states that the argument is a set of Claim that has meaning between one proposition and the other, so it is logical with increased the percentage of the CB in PBL, CD that increased in conventional learning, shows that understanding the two propositions with connections are indispensable. Another meaning for similarity of Claim on learning using conventional learning is a statement about using less real phenomenon or contextual support material is less meaningful, so that between the beginning and the end of learning used didn't show a different percentages. Based on the observations result that shows C has smaller percentage in PBL learning, the possibility to get more thought processes are: 1) Statements often use the basic knowledge, data, theories that have been owned so the results of the analysis are not categorized in the Claim; 2) Utilization of the data, theoretical or real events had an effect on the reasons of an answer.

Based on the difference of the percentage changes of CB and CD in the conventional class learning and PBL treatment showed that, at the end of learning, the answer learning has greater support in the form of data or theory. Data and theory is the basis of the study of problem solving. The increase of CB and CD on PBL class has greater percentage than conventional class, which is possible because; 1) The number of issues solved through scientific procedures, thus adding support for the answer; 2) PBL learning requires collaboration among students to do activities, because the statement is used to answer a teacher's question into an argument required to collaborate in studying science (Osborne, 2010).

In case of problem solving to the countermeasures of population boom which is based on human reproduction by using PBL requires several considerations such as: 1) The integrity of the propositions connected to each other with the content in question, so they have the meaning which needs to be understood; 2) reference is required to support the study, but not as fast

as providing an opportunity without the support of data. This fact is evident in the increasing of Claim Data (CD) before and after using the PBL, in the end which is relatively equal, meaning that the data used as the basis for constructing knowledge is the same, the beginning and the end of learning, data and theories used in quality does not experience any increase. Improving the quality of data and theory that is unreal is seen from: 1) The use of complex reproduction problems in PBL learning should be rooted in events around the learners, so it becomes a contextual learning (Allen & Tanner, 2003); 2) The process of thinking to obtain the reasons of an answer does not continue.

Another possibility of this assumption is, the competence of teachers using PBL in treatment class were not good, making it less able to convey the core of PBL which is expecting for the students independence in constructing knowledge in addition to a wide range of scientific skills that serve to improve reasoning based Claim supported by facts, events or theory, The research results showed a significant increase of CD in the control class while at the beginning and end of class PBL, no real change was observed for CD. The increase of CB was evident in PBL class, so the data changes of C, CB and CD do not look linear. The data shows that the competence of teachers in using PBL requires further study, because teacher competence have a big influence on the quality of the students learning outcomes. Teacher competence determines the quality of students learning (Opfer & Pedder, 2011), including organizing the planning and implementation in the class. The hardest to be done in organizing lesson plans to follow the stages PBL is stage of problem analysis and generation learning issues (Widoretno et al., 2016). *Problem analysis and generation learning issues* from unstructured problems requires various unknown studies and learned by the learners that it requires the teachers as companion in learning.

Mastery stages of PBL by teachers is a

Teacher Questions	Presention Num.	Learner Answers
"How long does menstrual cycle last?"	7	"Menstruation last for a week ."
	24	"Menstruation last for two weeks."
	17	"Menstruation last for four weeks, a week."
	11	"Menstrual cycle last for 28 days."
"How long does ovulation cycle last?"	18	"Ovulation last for 14 days."
	24	"Ovulation last for 14 days."
	20	"Ovulation last for two weeks."
	24	"Ovulation last for two weeks."

competence associated with the material as content, pedagogy as a learning science and context as a way to teach the materials to students contextually. Imbalance between them could result in difficulty for teachers to make question which serves to organize CB and CD. Result in study states that the competence of teachers which consists of content knowledge, pedagogy, context relating to how to motivate learners with questions and self-regulation is crucial to the learning outcomes (Harris & Hofer, 2011). Kunter et al., (2013) stated that the quality of teachers' academic level does not affect instruction, thus mastery of instructions and questions, teachers need training to support their competence and not on the academic level. The necessary training is to meaningfully communicating by using a variety of sources to improve the quality as the lecturer. Giannakos, Doukakis, Pappas, Adamopoulos, & Giannopoulou (2015) stated that the challenge of teaching should adjust the conditions and difficulties encountered, including reasoning build upon the arguments consisting of C, CB, CD, Cw and CR.

Mastering the PBL learning does not just prepare a lesson plan which is a scenario used to teach. Plan implementation which was compiled become more important than preparing lesson plans, for visualizing is the actual competence of the teacher. Implementation requires monitoring for perfection and compatibility between plans and their implementation, all of them require the involvement of policy makers and behavioral changes teachers become the lecturers

CONCLUSION

The reasoning of the learners using PBL on reproduction material are influenced by the integrity of proportion built by the learners which cannot be separated from teacher competence in using constructed instructional design. Claim Data and Claim Backing is the differentiator of PBL from conventional learning, PBL has a potential to develop identified reasoning from the increase of Claim Backing and Claim Data.

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DESIGN OF SCIENCE MOBILE LEARNING OF ECLIPSE PHENOMENA WITH CONSERVATION INSIGHT ANDROID-BASED APP INVENTOR 2

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ABSTRACT

Learning application is a medium that can be used to convey the content of the material involving mobile devices such as mobile phones based on Android. Learning Phenomena of Eclipse is android-based multimedia application that is created as a supplement of science instructional material in concepts of eclipses that can be accessed using a mobile device such as mobile phone. The methodology used to make this application is waterfall methodology. The purpose of making the application is the conception of conservation and science mobile learning is expected to help the students in particular and scientific community in general to get the ease of learning the concept of solar and lunar eclipses using a smartphone device without having to print using paper (paperless). The application also comes with interactive features of images, videos and quizzes. The conclusion is that mobile learning science applications of eclipse phenomenon in conception of conservation is developed and feasible to be used to study the concept of eclipse and support the efforts to reduce the use of paper (paperless).

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Keywords: science mobile learning, conservation insight, android

INTRODUCTION

The development of multimedia technology has great potential to change the way to learn by obtaining, customizing and using the information. Multimedia opens opportunity for education to develop science learning techniques. The source of information is no longer focused on conventional learning such as the text of the book, but more than that. According to Bustomi (2010), the lack of tools and aids at school raises problems for teachers to make students concentrate and understand teachers' explanation of material.

Learning is a process that occurs because of the interaction between people and their environment intentionally or unintentionally. They

are considered to learn if there is a change in their behavior to be better, and increasing their knowledge. Rapid technological development makes the need of a concept and mechanism of ICT-based education is not inevitable. This concept was then known as e-learning. The latest branch of e-learning is mobile based learning, or commonly referred to as mobile learning. Mobile learning is improved due to the demands of the use of sophisticated mobile devices (smart phones, Tab, note-book) is increasing and has not been used in the field of education. In addition, the number of mobile devices is produced compared to laptop or PC.

In general, mobile learning is media of learning by utilizing mobile devices. According to Majid (2012) and Ashari & Istiyanto (2009), mobile learning is a learning approach that involves mobile devices such as mobile phones, laptops, and tablet PCs, where students can access

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materials, instructions and applications related to subjects without being limited by space and time, wherever and whenever they are. Besides mobile learning is also flexible because it can be changed or updated at any time if there are some changes in material. In addition it can be used for self-learning, mobile learning can also be used as a learning medium that can be accessed anytime and anywhere (Tamhane et al., 2015; Nurhayati, 2013; Sarrab et al., 2012; Douglas et al., 2008).

Mobile learning is the latest ICT advances in the education world where the mobile device is used as media containing a variety of material or teaching aid and can be used at school and home and also it is easier and lighter to bring (Hanafi & Samsudin, 2012). The increasing of the use of mobile phone leads the opportunities using mobile technology in education, and more importantly as a function related to environmentally friendly approach of paperless media.

Taufiq et al. (2016) states that to support and realize the vision of the conservation university that is not only infrastructure needed, but also the preparation of the mental attitude of all academic faculty staff and students through the implementation of learning quality and character. To instill conservation insight to the academic faculty, the innovation of learning process oriented to future particularly in development of the instructional media, mobile learning can be the priority to support science learning-friendly environment through paperless program. Increasing the number of academic community who use mobile devices especially utilizing the OS (Operating System) Android that provides many applications including App Inventor 2 programming. MIT App Inventor 2 is a programming tool block-based that allows everyone, even beginners to begin programming and build a full functional application for Android devices.

The presence of Science Mobile Learning as instructional media is intended as a learning supplement and also supports conservation vision through the use of contemporary media and paperless habit. This certainly can provide a different experience in the learning process of science. Zheng et al. (2015) states that the development of today's smartphones is growing rapidly and quickly, the technology is not only done by the user as a communication medium, but can be used also as a learning medium that is reliable and user friendly.

Learning media according to Bakri (2011) is everything related to software and hardware that can be used as an intermediary to convey the contents of teaching materials from learning

sources to learners using learning methods that can give a feed back to the user of what has been put to the media. The development of multimedia technology has great potential to change the way to learn, obtain, and customize information. Multimedia is also an opportunity for education to develop learning techniques. The source of information is no longer focused on conventional learning such as the text of the book, but more than that. Limitations of the existence and function of laboratory instruments and aids makes difficulties for classroom teachers to make students do not pay attention and understand what is being explained by the lecturer. Bustami research result (2010) shows that the android-based learning applications can be used as the interactive learning media.

Android is the arrangement of some softwares (software stack). This stack generally includes the operating system, middleware, and key applications (Eueung, 2012). Android has several versions, starting from android version 1.1, Android version 1.5 (Cupcake), Android version 1.6 (Donut), the Android version 2.0 2.1 (Enclair), Android version 2.2 (Froyo), Android version 2.3 (Gingerbread), Android version 3.0/3.2 (Honeycomb), Android version 4.0 (Ice Cream Sandwich), Android version 4.2 (Jelly Bean) and most recently is the Android version 4.4 (KitKat).

Android provides an open platform for developers to create new applications. Android is a new generation of mobile platform that gives developers to develop based on their needs. The underlying operating system Android is licensed under the GNU General Public License Version 2 (GPLv2), that is often known as "copyleft" license where any third party repairs must continue to fall under the terms. Android is distributed under the Apache Software License (ASL / Apache2), that allows to distribute both derivations of open source and closed source code. The developers (especially handset manufacturers) can choose to raise the platform without having to provide their improvements to the open source community. Instead, developers can benefit from enhancements such as repair and redistribute their work under any license they want (Putra, 2012).

App Inventor is a tool to create interesting android application through visual based programming block, so we can create applications without using any codes. It is called visual programming block, because we will see, use, compile and drag-drops "block" that are symbols of commands and functions specific event handler to create applications, and simply we can call without writing code (coding less).

Below is the example of block program in App Inventor to a color list:



Figure 1. Block program display in App Inventor

To use App Inventor does not have to have a basic knowledge programmer, understand codes or dabbling in the world of information technology. The most important to make application using App Inventor paramount is on how the programmers use the logic, just as well as putting together a puzzle. For the programmer there are options to make it advance in accordance with the required standards.



Figure 2. Operating System of App Inventor in OS Android

App Inventor can be accessed via <http://beta.appinventor.mit.edu/> beta version of MIT. App Inventor has 2 features of:

Through this feature if we have the Android handset, or installing a new virtual Android handset on the computer, or even none at all, App Inventor could be used to create some interesting activity for example editing images, playing puzzle, sharpening your brain by doing crossword puzzles, or learning to strengthen logic skills.

These features provide convenience to students, teachers, professors or hobbist, they will be able to make the App Inventor as a learning tool. Teachers or lecturers can make a great teaching

tool through App Inventor, since visualization will facilitate students to understand and master what will be taught.

Starting from the prototyping, application for personal and organizational needs, or a serious application that can be sold, App Inventor visual -based drag drops gives many conveniences for: 1) It does not need to memorize and remember instructions or program codes; 2) Component and Block event are available, like an object we just put them together with the appropriate components and block its function, then put it down like a puzzle and change the properties, for example, give the numeric values to set the timer etc; 3) Event handler makes it easier to deal with any "events" that want to be handled, for example when making an application to handle SMS, in App Inventor by taking -Drag drops block that handle SMS event.

METHOD

In developing this application, the methodology used was the waterfall model. The waterfall model is a classic model of systematic and sequential (Sudarmawan, 2007; Martono & Nurhayati, 2014).

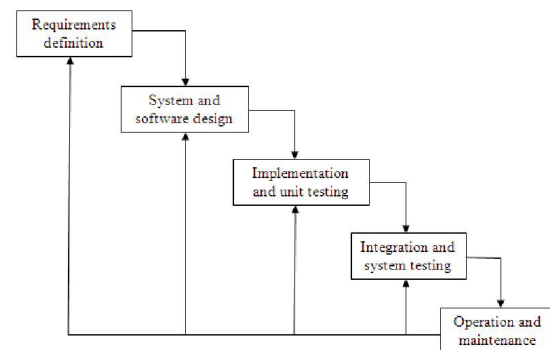


Figure 3. Development waterfall method

a. Requirements definition

Collect what was needed completely then it was analyzed in order to define the requirements that must be solved by the program. This phase should be done comprehensively to produce a complete design. A necessary condition in this phase is elaboration of material phenomena of eclipses, workflow software program and App Inventor, in this phase the researchers did not do the installation program but access the program online through the page: ai2.appinventor.mit.edu/.

b. System and software design

The design was done after the material needed was collected and completed.

- c. Implementation and unit testing
Program design is translated into codes using App Inventor programming language that has been determined. The developed program was directly tested in each unit, whether it was working properly.
- d. Integration and system testing
Unification of the program units was then tested as a whole (system testing).
- e. Operation and maintenance
The program was operated in its environment and performed maintenance, such as adjustments or changes to adapt to the actual situation.

RESULT AND DISCUSSION

Use case diagram is a representation of some interactions between the components contained in the application Science Mobile Learning introduced by the developed system. Actor/user can access the main menu that consists of five menu choices of material, picture, video, quiz, and exit menu.

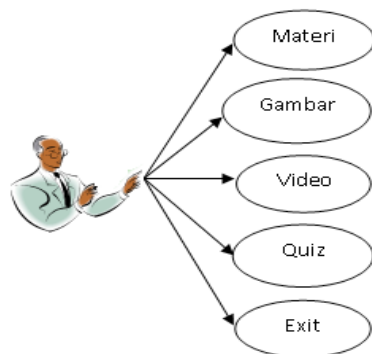


Figure 4. Use Case Diagram in Science Mobile Learning Application

The class diagram is the core of the object modeling process. It is a collection of object classes and provides an explanation of the classes contained in the application system of Science Mobile Learning. Through the diagram author designed the application system by describing some of the classes that will be used in the application as illustrated in Figure 5.

Activity diagram focuses more on execution and workflow systems rather than how the application systems assembling. Activity diagram shows the activity of the system as a series of actions.

Activity diagram to access material presents the user accesses menu of eclipse material.

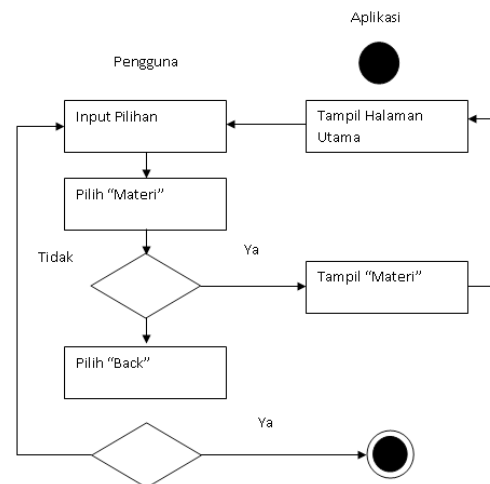


Figure 5. Activity Diagram to Access Material

Activity Diagram to Access Picture presents the user accessing the image menu of solar and lunar eclipses.

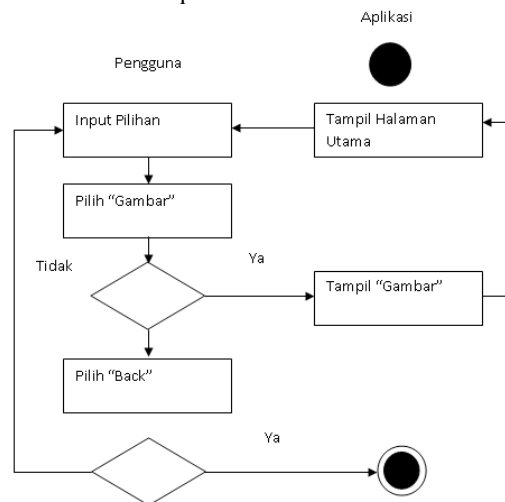


Figure 6. Activity Diagram to Access Picture

Activity Diagram to Access Video presents the user accessing the video menu of solar and lunar eclipses.

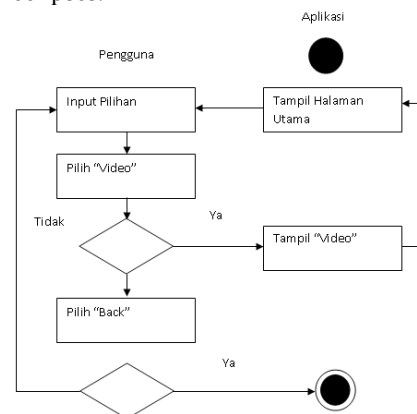


Figure 7. Activity Diagram to Access Video

Activity Diagram to Access Quiz presents the user access practice and achievement test of solar and lunar eclipse phenomena

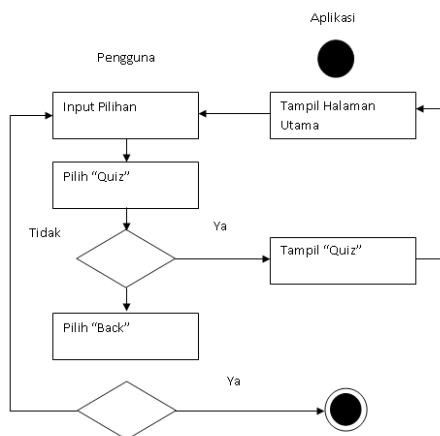
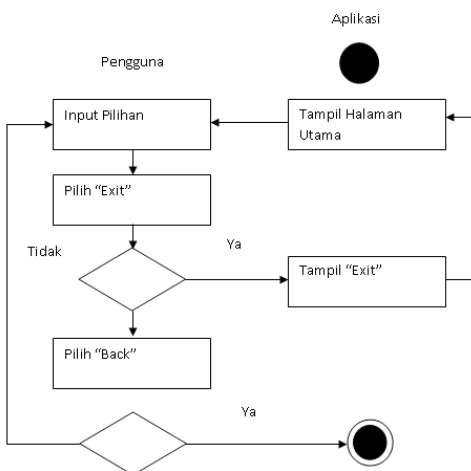


Figure 8. Activity Diagram to Access Quiz

Activity Diagram to Access Exit presents the user accessing exit menu in application.



Gambar 9. Activity Diagram to Access Exit Interface Design of Science Mobile Learning of Eclipse phenomena with Conservation Insight

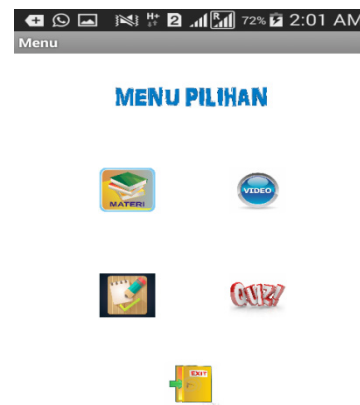
This display is the opening on the application. The system will display a splash screen. The splash screen is a condition that is used to describe the image or images that appear when an application or program is in the process of loading. The splash screen is used in applications as feedback that the application is in the process of loading. Images in the splash screen will be lost when the main application window appears. In this application, two splash screens will appear as in Figure 10 and 11. Figure 10 displays splash screen of the logo of UNNES as the first display and Figure 11 is the second splash screen before

entering the main display.



Gambar 10. Interface of Splash Screen

After displaying the splash screen, the system will display the main menu as can be seen in Figure 11. In the main menu there are five menus of material, picture, video, quiz and exit.



Gambar 11. Main Menu Display

In material display, the user can see information about the concept material of lunar and solar eclipses. The summary of the material eclipse consisting of five slides is presented and users can freely access the next button to see the next material and back button if you want to get back on the slide summary of the previous material.



Figure 12. Material Menu Display

In the picture menu the user can see the position of the sun, earth and moon during an eclipse. The material is presented in a slide that contains an image of the sun and the lunar eclipse, so users can easily distinguish the position of the sun, earth and moon when the eclipse phenomenon.

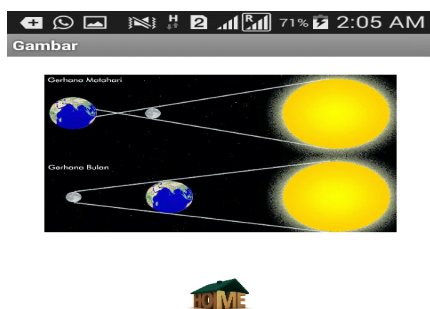


Figure 13. Picture Menu Display

Video menu displays interactive video simulation of the lunar and solar eclipses. The users will be more interested and able to understand the material presented through a interactive display designed. This menu allows the user to freely play, pause, repeat, and stop the video. The menu is also supported by explanation audio of the process of the solar and lunar eclipses so that users understand the concept well and comprehensively. It is supported by the results of research that has been done by Widiatmoko (2012), Sholikhakh et al. (2012), and Arda et al. (2015) that state learning science with interactive media is better than using conventional learning strategy, and able to enhance understanding of the concept and making the learning process more interesting.

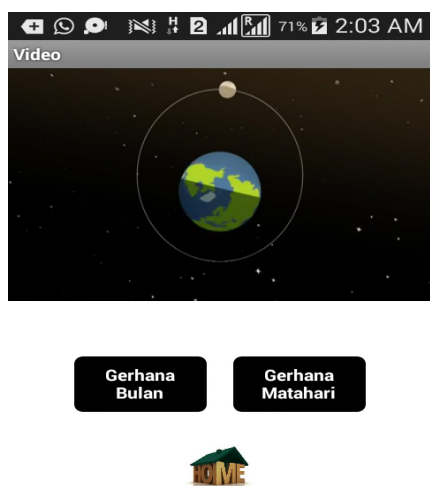


Figure 14. Video Menu Display

The consequence of the idea that critical thinking skills is essential in science learning and needs for stimulating element to create an evaluation system that could open the mindset of considering the facts towards critical thinking. On the quiz menu, it displays questions that will test the user's understanding of the concept of the eclipse phenomena. Users can test the understanding of the concept of the phenomenon of solar eclipse and lunar eclipse. There are 10 questions presented randomly from a total of twenty questions that are presented in the application. According Kartimi & Liliarsi (2012), the critical thinking needs exercises of doing evaluation questions to develop critical thinking skills.



Figure 15. Quiz Menu Display

Exit menu display gives users the option to be really sure to exit or quit the program or continue it. Once the user opens the exit menu if you select "Yes" it will exit the application, whereas if you select "No" it will return to the main menu.

The feasibility validation of Science Mobile Learning application was performed by experts of media and science material. The results are some suggestions and that can be used as a reference to improve the application. Furthermore, the validation was repeatedly done and analyzed in order to obtain the maximum score obtained from the validation instrument by dividing the score obtained by the maximum score multiplied by 100%. The result is presented in Table 1.

Table 1. Percentage Criteria of Product Feasibility

Percentage Score Interval	Criteria
81% - 100%	Very good
61% - 80%	good
41% - 60%	Moderate
21% - 40%	Poor
<20%	Very poor

The validation process consists of design and product performed by each field expert resulting score presented below. The result of design expert is presented in Table 2.

Table 2. Validation Data of Product by Design Expert

Validator	Average	Criteria
Media expert	3,88	feasible
Material expert	3,96	feasible

Based on the results of expert validation, it is obtained percentage of 98.44% in the criteria very good, so the design can be continued with some improvements.

Based on the display, media experts generally state that the product is good but it needs the right navigation key to enable users to access the application. In addition, the text color should be contrast and font type and size and arrangement of the link to the application interfaces need to be adjusted to make it more harmonious and orderly. In the aspect of programming, media expert claim that it is a good media.

Based on the material expert validation, the application is assessed to be good and the suggestion is to put pictures that match with the concepts and giving the caption. In general, the expert claims that the material is good enough. Researcher improved the product by considering the suggestion of experts, then conducted a series of discussions and evaluations to get a good design of products. In the aspect of learning, material experts stated that there are some materials that are still less interactive presentation and is generally stated that the application / media is already good.

Material expert states that there are some materials that are still less interactive in presentation but overall the media is already good.

The feasibility of products was collected by using questionnaire developed by the researchers. The results of expert validation to the product is presented in Table 3.

Table 3. Rekapitulasi Hasil Validasi Ahli terhadap Produk *Science Mobile Learning* Fenomena Gerhana Berwawasan Konservasi

Validator	Average	Criteria
Media Expert	3.92	Feasible
Material Expert	3.96	Feasible

Advantages of developed product consist of important features of materials, pictures, vide-

os and quizzes that support the learning process. Material is presented more attractively and easily understood because it is presented is not only in the form of writing. All of the features of the application can be downloaded through the Google Store or PlayStore, and then installed on the smart phone and used without having to print it out. This indicates that the application of Science Mobile Learning of Eclipse Phenomena affects on reducing the use of paper (paperless), so that the learning process of science can implement the conservation insight.

CONCLUSION

Based on the validation results from media and material experts, it can be concluded that the application of Science Mobile Learning of Eclipse Phenomena with Conservation Insight is feasible to be used and affects on reducing the use of paper (paperless) in the learning process.

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SOCIOSCIENTIFIC ISSUES (SSI) IN REACTION RATES TOPIC AND ITS EFFECT ON THE CRITICAL THINKING SKILLS OF HIGH SCHOOL STUDENTS

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ABSTRACT

The aim of this research was to investigate the difference in students' critical thinking which learnt cooperatively using different learning context. Quasy experimental posttest only control group design was chosen as experimental design using two equivalent classes as the sample. The first class (15 MIA 5, $n = 30$) was taught using socioscientific issues (SSI) as the learning context and the second one (15 MIA 6, $n = 30$) was not. The research instrument was a test consisted of 16 items of multiple choice questions developed based on Ennis' critical thinking indicators. This instrument have been validated and its reliability approved with $r = 0,765$. Students' post-test scores were analyzed using t-test with SPSS 16 for Windows. The result showed that statistically students' critical thinking skills between two classes was significantly different (Asym. Sig = 0,037). Students who taught using SSI have higher score (73,96) than the one wasn't (66,04). Result shows that using socioscientific issues (SSI) as learning context has significant effect on high school students' critical thinking skills.

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Keywords: cooperative learning, socioscientific issues, critical thinking skills

INTRODUCTION

As the central of science, chemistry is a fundamental science for science itself, technology, and industry (Mahdi, 2014; Chang, 2011), thus it is important to learn. In the 21st century, these fields have been growing very rapidly throughout the world (Friedman, 2007). Incredible advances in science and technology provides a lot of changes in people's life quality. The development of nanoscience and discovery of alternative energy sources create new hope for the survival of human life. But on the other hand, there are some developments which lead to the new problem that threatens life. Nuclear leaks, environmental pollution, and global warming are the example of

the problems face by the world globally. These problems can not be solved by individuals, but the cooperation between individuals who think of themselves as a global community are expected to reduce the risk of problems arising. To resolve these problems, it needs people who have the well-understanding of scientific ideas, intellectual ability, creativity, reasoning, and the concern for the issues and problems occur in nature. By this issue, they can preserve the environment, health, and can take the decisions on social policy for global society (Rahayu, 2014). People who already have these skills said to be people who have the scientific literacy. Therefore, the creation of a science literate-society is needed in modern society in this century.

In recent decades, the level of scientific literacy of the world community becomes a hot topic in the study of science education world. One of

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the international assessment programs that make science literacy as its conceptual foundation is PISA organized by the OECD (Organization for Economic Cooperation and Development). Based on data collected by the OECD (2015), the results of PISA assessment show the level of scientific literacy of Indonesian students are alarming. In 2006, Indonesia was ranked 53rd out of 57 countries, in 2009 was ranked 38th out of 40 countries, and on the order of 64 of the 65 countries in 2012. According to these data, students' science literacy in Indonesia is on the order of 2 to 4 from the bottom than other countries. This is possible due to the science learning process applied in Indonesia are still fixated on content that requires students to memorize and to perform complex calculations instead of referring to the context that requires students literacy (Strategic Plan, 2009). This exclusion has also pointed out that the purpose Indonesian education is not in accordance with the demands with all its problems. Yet on the other hand, the realization of science literate-community is one of the main goals of science education (NRC, 1996; Norris & Philips, 2003).

To overcome these problems, Indonesia needs to evaluate the educational curriculum. The implementation of Curriculum 2013 is one of Indonesia's efforts to catch up from the other countries in the field of education, especially in science. Pursuant to Rule 64 Ministry of Education and Culture in 2013, the competence that must be mastered by students in science learning are the development of a scientific attitude (curiosity, critical, logical, analytical, creative, honest, and responsible), analyzing and solve problems, and to apply knowledge in various fields of science and technology. The learning objectives are in line with the objective of creation in science literate-community (Kemendikbud, 2013). Therefore, the implementation of Curriculum 2013 in Indonesia is expected to form a literate-community which is capable of solving the global problems.

Critical thinking skills are a key component of scientific literacy (Lederman, Lederman, & Antink, 2013). As an important skill to be developed in the 21st century learning, mastery of critical thinking skills students are expected to realize the creation of community *berliterasi sains*. Ennis (1993) defines critical thinking as a reasonable reflective thinking and focus on decision about what people believe or what to do. Watson and Glaser in Nezami *et al.* (2013) describes critical thinking as a combination of knowledge, attitudes, and skills of individuals that includes the ability to understand, identify hypotheses, men-

ginferensi, analyze, and evaluate the reasonable opinion. The description in accordance with the characteristics of critical thinking expressed by Facione (2013), that the skills of interpretation, analysis, inference, evaluation, explanation, and self-regulation. The various skills are interconnected so that can not be separated from one another.

One effort to train the critical thinking skills to students as well as to address the relevance of chemical materials with everyday life, learning in the context of certain chemicals can be a solution. In connection with the development of scientific literacy, socioscientific issues (SSI) is the appropriate context to achieve the expected goals. SSI selected as a context for learning because it can be used (1) to make science learning more relevant for students; (2) directing the learning outcomes, such an understanding of the nature of science; (3) improving dialogue argumentation; (4) improving the ability to evaluate scientific information; and (5) developing scientific literacy (Sadler & Zeidler, 2004: 4). Generally, cases including SSI generated a lot of debate so it will not have an easy solution (Kolstø *et al.*, 2006). This is because SSI is not just fixated on the concepts of science, but involves the moral and ethical implications (Lee *et al.*, 2014). With provides an opportunity for students to discuss and debate issues of SSI controversial, their critical thinking skills will increasingly improve (Domenech & Márquez, 2013). It represents the excess of SSI that can not be found in conventional learning which tends to be teacher as the center of learning.

The purpose of constructivist approach based on student as the center of learning is to make student to be actively involved in the learning process. By involving them in this activity, they will have a greater opportunity to train their critical thinking skills. One model of learning that support the learning process is a cooperative learning model. This model has certain limitations that set it apart to group learning in general. Johnson & Stanne (2000) states that cooperative learning uses small groups of student, then students can collaboratively share their ideas, learn together, exchanging ideas, and are responsible for the achievement of learning outcomes individually or in groups. Through cooperative learning, students are encouraged to cooperate to the fullest with all members of the group for the group's success is determined by the success of each individual as a member of the group. According to Johnson & Johnson (in Ferder & Brent, 2007), the five basic elements of cooperative learning are required for the successful achievement:

(1) positive interdependence (positive interdependence); (2) the direct interaction / face (promotive interaction); (3) individual responsibility (individual accountability); (4) the effectiveness of the process group (group processing); and (5) skills of interaction among individuals and groups (social skills). By actively involved in the discussions during ongoing cooperative learning, students can interact to bring effective problem-solving strategies on socio scientific issues served with all aspects involved in it. Thus, the critical thinking skills of students can develop. Some research indicates that cooperative learning effect on students' critical thinking skills, such as research conducted by Klimovienė *et al.* (2006), Nezami *et al.* (2013), and Valdez *et al.* (2015).

One of the chemistry learning materials in class XI is closely related to everyday life and contains a lot of socio scientific issues is the rate of reaction. Some of the topics raised in the SSI for example learning about the use of nuclear power as a source of electrical energy, the impact of the use of calcium carbide in ripening fruit, alcoholic drinks controversy, and cigarette industry in Indonesia. Through cooperative activities, the students discuss to provide feedback on the issue and take the most effective solutions to problems that will arise as a result of the decisions. By discussing such socio scientific issues, it is expected that the student's critical thinking skills will be trained. Therefore, the following research objectives is to use the context of socio scientific to measure its effect on the high school students' critical thinking skills.

METHOD

The following studies used an experimental method, i.e. a quasi-experimental design with posttest only group design (Creswell, 2012: 310) with a scheme as illustrated in Table 1 below.

Table 1. Study Design

	Pretest	Treatment	Posttest
Experimental class	–	X	O ₁
Control class	–	–	O ₂

Information:

X: Cooperative Learning with SSI context on the topic of reaction rate

O₁: posttest experimental class that learned cooperatively with SSI context

O₂: posttest control class that learned cooperatively without SSI context

Samples used in this study were two classes X in one of the high schools in Malang and it was selected by convenience sampling technique. Based on the results of normality and homogeneity test, the second class was a class with a normal distribution of student ability and also a homogeneous class. Additionally, both classes have the equal initial capability seen from the Chemistry subject grade at the previous material. Both classes was applied to have the cooperative learning model. One class (15 MIA 5, n = 30) was selected as the experimental class that learned with the context of the SSI and another class (15 MIA 6, n = 30) without SSI context application. The hypothesis for the following research states that there is no difference in the students' critical thinking skills in both experimental class and control class.

Based on the study design, the variables used in the study include the following independent variables, control variables, and the dependent variable. The independent variables in this study is the use of socioscientific issues learning context. The learning without context is expected to generate critical thinking skills different with context. The dependent variable in the following research is the critical thinking skills, while the control variables are the breadth and depth of learning materials i.e. reaction rate, the duration of learning and cooperative learning strategies.

Measurement instruments use critical thinking test consisting of 16 items of multiple choice questions that are developed based on indicators of critical thinking by Ennis (2011). Eight indicators from Ennis developed into an instrument of test item includes (1) defines the term and consider using the definition of the appropriate criteria; (2) ask and answer questions that require an explanation; (3) focused questions; (4) to interact with others; (5) induction; (6) observe and consider the results of observation; (7) show or make assumptions; and (8) to deduce and assess the results of deduction. These indicators were selected based on the compatibility with the materials and learning activities that allow for critical thinking skills training in the classroom. The test instrument has been validated and tested in order to obtain the level of reliability of the instrument amounted to 0,765. The test results were analyzed using the two-class t-test with SPSS 16 for Windows. The results of the quantitative analysis was used to identify, analyze, and explain the difference in critical thinking skills of students of both classes on reaction rate material.

Learning topics on the rate of reaction was carried out in a meeting with one test. Both

classes studied the reaction rate study material cooperatively with the same level of breadth and depth. Each of the students in both classes obtain student worksheet (LKS) containing discussion and questions to guide their understanding on the material. The essence of each question on the worksheet for each class aims to help students in constructing the knowledge. In addition to meeting these objectives, the questions on the experimental class was designed to train the critical thinking skills in students explicitly. This is different from the control class that only engaged in cooperative activities to train the students' critical thinking skills. Figure 1 below is an example of student worksheets from each class.

In addition, the experimental class involving SSI as a context for learning lead the students to not only discussing about concepts relating to the reaction rate and the problems associated with this concept, but also doing the activities. They were also actively involved in discussions about the four cases related to the reaction rate, namely (1) Controversy of PTLN in Indonesia; (2) Carbide, Fruit Maturation accelerator; (3) The controversy of the alcoholic beverages; and (4) Dilemma of Cigarette Industry in Indonesia. These issues were respectively presented at the first, fourth, sixth, and seventh meeting according to the reaction rate studied. For example, after

studying about law and order of reaction rate at the sixth meeting, the students discussed the controversial articles on the rules of distribution of alcoholic beverages. In this article, they discussed the reason why alcoholic beverage consumption is banned in terms of science that involves the reaction of zero-order and first-order reaction. Therefore, after learning about the law concept and the order of reaction rate, the students were better able to understand the article. In terms of the social, students were asked to submit their opinions about the impact of easing the rules of distribution in alcoholic beverages. Students were also asked to answer the critical thinking questions related to the articles presented. Thus, the critical thinking skills of students increased explicitly. Figure 2 below is one example of SSI article presented on learning.

RESULTS AND DISCUSSION

The average grade of critical thinking skills test on both classes can be seen in Figure 3 below. Figure 3 shows that the average grade of students that learned in the context of SSI (MIA class 5) was higher than students that learned without context of SSI (MIA grade 6). The value of these two classes then quantitatively analyzed using t-test with SPSS 16 for Windows. The results of the

Pesta perayaan tahun baru selalu identik dengan pesta kembang api. Tidak butuh waktu lama bagi kita untuk menikmati warna-warna indah kembang api dari sejak sumbernya disulut. Lain halnya dengan pagar yang berkarat. Perkaratan membutuhkan waktu berbulan-bulan bahkan bertahun-tahun agar dapat berlangsung. Pembakaran kembang api merupakan contoh reaksi kimia yang berlangsung cepat, sedangkan perkaratan merupakan contoh reaksi kimia yang berlangsung lambat. Coba sebutkan contoh peristiwa lain yang merupakan contoh reaksi cepat maupun reaksi lambat!

Gambar 1. Perubahan pada reaksi $2A \rightarrow B$ tiap 10 detik.
 ● partikel A
 ● partikel B

Gambar di atas menunjukkan terjadinya reaksi sesuai dengan persamaan $2A \rightarrow B$. Perubahan jumlah partikel A dan B tiap 10 detik digambarkan dalam grafik di bawah ini.

Bagaimana kecenderungan perubahan jumlah partikel A dan B tiap 10 detik?

Kedua contoh di atas merupakan contoh reaksi kimia. Berdasarkan kedua contoh tersebut, apakah yang membedakan keduanya? (BK : memfokuskan pertanyaan)

Sebutkan dua contoh reaksi kimia lain yang ditinjau dari segi kecepatan mirip dengan peristiwa ~~berkarat~~ atau dua contoh reaksi kimia lain yang mirip dengan perkaratan! (BK : bertanya dan menuliskan pertanyaan yang membutuhkan penjelasan)

Gambar 1. Perubahan pada reaksi $2A \rightarrow B$ tiap 10 detik.
 ● partikel A
 ● partikel B

Gambar tersebut menunjukkan terjadinya reaksi sesuai dengan persamaan $2A \rightarrow B$. Perubahan yang terjadi diamati tiap 10 detik dan hasil pengamatan dicatat pada tabel berikut.

Waktu (detik)	0	10	20	30	40	50	60
Jumlah A							
Jumlah B							

Berdasarkan data diatas, gambarkan grafik perubahan jumlah partikel A dan B tiap 10 detik selama reaksi berlangsung!

(a) Cooperative class student worksheet

(b) Cooperative class student worksheet - SSI

Figure 1. Student Worksheet Example




Kontroversi Relaksasi Aturan Penjualan Minuman Beralkohol

Kementerian Perdagangan menyatakan dalam aturan penjualan minuman beralkohol yang baru Peraturan Menteri Perdagangan Nomor 06/M-DA/ dan Pengawasan terhadap Pengadaan, Peredaran yang ditetapkan oleh Menteri Perdagangan sebelum telah berjalan secara efektif sejak diterapkan April larangan penjualan minuman dengan kadar alk utama diterapkannya aturan tersebut adalah ad penjualan minuman beralkohol di minimarket menyebabkan keresahan sosial. Tidak sedikit tind penyalahgunaan miras sebagai penyebabnya. sejumlah ketentuan penjualan minuman berad distributor. Himbauan untuk menyimpan minuman ber khusus dengan stiker penutup masih kerap dilanggar, serta tidak adanya pengawasan dari petugas kasir terhadap pembeli di bawah umur kerap tidak dilakukan.

Penerapan aturan tentang pembatasan peredaran minuman beralkohol tersebut juga mendapat dukungan dari Kementerian Pendidikan dan Kebudayaan, Anies Baswedan. Menurutnya, peraturan tersebut dikeluarkan untuk menyelamatkan generasi muda dari dampak negatif minuman beralkohol. Namun, seiring dilakukannya reshuffle kabinet dan seruan untuk mendorong pertumbuhan ekonomi Indonesia yang selama dua tahun terakhir terus melemah, Pemerintah justru mengambil kebijakan untuk melonggarkan aturan ketat tentang penjualan minuman beralkohol.

tersebut dengan menggunakan logika empiris. Minuman beralkohol tidak dicerna terlebih dahulu di dalam tubuh, tetapi langsung diserap oleh pembuluh darah. **Laju penyerapan alkohol termasuk reaksi orde satu** dengan konstanta laju $k = 10/\text{jam}$. Semakin tinggi konsentrasi alkohol yang dikonsumsi, semakin cepat penyerapan alkohol oleh pembuluh darah.

Setelah minum minuman beralkohol, tubuh langsung bereaksi untuk mengeluarkan alkohol tersebut. Sekitar 2-10% dikeluarkan melalui nafas, keringat, dan urin. Sisanya sekitar 90-98% mengalami metabolisme dalam hati dengan bantuan enzim menghasilkan CO₂ dan H₂O. **Laju metabolisme alkohol tidak dipengaruhi oleh konsentrasi alkohol.** Proses metabolisme alkohol merupakan suatu proses yang tetap



Let's Think Critically!

Petunjuk: Jawablah pertanyaan-pertanyaan berikut sesuai dengan artikel yang disajikan!

Indikator berpikir kritis: mengidentifikasi asumsi (merekonstruksi argumen)

2. Pada artikel di atas dituliskan bahwa laju reaksi penyerapan alkohol oleh darah merupakan reaksi orde satu. Apakah yang dimaksud dengan reaksi orde satu? (BK: mendefinisikan istilah dan mempertimbangkan definisi menggunakan kriteria yang tepat)

Berdasarkan konstanta dan laju yang ditunjukkan oleh persamaan beralkohol pada petunjuk Anda dengan rencana Pemerintah DKI Jakarta untuk mendirikan minuman beralkohol?

Figure 2. Student Worksheet Example

analysis are presented in Table 2.

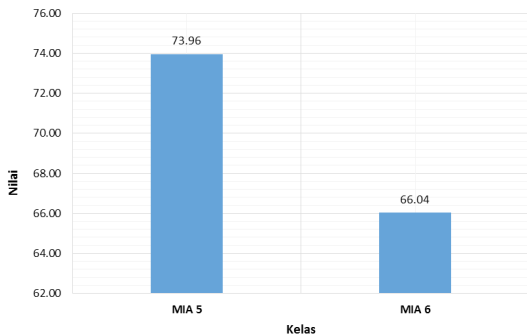


Figure 3. Average grade of the students' Critical Thinking Skills

Levene's test was used to determine the homogeneity of the sample group tested. The analysis showed that Levene's test value at 0.868 which indicated that the sample is homogeneous (Sig. > 0.05). Therefore, further analysis to compare the two groups of students was parametric comparative analysis the independent sample t-test. The results of t-test analysis showed a significance value at 0.037 (Sig. > 0.05). The data showed that the critical thinking skills of students between the two groups differed significantly.

In the following study, two classes employed the cooperative learning model, i.e. constructivist learning paradigm and student-centered

cooperative learning (student-centered). According to the constructivist paradigm, students are more actively construct or build their own knowledge. The cooperative learning includes a social constructivist model that emphasizes the importance of the relationship between students and instructors (Valdez *et al.*, 2015). The activities are designed for cooperative learning which involves students to working in groups. Teachers serve as the instructors during the learning process. The discussion activities occur during learning process allows peer tutoring among students in the group. Thus, students are not overburdened during the learning process and they can promote the active participation and reduce the dominance of teachers. By this activity, students tend to have more opportunities to think critically.

In addition of using cooperative learning model, students' critical thinking skills can also be trained by socioscientific issues (SSI). Even though context as learning models with the same level of breadth and depth of the material, but the results of the analysis showed no significant difference on the critical thinking skills among both classes. Classroom which employed the SSI context in learning had higher average grade than the classroom without SSI context. SSI-applied classroom students tend to have more opportunity for discussion or debate activities. With the same model of learning, both groups of students have

Table 2. Results of t-test analysis on the grade of critical thinking skills with SPSS 16 for Windows.

		Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means						95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper	
Berpikir/kritis	Equal variances assumed	.028	.868	2.130	58	.037	7.91667	3.71592	47844	15.35489	
	Equal variances not assumed			2.130	56.339	.038	7.91667	3.71592	47377	15.35956	

the same opportunity to discuss and construct the reaction rate knowledge. During the process, the students' critical thinking skills honed through questions posed to the students' worksheets. However, the experimental class that learned in the context of SSI, the worksheet contains four articles in accordance with the concept of reaction rate including: (1) The controversy of PTLN in Indonesia; (2) Carbide, Fruit Maturation accelerator; (3) The controversy of Alcoholic Beverage Sales Rules; and (4) Dilemma of Cigarette Industry in Indonesia. Selection of these issues was based on the fact that the issue has been commonly growing in the community, but it poses a dilemma in making decisions related to the issue. By these articles, it is expected that students have more opportunities to exchange their ideas, either through group discussions or through classroom discussion. This leads to increase the critical thinking skills of students.

Based on several studies, the integration of SSI in learning can improve critical thinking skills, including research conducted by Tal & kedmi (2006) and Eggert *et al.* (2012). According to Ratcliffe & Grace (2003), the use of SSI as a context for learning can train students' critical thinking skills through three important aspects, namely (1) the students need to understand and describe the problem situations involving SSI; (2) the students formulate a number of problem-solving solutions that enable on the situation that has dpelajari; and (3) students need to re-evaluate the decisions they have made before the decision is communicated within the forum. The process trains students to think more carefully and to be more reflective in making decisions. Students do not just use one source for consideration, but pay attention to other sources before the final decision is taken. Because SSI involves science and social issues, the students need to pay attention to the impact that would arise from the two sides. For example on the issue of the first SSI on the use of nuclear power as a power plant in Indonesia. According to science, the use of nuclear power plants will be profitable. In addition to its fast reaction, the high energy that can be utilized

as well as the lack of pollution generated a profit from the construction of the plant. However, the level of public anxiety of impending nuclear leaks as it has been widely reported in the media of social constraint of the nuclear power plant. In addition, the amount of funds needed for the construction of the initial installation of nuclear power plants is also a problem that needs to be considered. To formulate the solution of these problems, the students not only the profits in terms of science, but the social aspects also need to be considered. Solutions to problems are not specific and are multisolusi will train students to think critically.

CONCLUSION

The implementation of socioscientific issues (SSI) as a context for learning has a significant influence on the critical thinking skills of high school students. In this learning application, the controversial issues arise as the characteristic of SSI induce the students to be more actively discussing and debating to train their critical thinking skills.

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THE DEVELOPMENT OF LABORATORY-BASED EARTH AND SPACE SCIENCE LEARNING MODEL TO IMPROVE SCIENCE GENERIC SKILLS OF PRE-SERVICE TEACHERS

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ABSTRACT

This study focuses on the improvement of prospective teachers' science generic skills in learning for earth and space sciences subject using a laboratory-based model. Research methods were Research and Development used mixed methods design, i.e. Embedded Experimental models. The results showed that the structure of the learning using laboratory-based model consists of four stages, namely engagement, exploration, explanation, and elaboration; with details on description of natural phenomena, the identification of questions, linking concepts with practical topic; modeling, training, exploration, interpretation of data, conclude, and communicate the procedures and results of the investigation. Moreover, the ability of science generic skills of teacher candidates was low at 52.50%. In addition, the profile of lecturer performance in learning reached 55%. Also, the condition of the learning environment is generally sufficient in supporting the development of laboratory activities, for example: a comfortable laboratory room for conducting the practicum. Next, 75% student agreed that for understand the material; it needs a practice in lab. As many as 70% of students agreed that practicum will increase students' understanding, although students also agreed that clarification is still required by lecturers (80%). Furthermore, 69% of the students found the materials of Earth and Space Sciences is more attractive than other materials, although 78% said material of Earth and Space Sciences is fairly complicated and abstract. The interest of students to the material of Earth and Space Sciences is because these materials can foster curiosity (88%) as well as providing benefits to their daily life (90%). Finally, three out of four students agreed that the science generic skills can develop the ability of scientific work and critical thinking.

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Keywords: earth and space sciences, science generic skills, laboratory activities, prospective primary school teachers

INTRODUCTION

The challenge of new paradigm of earth and space sciences learning requires a further development of higher order thinking skills. High order of thinking is one component in intelligence issues of the 21st century (Gonzales, P. 2009). According to Bartholomew, H. (2006), high order of thinking is expected to solve new problems in life. In addition, Etkina, E. (2010) state that capability of high order of thinking includes activity analysis, synthesis, systematic evaluation, and the

ability to perform a variety of helpful predictions against natural phenomena and social life of the community.

Earth and space sciences are loaded with high-level thinking activities which can be developed through the nine kinds of generic capabilities of science proposed by Aulls, M. W; and Shore, B. M. (2008), i.e. (1) direct observation, (2) indirect observation, (3) awareness of the scale of magnitude, (4) the symbolic language, (5) the framework of logic obey the principle, (6) inference logic, (7) the law of causation, (8) mathematical modeling, and (9) establish the concept.

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Hodson, D. (1996) acknowledged the importance of generic skills in earth and space sciences learning needs the support from the curriculum in higher education institutions. It should be designed to provide a learning experience for prospective teachers to understand and develop their generic skills. Besides that, Buck and Gayle A. (2007) state that the generic capability is an ability that can be applied to various fields of knowledge. Nevertheless, the results Pujani and Liliyasi, (2011) found that earth and space sciences learning in schools and in universities is not yet fully organized in laboratory activities. In line with this opinion Rosnita, et al. (2011) found that earth and space learning at several high schools in Pontianak City is dominated by lectures, discussion and assignments. Lecturers and teachers have never taught earth and space sciences through laboratory activities. Previously, Cain, S. E., and Evans, J. M. (1990) found that the learning of science in schools generally in a form of theoretical through lectures, discussions and problem-solving. In relation with this case, many common reasons such as lack of laboratory space, lack of equipment, as well as teachers/lecturers have not been trained to implement laboratory activities.

The main problem in this research is the effect of laboratory-based learning model in earth and space sciences on the ability of pre-service teachers' science generic skills in Pontianak. To answer these problems, the research questions are generated as follows: How to structure the learning that can improve the ability of pre-service teachers' generic skills?; How the laboratory activities can improve the ability of pre-service teachers' generic skills?; What is the profile of the ability of pre-service teachers' generic skills perspective?; What is the profile of faculty performance in earth and space sciences learning?; How is the learning environment that can supports an improvement in the ability pre-service teachers' generic skills perspective?

The strategy of earth and space sciences learning using the laboratory-based method aims to develop scientific skills, understanding of concepts, creative thinking skills, and scientific attitudes (Gangoli and Gurumurthy, 1995). In line with this opinion Coffey, X.J; Elby, A and Levin, D.M. (2009) suggested another benefit of laboratory activities as follows: (1) To motivate and strengthen the interests and the activity of prospective teachers; (2) to train the skills to work in a laboratory; (3) to assist the understanding and (4) development of concepts; (5) to inculcate the scientific attitude. Rustaman (2005) found that

the type of effective laboratory activities are (1) the type of laboratory practice to develop generic skills and techniques such as using measurement and observation tools; (2) the type of experience to improve the mastery of concepts by providing real experiences directly to the students to a natural phenomenon; for example to understand the system of movement of the sun-earth-moon it can be either verified or inducted; (3) the type of investigation using the inquiry model implementation can be used; for example an investigation of factor that influence the greenhouse effect.

The ability to conduct the laboratory activities is an important element in earth and space sciences learning (Keys, C; and Bryan, L. (2004). Earth and space science learning through laboratory activities aims to give the learning experience for prospective teachers. They also can interact with the equipment to observe and understand the natural phenomena (Mao, LS and Chang, CY. (1999). Earth and space sciences learning using laboratory-based method is relevant to develop scientific skills, improve the concept understanding and creative thinking skills, also to grow a scientific attitude as a provision for future teachers (McDermot, LC (2009). In this regard, Nugent, G; et al. (2008) assert that the purpose of the laboratory-based learning in earth and space science for prospective teachers is to give them an activities of observing the natural phenomena, to develop understanding of what is observed and connecting scientific knowledge with critical thinking skills, and also to make them feel happy and excited (joyfull) in learning.

The approaches of laboratory operations are distinguished on inductive and deductive method (Pyle, EJ (2008). The inductive approach is a laboratory activity to establish principles, generalizations or theory of the relation of facts. Also, the inductive approach provides the opportunity to prospective teachers to develop the concept, principles, and laws through first hand experience before finding the ideas discussed in the classroom. In the other hand, the deductive approach or verification aims to validate the principle or theory comparing with facts. Deductive activity is the most common approach in scientific lectures to confirm the concept, principles, and laws that have been discussed in class discussions (Ramsey, J. 2003).

Gautier, C and Rebich, S. (2005) found that laboratory-based science learning give the positive impact, producing a complete understanding and meaningful, both the content and skills. In addition, Hoban, G. F. (2007) argued about the characteristics of laboratory activities which are

should be authentic and show the importance of data. Also, it must provide the collaboration between teachers and students, connecting students with local communities, demonstrating behavioral science, developing students' abilities, exploring the question of the students, constructing explanations and concepts based on the data, and applying the scientific knowledge.

Science generic capability is a result of a combination between intellectual abilities and the complex interaction of the knowledge and skills (Stasz, C. et al., 2001). It can be applied in every field to obtain knowledge and skills in a relatively long time (Drury, 1997). According to Abraham, I and Millar, R. (2008), the science generic skills can be improved in earth and space sciences learning. In line with this opinion, Gerace W.J and Beaty, I.D. (2005); Brotosiswojo, B.S. (2000); Rice, J and Neureither, B. (2006) proposed nine generic skills aspect of science, i.e. (1) direct observation, the observed object directly e.g. observation of the sun, earth, moon and other celestial objects in the sky; (2) indirect observation, i.e. the specific objects that require tools, due to the limitations of sensory organ. For example telescopes, magnifying glass, thermometer, compass, stop watch, hydrometer, and others. (3) Awareness of the scale of magnitude can be developed through investigation trial in earthquake seismograph scale reading; (4) The symbolic language, such as information from graphs, drawings, charts, or diagrams, understanding coordinate systems and symbols. For example: zenith (Z), nadir (N), the azimuth (a), high-Star (h), the declination angle (δ), the north (N), South (S), East (E) and West (W); (5) inference logic, which concluded activities or suspect using the logic of the data or the results of observation; (6) The framework of logic obey the principle is the ability to think systematically based on the regularity of natural phenomena. Example: Pluto is no longer included as a planet where its orbit is known cutting the Neptune orbit. (7) The causal link, the belief that natural phenomena are interrelated in a pattern of cause and effect. Example: an earthquake due to the movement of lithospheric plates; (8) Modelling, namely simplification efforts on something that is expected to help understand it better. For example the use of the earth as a globe, Stellarium as a model of the universe, weather and atmospheric models. The mathematical model of Newton's Law of Universal Gravitation ; (9) Developing the concept, i.e. the ability to interpret the laws, rules, concepts based on observational data, and others

METHOD

This study used the development of research from Gall, M.D; Gall, J.P; and Borg, W.R., in four stages, namely the preliminary study stage, designing, development of design, and phases testing. Also, this study was a preliminary study to design the learning models. This research was held on the Program of Primary School Teacher Education Degree students in the Faculty of Teaching and Education University Tanjungpura. A total of 30 students at sixth semester were tested for their science generic skills, and 50 students were tested for questionnaire. The data collection was performed by testing the generic science skills using the instruments such as multiple choice, questionnaires, and interviews. Data were analyzed using triangulation mixed-methods design (Creswell, 2008) which was to simultaneously analyze the quantitative and qualitative data as well as aggregated data.

The operational definition: science generic skills are the result of a complex interaction between knowledge (knowledge) and skills (skills) required for mastery of interaction repeatedly and relatively last in a long period. Science generic skills are developed including direct observation, indirect observation, and awareness of the scale of magnitude, symbolic language, logical inference, causality, and modeling. This research variables captured by the science generic skills tests.

RESULT AND DISCUSSION

Structural model of earth and space sciences learning using laboratory-based is shown in the following figure.

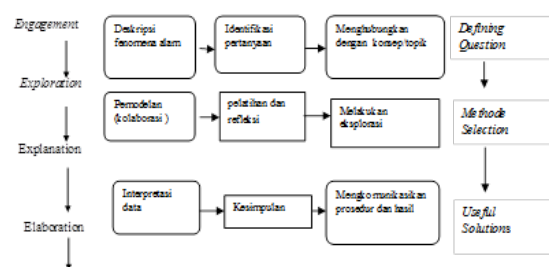


Figure 1. Structure of earth and space sciences learning for science generic skills improvement

Six laboratory activities were set in addition to compliance with the curriculum, considering the recommendations of the experts as well as the equipment available in the laboratory and also contextual aspects. The following topics were described with learning goals. 1) Global

warming: the student investigation can conclude that global warming is caused by the greenhouse effect because of the concentration levels of carbon dioxide (CO₂) in the atmosphere has exceeded the tolerance threshold; 2) weather and climate: through observation to BMKG of West Kalimantan province, students get to know the means of measuring the rainfall pattern, evaporation, temperature, humidity, wind direction and speed, as well as the basic of measuring equipment; 3) The water cycle: through student inquiry, it can be concluded that the process of water cycle affected by solar radiation, the source of water, evaporation of cloud formation, and rainfall; 4) weathering and erosion: through student inquiry, it can be concluded that the weathering and erosion are caused by fluctuating climatic factors such as temperature, wind, humidity, and precipitation; 5) miraculously the sun: through student inquiry, it can be concluded that the sun do daily apparent motion that causes day and night; 6) equinox: through the investigation to the Equator Monument, the student can prove that on the day of culmination (equinox) every March 21 at 12.00 there is no shadow of the sun, since the sun's position is directly above the equator.

Profile of Science Generic Skills on Prospective teachers is shown in Figure 2. The mastery of prospective teachers in the topic of laboratory activities is shown in Figure 3. In Figure 2, it is shown that the highest score was in the topic of water cycle and green hous effect reaching 80 and 70, respectively; whereas the rocks, rainfall pattern, and erosion reached 60.

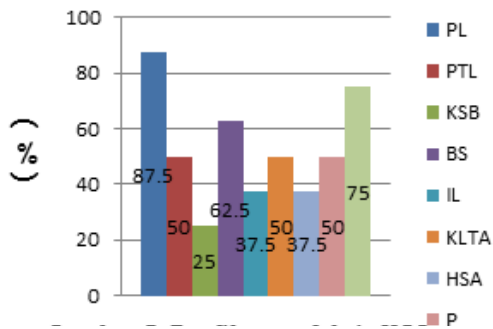


Figure 2. Perspective profil of Science Generic Skills.

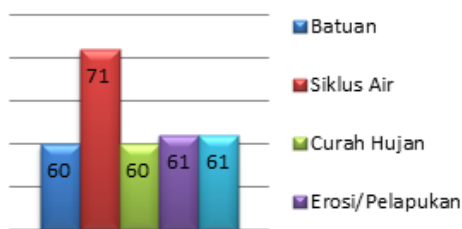


Figure 3. Mastery of materials or topic (score).

Figure 2 shows the low level on science generic skills of prospective teachers with an average percentage of 52.80%. Two observations on rocky material and water cycle shows the highest average score direct observation and applying the concept which reached 87.5% and 75%, respectively. The other science generic skills while others were still under 65%, science generic skills on the awareness of the magnitude scale only reached 25%. The indirect observation of science generic skills showed 50%, symbolic language at 62.5%, inference logic at 37.5%, frame logic obey the principle at 50%, causality at 37.5%, and modeling at 50%. The low science generic skills of the prospective teachers are possible when the learning process is conducted with lecturer as the center of learning.

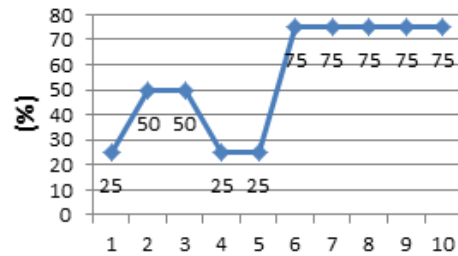


Figure 4. Lecturer performance profile

Description:

1. Opening
2. Information of learning purposes
3. Asking questions
4. Enable MHS
5. Involve MHS
6. Mastering the material
7. The effectiveness of the media / resources
8. Strategy
9. Disclosure
10. Clarification

Figure 4 shows that the performance of lecturers, especially in developing the liveliness for pre-service teachers needs to be improved. Meanwhile, the profile of lecturer performance based on the development efforts on science generic skills of prospective teachers; it shows almost all the lecturers never conduct the laboratory activities on earth and space sciences subject. The overall learning models for this subject use lectures, assignments, presentations for delivering the information.

CONCLUSION

Earth and space sciences subject structure in this study consists of four stages, i.e. 1) engagement, 2) exploration, 3) explanation, and 4) elaboration; with details of indicator for te-

acher candidates include: to describe of natural phenomena, to identify the questions, linking the concepts with practical topic; modeling, training, exploration, interpretation of data, to conclude, and to communicate the procedures and results of the investigation.

The profile of generic science skills of pre-service teacher was still low with an average percentage at 52.50%. The low result is probably due to lecturers' dominance in learning activities. Profile of lecturer performance earth and space science subject was low. Almost all lecturers never conduct the laboratory activities in this subject. The obstacles faced by lecturers caused by several things, for example, (1) small portion of the earth and space sciences study materials, (2) the lack of supporting facilities, (3) the lack of skills of lecturers to conduct laboratory activities, and (4) lecturers are less motivated to make the teaching props.

Generally, the environmental conditions with adequate learning support is needed for the development of laboratory activities, for example a comfortable laboratory room that allows to perform group activities. Three out of four students agreed that in order to understand the material, earth and space sciences practicum is needed, thus they are not only memorize but also practicing using interactive media. More than half of students agreed that the practicum will increase the students' understanding, although students also agreed that clarification is still required by the lecturers (80%).

The attitude of students to the lecture material was at 69%, the students found that the earth and space sciences material is more attractive than other materials, although 78% students said that this subject is quite complicated and abstract. However, the interest of students to this subject fosters their curiosity (88%) and provides benefits for their daily life (90%). 75% students agreed that earth and space sciences developed the ability of scientific work and critical thinking skills.

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THE INFLUENCE OF SCIENCE LEARNING SET USING SCIENTIFIC APPROACH AND PROBLEM SOLVING MODEL ON LEARNING OUTCOMES OF JUNIOR HIGH SCHOOL STUDENTS IN THE SUBJECT OF HEAT AND TEMPERATURE

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ABSTRACT

This research aims to produce the scientific approach for science learning using a problem solving model on the topic of heat and temperature on the junior high school learning outcome. The curriculum used during the study was curriculum 2013 (valid, practical and effective). The development of the learning set followed the four-D model which was reduced to three-D model (without dissemination). The study was tested in Class VIIA, VIIB, and VIIC in SMP Negeri 5 Academic Year 2015/2016. The data collection technique employed the validation of the learning set, observation, testing, and questionnaire. The results of study show that the developed learning set has a decent (valid, practical, and effective). The competency in learning outcomes show N-Gain in high level with the average value ranged between 0.80 to 0.86. The impact of learning on three classes were tested by ANOVA on 0.05 significance level to produce F value \leq F table, meaning that there is no difference in the impact of learning on three classes with consistent value. The student competence skills and demeanor, the skills of each category showed good and positive response to learning. The research concludes that the scientific approach for science learning using a problem solving model is suitable for learning application (validity, practicality, and effectiveness). By mastery in learning management, the learning objectives can be achieved smoothly.

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Keywords: Scientific approach, problem solving model, Mastery, Learning Outcomes

INTRODUCTION

The progress of a nation is marked by increasing the quality of society life such as the human resources quality in utilizing and developing the appropriate technologies as well as tackling the impact. One of the indicators is education as an embodiment of the dynamic and evolving the human culture. Competition in information and technology has a tendency to change rapidly requiring prompt and effective response to 21st century education. The education evolution is directed to integrate various sources of knowledge to solve the problem effectively.

The curriculum 2013 was developed with the improvement of active mindset reinforced in learning approach to scientific learning, in line with Permendikbud about the standards process, which is set with student characteristics and learning outcome. The quality of learning can be observed in terms of process and in terms of outcome. The assessment in the educational process is an important component since it is a form of information weaknesses and strengths in teaching and learning. Before the learning assessment, teachers have a role to assist the students in achieving the learning objectives by employing the approaches, strategies, methods, techniques and learning models which are needed to facilitate students to easily in achieving optimal learning

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outcome.

According to the Government Regulation (PP) No. 104 of 2014 on the assessment of learning outcomes, the mastery learning is indicated by the achievement of the demeanor, knowledge and science lessons skills. An attempt to use the knowledge and understanding in solving the problems of everyday life aims to improve the quality of life and foster the idea. Students who can associate the learning with their daily phenomena tend to be a dynamic student in achieving the demands of the curriculum.

At the international level, Indonesia participates in Trends of International on Mathematics and Science Study (TIMSS), a four-year study conducted by the International Association for the Evaluation of Educational Achievement (IEA). Based on TIMSS, the science assessment consisted of two aspects, i.e. content and cognitive domains. These domains content includes subjects of chemistry, physics, biology, and earth science. While cognitive domains include aspects of knowing, applying, and reasoning. According to TIMSS data in 1999 about the ability of science student, Indonesia ranked at 32 out of 38 countries with an average score of 435. There was a decrease in score in 2003, Indonesia was at 37th position out of 46 countries with an average score of 420. Fluctuatively, in 2007, Indonesian ranked 35 out of 49 countries with an average score of 433. Lately, in 2011 Indonesia declined at 40th position out of 23 countries with a score of 406 and it categorized as Low International Benchmark (Martin M. O. et. al. 2012).

The study results of TIMSS show that Indonesian students currently in a very low category in the ability to understand complex information; low in theory, analysis and problem solving; the procedures and troubleshooting tool; as well as conducting the investigations (Kemendikbud, 2012a).

Preliminary studies conducted by researchers showed that students still have trouble in understanding the material taught. Therefore, there is a huge number of students who have not reached the minimum completeness criteria and the learning result is considered as low. Based on the test to measure the students' ability in the heat and temperature topic, 34 students met only 20% minimum completeness criteria. This statement is reinforced by the results of discussions with teachers of science who suggested that the low results of student science learning subjects are influenced by several factors, i.e. teachers find it difficult to implement a constructivist learning; students tend to be passive, where they always

wait the explanation from the serving teachers; (3) time limitation on preparing a learning device to complete the learning outcomes.

The application of science learning is where teachers are expected to select the appropriate learning models is important. It is with the hope that students can improve their ability of a concept. Problem solving is a model that can be used for achieving the learning outcomes. The implementation problem solving model encourages the student to think reflectively in teaching and learning process, since they will undergo the stages of learning, from the stage of formulating the problem, analysing problems, formulating hypotheses, collecting data and testing hypotheses, and also formulating troubleshooting recommendations. Problemsolving model for students is intended to embody the ability to solve their life problems skillfully and rationally according to the stages of logical process. Moreover, they can do it efficiently and it is expected to achieve the students' learning outcomes, where students are directly involved with the learning process experience.

METHOD

The research was conducted in class 5 SMP VII Batang Academic Year 2015/2016. The set of learning includes lesson plans, worksheets, BAS, and examination gradas conducted to VII A, B, and C where each class numbered 25 students. The development of learning sets was following the four-D models which were reduced to 3D (without dissemination). Moreover, the design of the trial was in one group pretest-posttest. The technique of data collection was the validation of the set, observations to obtain lesson plans achievement, student activities, demeanor, and skills, as well as the obstacles in learning. Moreover, the evaluation used to obtain data on learning outcomes of knowledge; and questionnaires were used to obtain data legibility of BAS and learning. Analysis of students' response used descriptive quantitative and qualitative approaches. Analysis of the learning set development results were conducted as follows:

Analysis of Learning Tool Quality

Learning device (RPP, BAS, LKS and Assessment of Learning Outcomes) was evaluated by a validator to proof its feasibility. RPP, BAS and LKS examined with instruments that have been developed. The learning outcome assessment formed a developed validated content, language and writing about the instrument. Data

validation results were analysed using descriptive qualitative approach. In this study, the acceptance limit of P was the average score of the assessment results of the validator, and then it was matched with the learning outcomes assessment criteria. The criteria for the assessment of learning outcomes by Ratumanan & Laurens, 2011, can be seen in Table 1.

Table 1. Criteria for the assessment of lesson plan, books, and student's worksheet

Interval of Score	Grading category
$3.6 \leq P \leq 4$	Very valid
$2.6 \leq P \leq 3.5$	Valid
$1.6 \leq P \leq 2.5$	Fairly valid
$1 \leq P \leq 1.5$	Invalid

(Source: Ratumanan & Laurens, 2011)

Analysis of Readability Level in Student's Book

Readability level set that has been developed through a textbook was in a form of students were given the instrument that contains materials of study. The readability of textbooks was analysed with a close procedure, where it is to divide the word of correct answer by the total number of words omitted then multiplied by 100%. The formula used is:

$$K_B = \frac{K}{\sum k} \times 100\% \tag{1}$$

Description:

K_B =readability level

K = correct answer of words

$\sum k$ = all words that must be filled

To get the value of the book readability, the readability test to students as responden was then analysed descriptively based on the level of readability. The result is presented in Table 2.

Table 2. Value of Set Readability (Textbook Student)

Score	Readability level
Test score > 60%	High
Test score 40%-60%	Fair
Test score < 40%	Low

(Source : Taylor in Winarni, 2011)

Analysis RPP Implementation

Observations were made by two observers to measure the implementation of lesson plan

where the implementation at each step was determined by comparing the average scale of assessment given the observer with the assessment criteria are presented in Table 3.

Table 3. Criteria Rate implementation RPP at every step

Implementation result	Category
$1 \leq P \leq 1.5$	Poor
$1.6 \leq P \leq 2.5$	Fairly Good
$2.6 \leq P \leq 3.5$	Good
$3.6 \leq P \leq 4$	Very Good

Analysis of Student Results

Based on data from posttest results and data analysis using descriptive and qualitative approach, the learning outcomes demeanor, knowledge, and skills are resulted as follows:

Values are given for the learning outcomes in the aspect of demeanor by two observers and a self-assessment of students is determined by the average, then the results obtained are matched with the assessment criteria. Results of learning knowledge and skills were measured based on the posttest, while the learning outcomes are using individual completeness and classical. When students can individually complete the learning achievement, the average achievement indicators which are represented if the learning objectives meet the minimum completeness criteria score (KKM) at 70, it is calculated as follows:

$$P_{individual} = \frac{\sum skor\ yang\ dicapai\ siswa}{\sum skor\ maksimum} \times 100\% \tag{2}$$

The learning outcomes completion classically can be measured using this formula:

$$P_{klasikal} = \frac{\sum siswa\ yang\ tuntas}{\sum seluruh\ siswa} \times 100\% \tag{3}$$

The classical learning is said to be completed when it meets $\geq 75\%$ students can achieve the minimum criteria.

Normalized Gain

The analysis of treatment data is to show the difference in students' knowledge before and after treatment. The student's learning outcomes were measured at pretest and posttest, it was calculated using normalized gain formula as follows:

$$\langle g \rangle = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \tag{4}$$

Table 4. Conversion, score, and learning outcomes predicate

Demeanor		Knowledge		Skills	
Modus	Predicate	Average score	Letter	Optimum achievement	Letter
4.00	SB	3.85-4.00	A	3.85-4.00	A
		3.51-3.84	A-	3.51-3.84	A-
3.00	B	3.18-3.50	B+	3.18-3.50	B+
		2.85-3.17	B	2.85-3.17	B
		2.51-2.84	B-	2.51-2.84	B-
2.00	C	2.18-2.50	C+	2.18- 2.50	C+
		1.85-2.17	C	1.85-2.17	C
		1.51-1.84	C-	1.51-1.84	C-
1.00	K	1.18-1.50	D+	1.18-1.50	D+
		1.00-1..17	D	1.00-1.17	D

(Permendikbud, 104 year 2014)

Table 5. Category of *normalized gain* <g>:

N-Gain Score	Criteria of Normalized Gain
N-Gain ≥ 0.70	High
0.30 ≤ N-Gain < 0.70	Fair
N-Gain < 0.30	Poor

(Hake,1999)

Analysis of Varian (ANOVA)

Statistical analysis was performed ANOVA test aims to determine the impact of learning on the third-class model of problem solving that is VII.A, VII.B, and VII.C. Hypotheses were tested include:

Ho = there is no difference in the impact of problem solving learning model in the classroom VII.A, VII.B, and VII.C.

Ha = there is a difference in the impact of problem solving learning model in the classroom VII.A, VII.B, and VII.C.

Hypothesis according J. Surapto (2009) formulated:

$$H_o : \sigma_A^2 = \sigma_B^2 = \sigma_C^2$$

$$H_a : \sigma_A^2 \neq \sigma_B^2 \neq \sigma_C^2$$

The decision made according to:

If Sig. < 0.05 then Ho is rejected

If Sig. ≥ 0.05 then Ho is accepted, or

If $F_{value} > F_{table}$, then Ho is rejected

If $F_{value} \leq F_{table}$ then Ho is accepted

Problem sensitivity

The sensitivity of the items index is a measurement of how well a matter of distinguishing between students who have received a lesson with students who have not received the lesson. Sensi-

tivity indices to have a range between 0 and 1. To calculate the sensitivity of the matter, we used the following formula.

$$S = \frac{R_A - R_B}{T} \tag{5}$$

Description:

Ra = The number of students who give correct answers in post-test

Rb = The number of students who give correct answers in pre-test

T =The number of students who join the test

Sensitivity index ranged at 0.00 to 1.00 is said to be sensitive to the effects of learning. Moreover, the sensitivity is increased when it is greater than or equal to 0.30 (Gronlund, 1977).

RESULT AND DISCUSSION

The learning set using a scientific approach with problem solving models have been developed by researchers and further validated by experts. The results are implemented in class VII A, B, C SMPN 5 Batang where each class numbered 25 students. Data obtained from the results of the validation and implementation of the learning set is described to determine the feasibility of the learning set and learning model and its impact on the student learning outcomes.

Results of Learning Set Validation

Data validation results are presented in the form of expert assessment in terms of content, construction, and language. The results of the validity assessment from some experts who are competent in the field of science teaching software development are presented in Table 6.

Table 6. Results of learning set validation

Learning set	Score	Category
RPP	3.80	Very valid
BAS	3.78	Very valid
LKS	3.86	Very valid
THB	3.78	Very valid
Process skills	3.76	Very valid
Demeanor learning outcomes	3.84	Very valid

Table 6 shows that the learning set developed by researchers was proved to have a good degree of validity. The learning set developed using a strong theoretical rationale basic and there was a consistency between the internal components of learning, content aspect, construction, and language learning that used to complete the learning outcomes of students.

Researchers distributed instrument legibility of textbooks students to know the extent to which students understand Textbook Student (BAS) has been studied, textbook for students to complete the incomplete word (dilesapkan). Results of the analysis of legibility BAS presented in Table 7.

Table 7. Readability of BAS classVII A, B, and C

Class	Readability BAS (%)
VII A	70.5
VII B	70.9
VII C	70.7

Lesson plan completeness

The results of lesson plan completeness in every aspect of the introduction, the core activities, the closing, time management and classroom atmosphere was measured at average to good. Following the statement of Dimiyati and Mudjiono (2009), the success of teachers in managing the learning process is indicated by learning environment as one factor that can affect the quality of learning observations. The results of completeness of learning set developed are shown in Table 8.

The completeness of lesson plan refers to the scientific approach of the problem solving model to formulate the problem (observed), analyze the problem (queries), formulate hypotheses, collect data (information gathering) and hypothesis testing (associate / process information), formulating troubleshooting recommendations (communicating).

Table 8. Lesson plan completeness

Class	Σ Lesson plan completeness score	Category
VII A	3.63	Good
VII B	3.71	Very good
VII C	3.77	Very good

At the first phase, apperception was delivered to motivate and communicate the learning goals to the students. The students were asked to explore living phenomena and to review the material that has been studied before. They were then directed to a phenomenon that is often experienced by students to formulate a problem (observation). As suggested by Nur (2008a), students who are motivated to learn something will have higher cognitive and thinking skills on studying the material. Therefore, students will understand and listen to the explanation properly. Slavin, 2011 stated that students learn best when the concept from their nearest development zone.

The second phase, based on the phenomenon that encourages students to analyze problems, students were then asked to submit questions related to the phenomenon. Newell and Simon (1970) suggested that problem solving must focus on questions. It is a question that is directed to the scope of the problem and the answer is a key principle to question which will expand problem-solving heuristic search theory. Jonassen (2011) states that problem arising is an activity to assemble all the information and a few relevant sentences or translations into an accurate understanding of the problem as a whole information. Students need to understand what is the real meaning in question in the problem.

The third phase of formulating hypotheses guide the students to formulate hypotheses for answering the problems where students are directed to identify the control variables, manipulation of variables and the response variable consistent with the cognitive constructivist by Piaget. Moreover, students were asked to organize the material and to recall information-related information that can be used to assist in integrating the new information for learning (Arends, 2013: 105).

The fourth phase was data collection and hypothesis testing (associating and processing the information) where students plan to work in steps. The hypothesis testing at this phase is in accordance with the opinion of cognitive psychology by John Dewey. In fact, the number of student at school will reflect the community, whereas classroom is a laboratory for invention and solving

real problems (Democracy and Education, 1916). The theory of constructivist by Vygotsky scaffolding proved that students more easily understand on the procedural knowledge, in which with the help of structured step at the beginning of the lesson. Then, it gradually transfers the responsibility for learning to the students to work on their referrals themselves. It is in line with the theory of Jerome Bruner; a learning model emphasizes the importance of helping students to understand the key ideas structure. The need for active involvement of students in the learning process takes place through personal discovery (Nur, 2008b: 24).

The fifth phase was formulating the troubleshooting recommendations (communicating) where students analyzed and evaluated learning outcomes by group discussion. Then, they presented in front of the class. At this phase, it served for strengthening a smaller given immediately generally have much greater compared to large gains were given delayed (Nur, 1998: 24). Dewey theory emphasizes the importance of reflective thinking and processes that should be used by teachers to help students acquire the skills and thought a productive processes.

In this study, student learning outcomes were divided into demeanor, knowledge and skill aspects. This is in accordance with the mandate of the curriculum in 2013 which states that the graduate competence includes qualified graduates capabilities ondemeanors, knowledge and skills aspects needs to be achieved from the educational unit from the level of primary and secondary education (Department of Education, 2013).

The results of students' knowledge competencies in this study was obtained by the test results which were underway to learn, and before the learning process, students were given by the the initial test (pretest). The results of student learning competencies on knowledge by pretest and posttest were analysed using Normalized Gain Score which shows the difference in students' knowledge before and after treatment. Results competencies knowledge data was taken on average VII A, B, and C are presented in Table 9.

The results of calculation of the learning outcomes by average of N-Gain knowledge of three classes with 75 students expressed at a highest number. This is according to Hake (1998) which states N-Gain can show differences in the understanding of students before and after being treated, the statement of Hake (1999) show that if $\langle g \rangle \geq 0.70$, it is categorized as "high gain".

Table 9. THB of knowledge

Class	Pretest	posttest	N-Gain	Category
VII A	35.00	86.80	0.80	High
VII B	41.00	89.60	0.84	High
VII C	41.20	91.80	0.86	High

These results are similar to the results of research that has been done by Liezza, N (2011), there is an increase in student learning outcomes in the experimental group after being treated with the approach of problem solving dengan calculation result a gain of 0.52. Each student has a different N-Gain (score improvement), this is because the cognitive abilities of each individual is different, students require time, guidance and direction to master concepts. According to the opinion of Piaget (in Slavin, 1994) who state that all students grow past the same sequence of development, but the growth is taking place at different speeds.

Based on Permendikbud number 104 on assessment of learning outcomes by educators on the elementary education and secondary education, the mastery in learning set with a mean score of 2.67. Also, the criteria of completeness are achieved when the students complete the basic competence minimum criteria at 66.7.

The completeness of individual was measured based on the results of knowledge learning by providing the knowledge achievement test in all students in grade VII.A, VII.B, and VII.C. During the pretest, the result achieved in the classical style was 0% and it was not complete, then when it was measured by classical posttest, it was 100% completed.

Test of variance (ANOVA = Analisis of Variance) was performed using N-gain achievement test score using tools SPSS.19 software. Data is presented in Table 10.

Table 10. Result of Analysis of Variance (ANOVA)

F value	Significance
2.018	0.140
$\overline{F\text{-table}(5\%, 2.72)} = 3.15$	

According to Table 10, based on F value it is concluded that H0 is accepted. There is no difference between N-Gain of VII.A, VII.B, and VII.C at significance level of 5%. It means that the problem solving learning model impacted consistently in three classes on student learning outcomes.

The completeness indicator is the most im-

portant thing to know the achievement of learning objectives. Based Permendikbud number 104 on assessment of learning outcomes by educators in primary and secondary education, the indicators of competency achievement is derived from the knowledge of basic competence. Moreover, competence achievement indicator uses the operational word and is used as a reference in determining the items. The percentage of achievement indicators is obtained by students in the pretest or posttest and it is divided by the maximum score multiplied by 100%. The average N-gain values of class VII A, B, and C is presented in Table 11.

Table 11. The average N-gain value of class VII A, B, and C

Class	Score percentage		N-Gain	Category
	pretest	posttest		
VII A	34.00	86.00	0.79	High
VII B	33.00	74.60	0.82	High
VII C	33.20	76.00	0.85	High

A test to measure the effect on student learning in problem solving is necessary to find the level of sensitivity. Interest sensitivity is employed to know the number of questions, and to measure whether the student is affected by the learning process or not affected. The equation used to calculate the sensitivity is the equation 3.9. The results of the sensitivity of class VII A, B, and C according to the learning results and the sensitivity analysis for the academic study are presented in Table 12.

Table 12. Students' sensitivity

Class	Sensitivity	Description
VII A	0.52	Sensitive
VII B	0.49	Sensitive
VII C	0.51	Sensitive

The level of sensitivity about the learning process can be seen in Table 12. It shows asensitive index of 0.32 to 0.76. This is consistent with the statement of W.J.Kryspin and J.T. Feldhusen in Groundlund (1981: 266) where some items were said to be sensitive to learning when ≥ 0.30 , the average index of sensitivity by researchers is worth at an average grade which is categorized as sensitive to learning.

In the realm of abstract skills assessment process skills, students are given the test one of the phenomena associated with the activities of the student in student activity sheet. The tests

were in a form of pretest and posttest before and after the learning process. The results of the test were then analysed using the Normalized Gain which shows the difference in students' knowledge before and after treatment. The learning outcomes assessment model of problem solving process can be seen in Table 13.

Table 13. Results of analysis of skills learning outcome

Class	pretest	posttest	N-Gain	Category
VII A	42.67	90.00	0.82	High
VII B	42.67	88.44	0.84	High
VII C	45.56	92.22	0.86	High

Students are successfully completing the learning process when they achieve the minimum value (B-) with a minimum score at 66.7. The process of learning affect the student's skills using practicum and guidance for students to observe phenomena like putting variables manipulation, response and control. Moreover, after 8 activities, the students have the trial skills of a good process. It is seen by the results of the N-gain of all classes with average at 0.84 which means as a high average category. This is similar to the discovery of the theory of Bruner (1996) that argues about the teaching of subjects is not only to produce a library but also induce the students to think for themselves to know the process and the product.

Learning outcomes competences demeanor in the learning process consists of spiritual demeanors and social demeanors. Assessment conducted by researchers at the spiritual demeanor of observation, assessment of social demeanors do a self-assessment. Students are said to be complete if the achievement of at least getting good value category (B). As for the analysis of demeanors presented in Table16 states that all students of class VII A, B, and C completed within the competence of demeanor.

Table 14. Results of demeanor score in learning

Class	Demeanor score and student's number	
	Good	Very Good
VII A	14	11
VII B	19	6
VII C	15	10

The results obtained from the four meetings showed100%completeness. The completeness is realized as indicators o demeanor. Trai-

ning in teaching social demeanor measures the curiosity, thoroughness and honesty adapted to the character of learning. It is conducted in the hope that students will have a great curiosity in learning. Therefore, when they face a difficult problem, students are eager to learn and sustain their study since the material of heat and temperature are always applied in everyday life. Accuracy in measuring the student learning required to use a measuring instrument which has a measuring scale that is well suited to train the student accuracy. Honesty, related to measurement with direct measurement of students directly or indirectly embedded honest demeanor with indicators honesty. This is in accordance with the opinion of Sulhan (2011) who state that to build character (demeanor) of a nation is not easy like turning back your hand. However, it does not mean that it is impossible. The results of demeanor assessment using an average value for the learning with only four meetings can not be used to infer the social demeanors of the students. Honesty means to the average value of the demeanor of each meeting. Then, it was converted to the value of the ideal demeanor, then students get their demeanors in accordance with the predicate, the assessment will continue at the next KD up to one semester and take place on the entire assessment of teachers. Therefore, at the end of the semester, it can be inferred demeanors of students' learning outcomes for one semester.

CONCLUSION

Based on the results of the learning set achievement test, data analysis, discussion, and the findings of the research, it can be concluded that the science learning using scientific approach with problem solving models are developed in compliance with the eligible criteria (validity, practicality, and effectiveness). The impact is consistent with the results of student learning. Researchers and teachers need to coordinate and further discuss the suggestion obtained from the observers after the learning process. Therefore, a problem solution is found in a common perception in order to improve future learning. Further research in the form of improving critical and creative thinking skills is needed.

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THE EFFECTIVENESS USING INQUIRY BASED NATURAL SCIENCE MODULE WITH AUTHENTIC ASSESSMENT TO IMPROVE THE CRITICAL THINKING AND INQUIRY SKILLS OF JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

The aim of this research is to investigate the effectiveness of inquiry-based science modul with authentic assessment to develop students' inquiry skills and critical thinking. This research employed a quasi experiment method with pretest-posttest control group design. This research is conducted on 7th grade of one of Junior High School in Pontianak, by using 2 classes as a sample. The data was collected by using inquiry skills observation sheets, critical thinking test, and interview. The result shows that the mean of inquiry skills and critical thinking scores of experiment group is higher than the control group, and the significance score from using t-test is $(0.00) < 0.05$, which means there is a difference of inquiry skills in the experiment and control group. Score of N-gain shows that the mean of experiment group's inquiry skills and critical thinking score after the treatment, is higher than control group. It concludes that science learning by using inquiry-based modul with authentic assessment is effective to develop students' inquiry skills and critical thinking.

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Keywords: authentic assessment, critical thinking, inquiry, inquiry skills, science modul

INTRODUCTION

Students' involvement in the activities under investigation (inquiry) in order to find a concept is considered primary in science learning. This is important as, in science, learning prioritizes skills development and process.

Science learning and inquiry cannot be separated referring to the 2013 curriculum that emphasizes on direct experience in order to develop students' competencies. Thus, students are able to understand the nature around them scientifically and to have the skills of inquiry and critical thinking. There are several findings as the result of the preliminary study of the learning

process in Pontianak Junior High School: 1) teaching and learning process is centered on the teacher, so that students would potentially not develop; 2) most of the time, students only listen and record what is described by the teacher. The learning activities tend to be dominated by rote and verbal submission to master knowledge, therefore, it does not develop students' critical thinking skills and scientific work; 3) the assessment of teachers is still limited to paper and pencil test, while the students' aspects of skills and attitudes tend to be neglected; and 4) the science practicum is still rarely performed.

One of the learning strategies that develop curiosity and scientific thinking of students is inquiry learning. Inquiry learning is a method that refers to the students' activities that develop knowledge (Oguz-Unver & Arabacioglu, 2011).

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This learning method can help students develop critical thinking skills and construct knowledge as if they are real scientists (Corlu & Corlu, 2012).

Kuhlthau & Todd (2007) stated that in the inquiry strategy, knowledge can be built by the students, so that they are able to carry out independent learning in science-related issues. Guided inquiry learning model is ideal for science subjects, and some studies have shown that this method is effective to improve student learning outcomes (Abdi, 2014).

Experts' opinions above reflect that the inquiry learning objective is to develop the thinking skills of students logically, critically and systematically through inquiry regarding science facts, concepts, and principles. Through inquiry, the critical thinking of students can be developed. Bassham, et al. (2011) suggests that critical thinking skills are the cognitive skills required to effectively identify, analyze, evaluate arguments or claims what is true, locate and resolve allegations that are subjective, formulate and present the right reason and support the logical conclusion, as well as make decisions about what is to believe and what will be done. Critical thinking skills are also influential for students' academic and professional success in the future (Quitadamo, et al., 2008)

In the inquiry-based science learning, students' performance in every inquiry activity is being assessed. For example, during practicum, teachers can assess the process as well as the product when students conduct group discussions, collect data, answer questions or problems in the handout, conclude solutions, make hypotheses, design experiments, take measurements, etc. Thus, the achievement of students in cognitive, affective, and psychomotor can be known quickly and continuously with various types of assessment, making it easier for teachers to provide feedback. Assessment that involves all three aspects are authentic assessment.

The reality in the science learning in Pontianak Junior High School shows that many teachers use the teaching and learning method that is centered on the teacher (traditional). This is because the teachers consider the inquiry strategy difficult to attempt (Wilke & Strait, 2002). According to Rustaman (2005), one of the constraints of the implementation of inquiry learning is the limited teaching materials or learning resources. The observations in Pontianak Junior High School show that the inquiry model is rarely practiced because of the lacked supports especially the facilitation for the inquiry activities. Also, teachers are less skilled in applying inquiry learning strategy. During the science teaching, teachers of-

ten dominate. It is thus necessary to use a new student teaching method, such as inquiry-based science modules. Using inquiry-based modules can help the students to determine the steps of science investigation individually, so that they can develop inquiry skills. Accordingly, this research is to answer the question about the effectiveness of the implementation of inquiry-based science modules with authentic assessment for junior high school students in improving the skills of inquiry and critical thinking of students.

METHOD

This study aims to determine the effectiveness of the use of inquiry-based science modules with authentic assessment. The study used a quasi-experimental research method and the object was the students of Pontianak Junior High School with the material of food additives. The research design was pretest-posttest control group design (Gall, et al., 2003), with its design as follows:

	<i>Pretest</i>	<i>Treatment</i>	<i>Posttest</i>
Experimental Class	O ₁	X	O ₂
Control Class	O ₁		O ₂

Information:

O₁: *Pretest* Implementation

O₂: *Posttest* Implementation

X: *Treatment*

In this study, the pretest was given to the experimental and control class. Then, the posttest was practiced to the experimental students after they learn about food additives using inquiry-based module with authentic assessment, meanwhile the control class was given the conventional learning method.

The population in the study were all of the VII-grade students of 11 Pontianak Junior High School that amounted to 7 classes. The sampling technique was cluster random sampling, as the homogeneity test results the average score of students' science daily test is homogeneous. The VIIA class was selected as the experimental group and VIID class as the control group.

The primary variable of this study is the independent and dependent variable. The independent variable is the learning science using inquiry-based module with authentic assessment in the experimental group, and the learning science conventionally uses discussions in the control group. The dependent variable in this study are

the skills of inquiry and critical thinking.

The data collection technique used is data collection tool measurement with the critical thinking & skills tests and observation sheet. Observation sheet is used to measure the skills of inquiry during the learning inquiry-based. The inquiry skills include making observations, asking questions, drawing up hypotheses, and communicating. The complete aspects and indicators of inquiry skills can be seen in Table 1.

The test of critical thinking skill was arranged referring to the indicators of critical thinking skill, which is by formulating answers about cases relating to food additives, assessing arguments relating to food additives, identifying the relevance and non-relevance on food additives, finding similarities and differences, and making decisions about the negative effects and misuse of food additives. Aspects of critical thinking skill can be seen in Table 2.

Interview implementation referred to the data analysis results of observation, with the aim to support the test result data of critical thinking skills and inquiry skills observation results. Data analysis was performed by grouping the research data based on the indicators on each aspect inquiry skill and critical thinking. The average score of students in every aspect was determined by the sum of the scores for each skill aspect, then by the division of number of students. Furthermore, an assessment with hypothesis test using SPSS at the 5% significance level was applied to determine whether there was a difference of critical thinking skills and inquiry among students who applied inquiry-based science module and conventional learning.

The effectiveness in this study can be

seen in the students' improved skills of inquiry and critical thinking before and after the learning module with inquiry-based food additives with authentic assessment, calculated using the equation normalized gain (Meltzer, 2002), namely:

Normalized gain criteria (g)
 $g < 0,3$: low
 $0,3 \leq g \leq 0,7$: middle
 $0,7 \leq g$: high

The data obtained from the test of critical thinking skills and inquiry skills of observation sheet would be applied with normality test of data distribution using the Shapiro-Wilk statistic, as the sample was < 50 . If the test results indicate the the data distribution was normal, then the homogeneity test would be attempted to see diversified data using Levene's Test of Equality of Error Variance. To answer a hypothetical problem, AsympSig paired t test (two-tailed) was used.

RESULTS AND DISCUSSION

Based on the research data collection, the data of inquiry in the experimental and control class is shown in Figure 1.

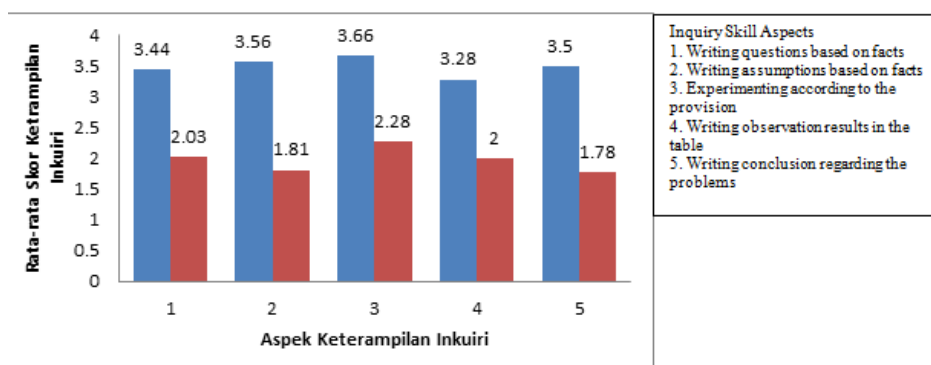
Figure 1 above shows that the average skills of inquiry in the experimental class is higher than the control class for all inquiry aspects (writing down the observations results in detail, the questions based on the data, the provisional assumptions based on facts, the observations results in the table, and the conclusion according to the problems). Thus, it can be seen that the inquiry-based science learning on food additives improves the

Table 1. Aspects and Indicators of Inquiry Skills

Inquiry Skills Aspects	Indicators
Asking questions	Writing questions based on data
Compiling hypothesis	Writing temporary assumptions based on the fact
Experimenting	Experimenting according to the provision
Communicating	Writing experiment results on the table Writing conclusion regarding the problems

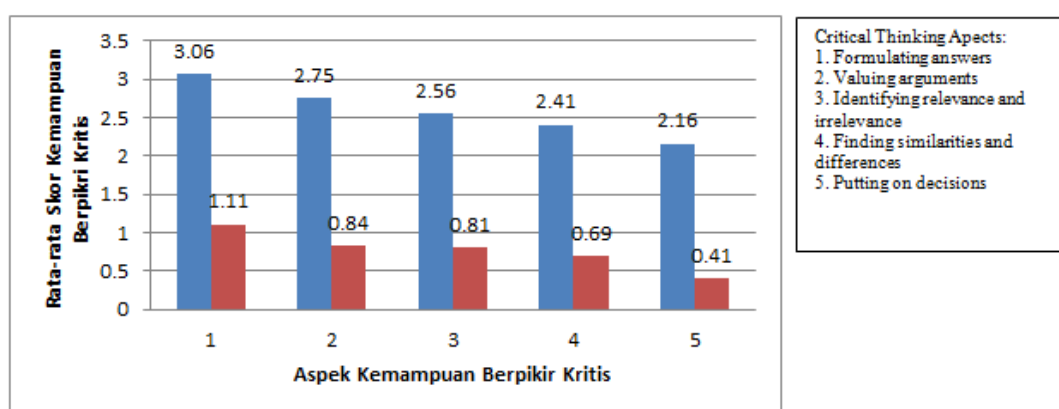
Tabel 2. Critical Thinking Skill

Aspect	Critical Thinking Indicator
Giving simple explanation	Formulating answers regarding food additives cases Valuing arguments regarding food additives
Building Basic Skills	Identifying the relevance and the irrelevance of food additives Finding the similarities and differences of food additives
Making Decision	Deciding the negative impacts of the misapplication of food additives



Information: Blue = Experimental, Red = Control

Figure 1. Inquiry skills of the experimental and control class



Information: Blue = Experimental, Red = Control

Figure 2. Critical thinking skills of the experimental and control class

skills of inquiry. Analysis of the test data of students' critical thinking skills in experimental and control class obtained on Figure 2:

Figure 2 shows that the average critical thinking skills of students in the experimental class was higher than the control class for all aspects of critical thinking. Thus, the use of inquiry-based science modules with authentic assessment was considered effective to improve students' critical thinking skills.

Research hypothesis test was conducted after the test requirements, which is the normality test on all inquiry and critical thinking skills data. The test results of normality with the Shapiro-Wilk test was obtained as follows:

Price Sig. > 0.05, meaning that data is otherwise normal. As all the data is normally distributed, then the homogeneity test was conducted, which results as follows:

	Critical Think- ing	Inquiry
Levene Sta- tistic	Sig.	
Based on Mean	.420	.065

Sig price obtained. > 0.05 for all data, meaning the data is expressed homogeneous. All meets the requirements, followed by a test of the hypothesis. Hypothesis test results used paired t-test sig price. (0.00) is less than 0.05, then Ho is rejected, which means that there is a difference between students' inquiry skills that used inquiry-based science modules with authentic assessment and conventional learning. Thus, the use of inquiry-based additives module with authentic assessment affects the students' inquiry skills. Similarly, the results of hypothesis testing on the data of critical thinking skills, the sig. (0.00) price

Class	Inquiry Skill		Critical Thinking Skill			
	Shapiro-Wilk					
	Statistic	Df	Sig.	Statistic	Df	Sig.
Control	.940	32	0.076	.943	32	.089
Experiment	.945	32	0.107	.939	32	.069

obtained is less than 0.05, meaning that there are differences in critical thinking skills among students who applied inquiry-based science modules with authentic assessment and conventional learning.

Based on the calculation of N-gain score, an average N-Score of inquiry skills is obtained for inquiry skills in the control class with 0,25 in the low category, and in the experimental class with 0,70 in the middle category. Meanwhile, the N-gain score of critical thinking skills in the control class is 0,14 in the low category and in the experimental class with 0,57 in the middle category. It can be concluded that the inquiry-based learning science module with authentic assessment is effective (the middle category) in order to improve the students' skills of inquiry and critical thinking. It shows that learning to use inquiry-based science modules with authentic assessment is effectively used in learning activities.

Based on the results of the research hypothesis test, it is concluded that there are differences in the skills of inquiry and critical thinking among students who applied inquiry-based science modules and conventional learning. Therefore, inquiry-based science modules with authentic assessment affect the inquiry and critical thinking skills of junior high school students.

The experimental group has average skills of inquiry and critical thinking which is better than the control class, therefore, it can be said that the learning module using science-based inquiry learning with authentic assessment is effective to increase inquiry and critical thinking skills of students. This is in line with the results of the research by Neuby (2010) on inquiry that the initial knowledge and student involvement in learning is increased. Furthermore, the results of the research by Remziye (2011) concluded that the science process skills and scientific attitudes of students increased in inquiry-based learning. This is also in line with Wenning (2011) who concluded, the inquiry can improve scientific literacy of students and has a better learning value. Further Sochibin, et al., (2009) found that the understanding of the concepts and critical thinking skills increase.

The high average score of inquiry skills in the experimental class compared to the control

class is due to the inquiry-based science modules with authentic assessment. This module greatly assisted students in finding concepts independently. In addition, students also felt motivated in learning because of the activities students had to do. The involvement of students in learning can be very high, too. Hmelo, et al., (2006) stated, inquiry as an activity which also includes many activities that students have to do, such as making observations, making questions, reading the source books and other sources of information, planning investigation, reviewing what is already known for obtaining evidence in experiments, analyzing and interpreting data, finding answers, explaining and predicting. The activities of inquiry students have to do can create better understanding and positive attitude in learning (Kubicek, 2005)

During the teaching and learning that used inquiry-based science modules with authentic assessment, students enthusiastically participated in learning activities at every stage of the proceedings. The curiosity of students was clearly visible at the time of the practicum. Students got curious and excited to see the results of the investigation of food ingredients that they consume daily. The results of these activities can train students in considering the option of daily food intake. This is important, because when students face problems in life, which requires them to take important decisions, the students already have a stock of how to take the right decisions (Patricia & Ganaden, 2008).

The module assist students in achieving the learning objectives at every stage of the inquiry through questions in order to guide students in finding answers to problems. In the experimental class students, the use of tools and materials was in accordance with the student practicum work procedures. The observations also show that the experimental class students perform accurately, carefully and seriously. In practical activities, the experiment results that students obtained was written meticulously organized and tidy in the report book. Meanwhile, in the control class, the experimental results were less complete and less organized. Results of the analysis of observational data showed, students in the experimental class are more skilled in the classroom than the

control class. Thus, the experimental class students have a better psychomotor abilities.

Modules can be studied by students independently (Prastowo, 2011). Pummawan research results (2007) regarding the effectiveness of the module development concluded that the module can develop students' cognitive abilities. Therefore, the inquiry-based module is considered a teaching material that is systematically arranged by following the steps of inquiry and equipped with authentic assessment, which is to help students achieve learning goals. The use of inquiry-based learning modules in the experimental class greatly assist students in inquiry activities. Module-based inquiry can guide students in conducting investigations based on the stage in the inquiry learning.

Inquiry strategy provides an opportunity for students to be active in the working groups (Rigeway & Padilla, 1998). This is in accordance with the opinion of Harlen (2014) that during inquiry learning, students play an active role to develop understanding in finding ways to resolve the problem. Thus, the critical thinking skills, the communication, and the ability to work independently can be developed in a collaborative inquiry-based learning.

According to the aspect of the inquiry skill, observing is the highest acquisition of the score both in the experimental class and the control class (indicator: writing down observation results in detail). On the indicator to make observations, students' direct observation is to find information. Interview with chemistry teachers obtained information that during this time in chemistry learning, students are used to the lab and creating an individual report after practical completion. Thus, students are used to creating and reporting the results of the practicum.

Observational data on both class show that actually most students had followed the procedure when they are experimenting in the lab, however many students in the control class had not yet done their Student Worksheet rightly and completely. More in-depth interviews obtained information that the students did not complete filling because the time was already over. They also thought that the teachers would not grade their work on the Student Worksheet. Interview with the science teachers obtained information that the student worksheets so far were only being collected, without being given any feedback. This is different with what of in the experimental class. Each student was given inquiry-based modules. In addition, authentic assessments were also provided in the modules, so that students could

gauge their own understanding and skills as accompanied guide / assessment rubric was already available. Azim and Khan (2012) concluded that authentic assessment can develop high-level skills, such as: developing questions, interviews, collect data or information, analyze information, presentation, and communication.

Inquiry skills on conclusion writing in accordance with the problems of the control class obtained the smallest average score compared to other aspects, both in the control class itself and the experimental class. According to observation and interviews, it can be concluded that the data written in student worksheet was incomplete. This might be the reason of why students were less interested in filling the questions in the worksheet. Consequently, when asked to make inquiries based on existing data, the students could not do it. When they were asked to make a hypothesis, they did many erroneous, too. Therefore, inquiry was highly recommended to practice analytical thinking skills and student learning satisfaction (Nuangchalerm & Thammasena, 2008).

The module assist students in achieving the learning objectives at every stage of the inquiry through questions in order to guide students in finding answers to problems. In the experimental class students, the use of tools and materials was in accordance with the student practicum work procedures. The observations also show that the experimental class students perform accurately, carefully and seriously. In practical activities, the experiment results that students obtained was written meticulously organized and tidy in the report book. Meanwhile, in the control class, the experimental results were less complete and less organized. Results of the analysis of observational data showed, students in the experimental class are more skilled in the classroom than the control class. Thus, the experimental class students have a better psychomotor abilities.

CONCLUSION

The results of the calculation of the N-gain score indicates that inquiry and critical thinking skills of the students in experimental class is higher than the control class. Therefore, inquiry-based science modules with authentic assessment on food additives is effective to improve the skills of inquiry and critical thinking of students. The results of this study can be used by teachers to improve the skills of inquiry and critical thinking of the junior high school students in learning science.

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THE EFFECT OF 5E LEARNING CYCLE INSTRUCTIONAL MODEL USING SOCIOSCIENTIFIC ISSUES (SSI) LEARNING CONTEXT ON STUDENTS' CRITICAL THINKING

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ABSTRACT

The aim of this study was to investigate the effect of 5E learning cycle instructional model using socioscientific issues (SSI) learning context on students' critical thinking skills of acid-base. This study used quasi-experimental posttest only control group design. The sample consisted of three classes, which were XI MIA-4 class ($n = 32$) that learned using 5E LC model, XI MIA-5 class ($n = 33$) that learned using 5E LC+SSI, and XI MIA-6 class ($n = 32$) that learned using conventional method. The samples were chosen by convenience sampling technique. The test instrument consisted of 15 multiple choice items which were valid and reliable ($r = 0.806$). The data were analyzed using one way ANOVA test and LSD posthoc test. The results of this study indicated that the students who learned using 5E LC+SSI model showed greater levels of critical thinking skills ($\bar{x} = 74,95$) than both the student who learned using 5E LC model ($\bar{x} = 74,17$) and the student who learned using conventional method ($\bar{x} = 68,96$). Based on statistics analysis, there was significant differences on students' critical thinkings between students taught using conventional method and students taught either using 5E LC+SSI model and 5E LC model. However, there was no significant differences on students' critical thinking skills between students taught using 5E LC+SSI model and the students taught using 5E LC model.

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Keywords: socioscientific issues, 5E learning cycle model, critical thinking skills, acid base concept

INTRODUCTION

Critical thinking has been a very popular term in education world these few years (Fisher, 2007). Developing critical thinking skill is one of the main point in education (Lubezki *et al.*, 2004), including in science education (Bailin, 2002; Akarsu *et al.*, 2013). Norris (1985) in (Klimoviene *et al.*, 2006) defined critical thinking as a rational decision towards something believable or unbelievable. Ennis (2011) stated that critical thinking is reflective and logical thinking that fo-

cused on decision that has to be believed or done. This way, critical thinking is a thinking skill that someone used to create a logical decision.

Critical thinking is an important thinking skill to be developed. This is because critical thinking not only act in student's success in educational part but also in their work, either in social or interpersonal context (Birjandi & Bagherkazemi, 2010). Besides, Facione (2011) contended that critical thinking skill acted to train someone in taking a wise decision that can fix their own future so they can contribute in their social life indirectly, not to be a burden in their society. This is strengthened with Pithers & Soden (2000) who

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stated that critical thinking skill become an important skill to be owned by the students as an effort to answer the challenge from the government and businessmen who need a smart-thinker fresh graduate so they can face the globalization with economic competition that grow endlessly.

Most of the teachers think that thinking skill, including critical thinking skill, can be taught indirectly through a learning that emphasize in content and information. But, the effectivity of teaching thinking skill this way in a long term is doubted because most of the students didn't understand the critical thinking meant (Fisher, 2007). This is supported by the fact in the field which showed that many learnings still conditioning their students in rote learning (Rendhana & Liliyasi, 2008). In this kind of learning, the students usually just absorb the information given by their teacher to be remembered again while doing their test, so the learning become less effective and won't give any chances for students to elaborate their critical thinking at all.

Critical thinking skill is a skill that can be trained (Bailin, 2002). The effort to train critical thinking skill is by implementing a learning model that centered in the students, especially learning model that related to intellectual development like learning cycle. The phases in learning cycle model experiencing many development, one of them is learning cycle 5E(LC 5E) developed by Bybee *et al.* (2006). The phases that included in LC 5E are engagement, exploration, explanation, elaboration, dan evaluation. Some research showed that LC 5E model can increase student's critical thinking skill (Budprom *et al.*, 2010; Sulistyowati *et al.*, 2014).

Chemistry is unpopular and irrelevant subject in student's vision because chemical learning usually just emphasizing in concept mastery without showing the relation between the concept that they learn with their daily life. (Hoolbrok, 2005). This caused the student's low interest and motivation in learning chemistry. The effort that can be done toward this problem is by relating chemical concept with daily life concept, one of the way is by using socioscientific issues (SSI) learning context. This is in step with Sadler & Zeidler (2005) that stated that SSI learning context makes science learning become more relevant to student's life.

Socioscientific issues (SSI) is a problem that related to social issues that happened in society that cover concept and technology and their relation to science (Sadler, 2004). SSI is a mix between social issues that involved moral component and ethic and the revelation with science

(Callahan, 2009). Thus, SSI is a problem that related to social issues and connected to science and involving moral component and ethic. The issues provided in SSI is controversial issues like global climate change, genetic engineering, alternative energy, research about cell stem, and the others that demanded the attention of the society, not only scientists in specific expertise (Fowler *et al.*, 2009).

The implementation of SSI in science education can push the students to be involved in a dialog, discussion, and debate actively that can provide challenges to the students to evaluate their knowledge and give a chance to rebuild their concept mastery related to the concept that they learned from their own experiences and social phenomena. Besides, the implementation of SSI in science learning will ease the achievement of science education's aim towards the effort of increasing high level thinking ability, discussion skill, scientific argumentation, inquiry learning, and science facts understanding (Nuangchalerm, 2010). Roberto & Bernando (2012) revealed that implementation of SSI in science education can help the students to develop their critical thinking skill by a discussion about controversial topic and social-science. This opinion is supported by the result of Burek's research (2012) that showed the implementation of SSI in education can increase the critical thinking skill.

One of the chemistry material that appropriate to be taught with SSI is acid-base. In acid-base material, there are some issues that included to SSI, one of them is acid rain. rain water is basically acid, but the acidity can increase as the air pollutant level increase (Dubey, 2013). Pollutant which can come from waste gas like sulfur dioxide and nitrogen oxide mostly caused by human activity in industrial activity, power plant and vehicles. Acid rain has negative effect toward the environment, like destroying water animal, destroying plants, causing peeled paint and causing steel corrosion in buildings, bridges, and stone statues.

According the commentary above, we know that LC 5E instructional model using SSI learning context hypothetically can increase student's critical thinking skill. Thus, if learning cycle 5E instructional model is using socioscientific issues (LC 5E+SSI) context is planned, we hope that student's critical thinking skill can be developed. The aim of this research is to know the effect of learning cycle 5E instructional model using socioscientific issues (LC 5E+SSI) learning context towards student's critical thinking skill in acid-base material.

METHOD

The research was conducted in one of the senior high school in Malang on second semester in school year of 2015/2016. This research using quasi-experimental posttest only control group design. The design of this research is shown in Table 1.

Table 1. Research Design

Group	Treatment	Posttest
Class Experiment I	X ₁	O
Class Experiment II	X ₂	O
Control Class	-	O

(Creswell Adaptation, 2012)

Information:

O: observation (measurement)

X₁: learning using LC 5E+SSI model

X₂: learning using LC 5E model

Sampling used in this research is using convenience sampling technique. Classes that used in this research are XI IPA 4 ($n = 32$) as Experiment Class II that was taught by using LC 5E instructional model, class XI IPA 5 ($n = 33$) as Experiment Class I that was taught by using LC 5E+SSI instructional model and class XI IPA 6 ($n = 32$) as control class that was taught by using conventional method.

The research instruments consist of treatment instruments and measurement instrument. Treatment instruments consist of syllabus, lesson plan, student's activity sheet and discussion observing sheet. Measurement instrument is critical thinking skill test that consists of 15 multiple choices item. Expert's validation result stated that the instruments are valid. The next measurement instrument was tested to know the validity value of the items and the test reliability. According to the result, 15 critical thinking test items are valid and reliable ($r = 0,806$). The learning observation activity was done by three researchers. Critical thinking skill data that has been obtained from the research were analyzed statistically using one way ANOVA with posthoc test using LSD, while the data about learning activity were qualitatively

analyzed with percentage.

RESULT AND DISCUSSION

Hypothesis test statistically needs normality and data homogeneity to know whether the statistic method that used is parametric statistic or nonparametric statistic. Thus, before the hypothesis test was done, the researcher must do the precondition test that consist of normality test and homogeneity test.

Critical Thinking Data's Normality Test

The result of experiment and control class student's critical thinking skill data normality test can be seen in Table 2.

Hypothesis Test

According to the result of precondition analysis test in Table 2 we know that experiment class and control class student's critical thinking skill data distributed normally and homogenically. Thus, hypothesis test was done with statistic parametric method which was one way ANOVA. Hypothesis that submitted:

H₀: There is no difference in student's critical thinking skill that have been taught by using LC 5E+SSI instructional model, LC 5E instructional model, and conventional model in the main material of acid-base.

H₁: there is a difference in student's critical thinking skill that have been taught by using LC 5E+SSI instructional model, LC 5E instructional model, and conventional model in the main material of acid-base.

The result of one way ANOVA test toward student's critical thinking skill point in experiment and control class can be seen in Table 3.

Posthoc test Using LSD

Posthoc test using LSD towards student's critical thinking skill point in experiment and control class can be seen in Table 4.

The Percentage of Right Answer in Critical Thinking Skill Test

The Percentage of Right Answer in Criti-

Table 2. The Result of Critical Thinking Skill's Normality Test and Data Homogeneity

Class	Kolmogorof-Smirnov Test	Conclusion	Variable	Levene Test	Conclusion
	Signification Value			Signification Value	
Control	0,131	Normal	Critical Thinking Skill	0,168	Homogen
Experiment I	0,334	Normal			
Experiment II	0,189	Normal			

Table 3. The Result of one way ANOVA Test Critical Thinking Skill

Variable	Rata-Rata			one way ANOVA Significant Value	Conclusion
	Control	Experiment 1	Experiment 2		
Critical Thinking Skill	68,96	74,95	74,17	0,038	Thereis a difference in student's critical thinking skill

Table 4. Posthoc test Using LSD Critical Thinking Skill

Class	LSD Test			Conclusion
	Significant Value			
	Control	Experiment 1	Experiment 2	
Control	0,018			There is a difference in student's critical thinking skill
Experiment I	0,754			There is no difference in student's critical thinking skill
Experiment II	0,041			There is a difference in student's critical thinking skill

Table 5. The Percentage of Right Answer in Critical Thinking Skill Test

Critical Thinking Indicator	Item Number	Right Answer (%)		
		Control	Experiment I	Experiment II
Doing induction	1, 2, 3	82,29	83,84	83,33
Doing deduction	4, 5, 6, 7	71,09	71,97	71,88
Interact with others	8, 9, 10	72,92	81,82	81,25
Doing evaluation	11, 12	37,50	39,39	39,06
Identify assumption	13, 14, 15	69,79	86,87	84,38

Table 6. Persentase Aktivitas Diskusi

Activity	Discusion Activity (%)	
	Experiment I	Experiment II
The seriousness in following the subject	73,74	73,61
The student's activeness in gathering information	71,38	70,83
The activeness in giving idea and problem solving solution	72,05	70,49
The activeness in asking and answering question	73,40	72,57
The ability to give an opinion	72,05	71,53
Communication ability	74,07	70,14

cal Thinking Skill Test in experiment I, experiment II, and control class can be seen in Table 5.

The Percentage of Discussion Activity

In this research, observation towards student's activity only done in elaboration phase. The percentage of discussion activity in experiment I and experiment II class can be seen in Table 6.

The acid-base learning have been done in

eight meetings. The 1st to 7th were done to deliver the material, while the 8th was to do the test. The lesson in experiment class, either in experiment I or II, were done in groups consist of 4-5 persons. The order of the material in experiment class is acid-base characteristic, acid-base theory, acid-base power, acid-base pH indicator, concept and pH calculation, acid-base indicator and neutralize reaction. In experiment class, the first meeting was began with internship. The internship

procedure in experiment class was conducted by the students with the help of the teacher. The students were asked to discuss to create a procedure that appropriate with the aim of the internship, the problems and equipments and ingredients that have been served. This inquiry-based internship can led the students to build their concept independently. This is supported by Parappilly *et al.* (2013) that stated that inquiry-based internship is fit to constructivistic theory that aimed for students can build concept.

The learning in experiment class I (LC 5E+SSI) were done with LC 5E instructional model. In engagement phase, the teacher served daily life fact that related to the concept that will be leaned to gain the student's interest and motivation. In exploration phase, the students were asked to discuss the student activity sheet that has been served in groups. The students were allowed to explore their literature. In exploration phase, the teacher only acted as facilitator and gave help to student who faced difficulties in group discussion. The helps that provided are guide questions that will help students to build their own concept independently. In explanation phase, the teacher asked the student's representative to present the result of their group discussion and asked the other groups to give responses toward the presentation of serving group. In this discussion, the teacher assessed how far the student's understanding towards the material learned. Besides, the teacher also gave strengthening in the concept by doing question and answer to the students so the students can understand the concept that they just learned in that meeting. In elaboration phase, the students were asked to read article consists socioscientific issues in the activity sheet then discuss the critical thinking questions that related to the socioscientific issue. The critical thinking questions were arranged based on the critical thinking indicator developed by Ennis (2011). There are 12 indicators that have been developed, but in this research the researcher only used five indicators. Those indicators were selected based on the appropriation to the socioscientific issues served. Those indicators are (1) doing induction; (2) doing deduction; (3) interact with others; (4) doing evaluation; and (5) identifying assumption. Next, the teacher asked group representative to present their answer and asked the other groups to give responses. After that, the teacher gave feedback towards the discussion. Evaluation phase was done in the process by making small notes to rate the ability of each group in understanding the material. SSI discussion wasn't done in every meeting, but only in 1st, 4th, and 7th meeting.

SSI provided in 1st meeting was about carbonated beverages and the dangers, in 4th meeting was about pollution caused by tofu industrial waste, and in 7th meeting was about acid rain and acid ground caused by fertilizer.

The same with the learning in experiment class I, the learning in experiment class II (LC 5E) also done with LC 5E instructional model. The difference between those two classes lies in elaboration phase in the 1st, 4th and 7th meeting. In 1st meeting's elaboration phase, the students were asked to do an internship to know the character of acid-base solution in our daily life. In 4th meeting's elaboration phase, the students were asked to do an internship to know the solution's pH value in the daily life, while in 7th meeting's elaboration phase, the students were asked to do the exercises that related to neutralization.

Learning in control class was done by conventional model. Conventional model is a learning method that usually used by the teacher. The arrangement of the control class's materials are acid-base theory, acid-base characteristic, acid-base power, concept and pH calculation, pH of acid-base solution, acid-base indicator and neutralize reaction. In class learning, material delivery was done by speech method that continued by doing exercises. In laboratory learning, internship was done to prove the concept with the internship steps that provided by the teacher.

Based on the posthoc test using LSD in Table 5, we know that there is a difference in student's critical thinking skill that has been taught with conventional method and LC 5E instructional model. Student's critical thinking skill that has been taught with LC 5E instructional model is better than those who taught with conventional method. This find is strengthening the previous studies that stated LC 5E instructional model can increase student's critical thinking skill (Budprom *et al.*, 2010; Sulistyowati *et al.*, 2014). It is because the common conventional method that used by the teacher only done in one way so this will not give any chance to the students to train their thinking skill, including critical thinking skill. This kind of learning usually still emphasize in low level thinking skill. This is supported by Bassham *et al.* (2010) that stated school learning generally still emphasize low level thinking skill where students only received the material passively then remembered it when they are doing their test. Besides, Hastuti *et al.* (2013) also stated that school learning generally still emphasize in product achievement in cognitive form without noticing the process, character and thinking skill.

LC 5E instructional model is an inquiry-

based learning model (Turkmen, 2006). LC 5E instructional model consists of phases that allowed the students to act actively in the learning process. In learning process, the students are challenged to solve the problems related to concept in their activity sheet by group discussion. It is different from conventional method, learning by using LC 5E instructional model will make the students actively involved to build their concept independently with the help of the teacher. Besides, LC instructional model, including LC 5E, was developed based on the Piaget's intellectual development theory like assimilation, accommodation and organization that fit with exploration, explanation and expansion phase that give a chance to the students to train their intellectual system so they can increase their critical thinking skill (Budprom *et al.*, 2010).

Table 5 also shows that there is still a difference in student's critical thinking skill that taught by using conventional method and LC 5E+SSI instructional model. The student's critical thinking skill that taught by using LC 5E+SSI instructional model is better than those who taught by using conventional method. According to Dawson (2015), SSI implementation in the learning process makes the learning process become deeper and meaningful compared to conventional method. It is because the students are more involved in the learning process and the students will also know the concept relevance that they learn and the relation in life. Besides, SSI also combine the scientific concept with challenging problems so it become an effective way to involve the students in discussion that will affect student's ability in decision making and critical thinking (Christenson *et al.*, 2014). Furthermore, Burek (2012) stated that moral dilemma presentation and ethic in SSI potentially make the students use their critical thinking skill so they can analyze and synthesize scientific information that they need to strengthening their opinion related to socioscientific issue that they face. Thus, the student's critical thinking skill will improve.

Table 5 shows that there is a difference in student's critical thinking skill that taught by using LC 5E and LC 5E+SSI instructional model. It is caused by some factors, which are:

Discussion in SSI working less optimal. This was caused by the student's study pattern that centered in the teacher so the students are not used in the learning system that involved them actively in discussion and debate.

Five critical thinking indicators that become the references to develop the critical thinking test item are common and frequently used

indicator in learning process. Critical thinking test items that have been developed are not so vary because only referenced to five critical thinking indicators.

But, if we see from the average of the test result in Table 3, the average value of the students that taught by using LC 5E+SSI instructional model is higher than the average critical thinking value of the those who were taught by using LC 5E. Besides, the student's right answer percentage in each critical thinking indicator that has been shown in Table 5 shows that the right answer percentage of the students who were taught by using LC 5E+SSI instructional model is higher than those who were taught by using LC 5E instructional model.

Moreover, if we see from the observation result of the students that shown in Table 7, we know that the student's activity is higher in those who were taught by using LC 5E+SSI than those who were taught by using LC 5E. This fits to Zeidler & Nichols (2009) who stated that student's involvement in a discussion about socioscientific issues will push the students to be active in dialogs, discussions and debates. Debates functioned to increase the understanding of the socioscientific issues and push the students to develop their critical thinking skill as a way to make a better decision (Siribunnam *et al.*, 2014).

CONCLUSION

Based on the result of the research, we can conclude that LC+SSI instructional model affect the student's critical thinking skill in acid-base material. The student's critical thinking skill can be taught by using LC 5-SSI instructional model ($\bar{x} = 74,95$) which is higher than LC 5E instructional model ($\bar{x} = 74,17$) or the conventional method ($\bar{x} = 68,96$). The result of the statistic analysis shows that there is no significant difference in the critical thinking skill between those who were taught by using LC 5E+SSI instructional model and LC 5E model. It is caused by some factors, which are: (1) Discussion in SSI working less optimal. This was caused by the student's study pattern that centered in the teacher so the students are not used in the learning system that involved them actively in discussion and debate. (2) Five critical thinking indicators that become the references to develop the critical thinking test item are common and frequently used indicator in learning process. (3) Critical thinking test items that have been developed are not so vary because

se only referenced to five critical thinking indicators. But, some finds make it clearer that LC 5E+SSI instructional model give a better result than LC 5E model as seen from the average value, student's right answer percentage in each critical thinking indicators and student's discussion activity percentage. Thus, we can conclude that LC 5E+SSI instructional model gives a better effect toward critical thinking skill.

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THE DEVELOPMENT OF THEMATIC-INTEGRATED E-PORTFOLIO MEDIA WEB BLOG BASED TO INCREASE THE SCIENTIFIC LITERACY OF ELEMENTARY TEACHER EDUCATION PROGRAM'S STUDENT

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ABSTRACT

The aim of this study is to improve the scientific literacy of Elementary Teacher Education Program's students using a valid thematic-integrated e-portfolio media web blog based. Applied research and development methods for elementary school's course planning by applying thematic-integrated e-portfolio media web blog based. The result of media and evaluation experts recommend that e-portfolio which has been developed gets 98.75% of eligibility percentage which means that it is very decent to be used in the lecturing. Thematic-Integrated e-portfolio media web blog based effectively improves the scientific literacy of students to reach multidimensional level, in which students are able to take advantage of various concepts and demonstrate the ability to connect these concepts to daily life. Students understand how science, society and technology are interrelated and influence each other. Students also demonstrate an understanding of the nature of science through his answer.

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Keywords: E-Portfolio, thematic-integrated, scientific literacy, student of elementary teacher education program

INTRODUCTION

The society life that has developed along with the development of science and information technology forces people to be more critical and creative in order to successfully adapt to every aspect of life. Education is one of the aspects of life that determine the up and down of a society in the world where everything becomes very competitive. Therefore, education progress is supposed to evolve people to be people who totally comprehend science and technology (scientific and technology literacy) to shape people with characteristic. Education is also expected to be a bridge which connect individual to his environment in the fast developing globalization era, therefore individual is able to participate as qualified human

resources.

According to comparative study that had been done by PISA (Program for International Student Assessment) in 2006, it was acquired that scientific literacy ability of Indonesian students was on the rank 50 from 57 total countries. This study was acquired by: (a) comparing literacy of reading, math, and science of students from every country; and (b) understanding the strength and weakness of every country's education system.

Research of Sujana et al. (2014) showed that scientific literacy of Elementary Teacher Education Program's students and Elementary teachers are far from expectation. This situation may negatively influence the learning process of science at elementary school if it is left unchecked. The effort to increase the scientific literacy of Elementary Teacher Education Program's students needs a more serious attention because they will apply science concepts especially to elementary

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school's students

Learning science needs comprehensive media and assessment to evaluate the overall skill of the students. The assessment that can be developed is authentic portfolio assessment. Setyan-dari et al. (2012) stated that assessment portfolio media is effective to be used to increase activity, learning mastery, skill and students' interest in learning science. According to Nugiyantoro (2008), authentic assessment system concerned on evaluating process and learning outcomes, therefore all the performance of the students in the learning process can be evaluated objectively and not only evaluate the final result. Wahyudi (2008) stated that alternative portfolio assessment is a continuing process. This assessment system can be used to observe the process of students' skill.

The implementation of portfolio assessment in teaching in college had been done by several researchers (Birgin, 2011). After it was compared to forms of performance assessment, portfolio assessment has more strength since it gives a series of process and document as evidence of students' learning outcomes (Davis&Ponnamperuma, 2005)

Nevertheless, conventional portfolio assessment has several weaknesses such as requires a lot of storages to save the documents and requires more time to give feedback; hence it cannot be finished in short of time (Wulan, 2009). These problems can be solved by doing portfolio assessment through web, which is called electronic portfolio assessment. This assessment can record and monitor the student's progress (Wyllie, 2010). Electronic Portfolio Assessment (e-portfolio) is evaluation based on assessment procedure for learning, which the students' work are collected digitally (Ramlawati et al, 2014).

According to the explanation above, thematic – integrated e-portfolio media web blog based is needed to be developed to increase the scientific literacy of Elementary Teacher Education Program's students. The aim of this study is focusing on revealing scientific literacy through development of on-line thematic – integrated learning method web blog based to increase the scientific literacy of Elementary Teacher Education Program's students.

E-Portofolio Media

Electronic portfolio (e-portfolio) becomes something that really important in education especially in the senior high school and university. E-portfolio is not a new term in education research field, but its implementation in Indone-

sia as learning and assessment tool has not been widely used. E-Portfolio reflects the important of technology, access technology in life and anticipatory accommodation of electronic market labor improvement (Cheng, 2008; Wang, 2009). Portfolio assessment which does not use information technology as the basis is called traditional portfolio or Pencil and Paper portfolio based. Traditional portfolio hereinafter is called as portfolio, whereas ICT (Information, Communication, and Technology) portfolio based is known as electronic portfolio.

The term of electronic portfolio is described as process and portfolio assignment result which is saved in electronic format. Electronic Portfolio is assignment document or students' project during the lecture in an electronic format which is collected in one online portal media in the form of website or blog.

The development of electronic portfolio includes two different processes; they are multimedia project development and portfolio development. E-portfolio development must be considered parallel because both of them are effective essential electronic portfolio development. Moritz and Christie (2005) explain that e-portfolio development undergoes several steps, they are: *Collection*: portfolio's significance, audience and its implementation of the artifact for the future's interest must firstly be considered what kind of artifact that would be collected; *Selection*: choosing material criteria which fits to the learning's purpose and appropriate with portfolio's purpose that is created. The purpose may refer to national goal or competency standard that has been settled; *Reflection*: including reflection of every part of portfolio and reflection in total; *Projection (Direction)*: reviews the reflection of learning, has futuristic view and arranges purpose for the future; *Connection*: it is a step to develop the hypertext links and publish the portfolio to get feedback from the others; this step can be taken place before or after the projection step.

Scientific Literacy

Literally, literacy is from the term literacy which has meaning as the ability to read or write. And the term science is rooted from the English word science which has meaning as knowledge. Science is interrelated to find out natural world systematically, hence, science is not only about the mastering of collection of knowledge which are consisted of facts, concepts or principles, but it is also a process of finding.

Scientific literacy according to PISA is the ability of using science knowledge, identi-

fyng question, and taking a conclusion based on the given evidence in order to understand and make decision related to nature and the change happened to the nature that done by human. This definition considers scientific literacy has multidimensional characteristic, it is not simply about the understanding of science knowledge, it is something more than that. PISA regards the students' understanding of the characteristic of science as scientific investigation, the awareness of how science and technology shapes the environmental material, intellectual and culture and the willingness to engage with issues related to science. Think scientifically is a necessity for everyone, not just scientists. Scientific literacy is general competency of life reflects the tendency that is appeared in scientific questions which is in line with the development of technology.

Learning based on scientific approach is fit with the 2013 curriculum context, focusing on material content of elementary school science is allowing the teacher to use scientific approach in order to do learning by doing activity. Science learning process is needed to be guided by scientific approach principles. The characteristics of scientific approach are eye-catching observation dimension, reasoning, finding, approval, and explaining a truth. Hence, the learning process should be guided by the values, principles or scientific criteria (Taufiq & Wijayanti, 2014).

According to the opinions above, the assessment of scientific literacy that was used by PISA was not simply about measuring the level of scientific knowledge, further it was about the understanding of every aspect of science and the ability to implement the knowledge and the scientific process in the real situation that is faced by the students either as individual or part of the society and citizen of the world. According to Thomas and Durant in Shwartz (2005), the knowledge that are connected to scientific literacy are: Understanding science – norm and scientific method and scientific knowledge; Understanding key of scientific concept; Understanding how science and technology work together; Understanding and appreciating the influence of science and technology in the society; The relationship of competencies in the scientific context – the ability to read, write and understand human knowledge system; Applying scientific knowledge and the ability to consider the knowledge in the daily life.

METHOD

This study was development research that was directed to develop thematic - integrated e-portfolio media web blog based to increase scientific literacy of Elementary Teacher Education Program's students. This research was done in *LPTK* (Institution of Education's Personnel Development) of one of University in Semarang, Central Java which has Elementary Teacher Education Program, which educates student to be a candidate for Elementary school's teacher. This *LPTK* (Institution of Education's Personnel Development) was chosen as the place to take data, analyze data and interpret the result of the research. This research took around one odd semester in the 2015/2016 period to do the trial, revision, verification, implementation, further revision, further verification, data processing, analysis, discussion, seminar, and writing the article and research report.

This research was conducted to produce thematic-integrated e-portfolio media web blog based to increase scientific literacy of Elementary Teacher Education Program's students which empirically precise and tested. The result that had been acquired is thematic-integrated e-portfolio media web blog based which can increase scientific literacy of Elementary Teacher Education Program's students.

RESULT AND DISCUSSION

The eligibility of e-portfolio media was done by the media expert and character building expert; the experts are lecturer from Faculty of Science and Math, Semarang State University. The results of the validation were in the form of suggestion and commentary which was used as the reference to fix the e-portfolio media that is developed. Furthermore, there was another validation and analysis in order to get average score from the division of acquired score with the maximum score.

The researchers accumulated the result of expert's responds that were acquired through questionnaire sheets, and then it was accumulated by dividing the score acquired with the maximum score and then it was multiplied to 100%. The percentage result was interpreted to the criteria that are settled on the Table 1.

Table 1. Criteria of E-Portfolio Thematic – Integrated Media Percentage Score Eligibility Assessment

Interval of Score Percentage	Criteria
81% - 100%	Very Good
61% - 80%	Good
41% - 60%	Enough
21% - 40%	Not Good
<20%	Not Very Good

E-portfolio Media Validation in the research included the validation on design and product. The results of the validation that had been done by the media and evaluation lecturer experts are: According to the result of eligibility questionnaire design by the expert, the values acquired are showed on the Table 2.

Table 2. Recapitulation of Data Validation by the Expert towards the Design of Thematic – Integrated E-Portfolio

Validator	Average	Criteria
Media Expert	3,78	Appropriate
Evaluation Expert	3,95	Appropriate

According to assessment result which used questionnaire by the expert, it was acquired that the percentage value of the eligibility of media design was 95, 84%, it was included in very good criteria, therefore this design can be continued to get several revision on the font style and font size aspects, and link of the students' web blog placement on the main e-portfolio web blog which was developed. The researchers did revision that the validator suggests, after several discussions and reflections the e-portfolio media developed was given good and valid recommendation.

The product eligibility was acquired through the expert assessment using questionnaire which was developed by the researchers. The result of E-portfolio product validation by the expert is on the Table 3.

Table 3. Recapitulation of Data Validation Result by the Expert towards the Design of Thematic – Integrated E-Portfolio

Validator	Average	Criteria
Media Expert	3.93	Appropriate
Character Building Expert	3.96	Appropriate

The average score of all aspects that were given good mark by the media expert and character building expert towards the product of e-port-

folio media are 3.95, it showed that the product can be implemented.

The implementation of thematic – integrated e-portfolio media web blog based is supposed to test the effectiveness of media utilizing which is developed using ability to increase scientific literacy and trigger either critical or creative character of Elementary Teacher Education Program's student. The implementation of the media was done in two steps, they are small-scaled trial and field test.

Early step of the research was composing the literacy ability test and guidance of students' answer categorization according to scientific literacy level. The test and guidance of scientific literacy categorization were adapted from Soobard & Rannikmae (2011). To categorize the scientific literacy ability of the student Bybee (1997) suggested that the work plan consist of four levels, they are nominal, functional, procedural and multidimensional. The General description or the categories of scientific literacy composed are shown on the Table 4.

The students' scientific literacy pretest result showed that most of the students were in the first and second category, only a few of them were in the conceptual / procedural level. Most of the students did not answer the questions in the test except from the four answer categories above. The students' scientific literacy post test result showed there was significance increasing from the students' scientific literacy categories, especially from the nominal level to the functional level and from the functional level to the conceptual / procedural level. There was student who reaches multidimensional level in which in the previous test there was no student who reaches this level. The Category of Students' answer Percentage According to Scientific Literacy Category in detail is showed in the Figure 1.

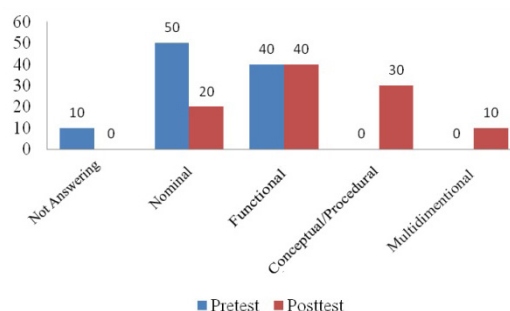


Figure 1. Level of Scientific Literacy Percentage Before and After the Implementation on Question No. 1.

Table 4. Categorization of Student's Answer According to Scientific Literacy Level

Level	Description
Nominal	Students agree with other's suggestion without having their own idea. Students utilize and write scientific term, but they are not able to correct the term or there is misconception.
Functional	Students can remember information from the text book such as writing fundamental facts, but they cannot correct their own opinions according to the texts or graphics given. Students understand the concepts inter disciplines, but they cannot describe the relationship between the concepts.
Conceptual/Procedural	Students utilize the inter disciplines concept and show the understanding and relevance. Students understand the problem; correct the answer with the help of the information from the text, graphic and table given
Multi-dimensional	Students utilize several concepts and show the ability to relate the concepts to the daily life. Students understand how knowledge, society and technology interrelate and influence each other. Students also show the understanding of the characteristics of knowledge through their answer.

Figure 1 shows the Level of Students' Scientific Literacy Percentage before and after the implementation of Thematic – Integrated E-Portfolio Media Web Blog Based, the highest of each value are nominal 50% and functional 40%. Before thematic – integrated E-Portfolio web blog based was implemented, the highest percentage was on the level functional 40%, and after the implementation of thematic – integrated E-Portfolio media web blog based, the highest percentage reached was 10% of multi-dimensional level. The measured scientific literacy indicators were: identify scientific question, explain scientific phenomena, and use scientific evidence. Scientific literacy sub indicators for question number one are diagnosing question that can be investigated scientifically and making prediction.

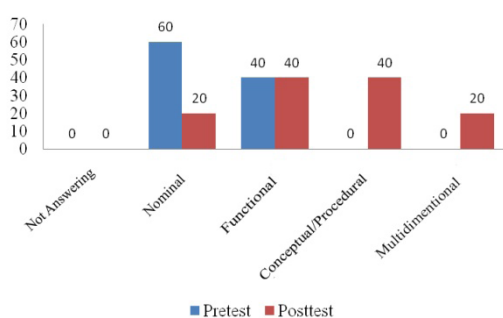
**Figure 2.** Level of Scientific Literacy Percentage Before and After the Implementation on Question No. 2.

Figure 2 shows the Level of Scientific Literacy Percentage Before and After the Implementation of Thematic – Integrated E-Portfolio Media Web Blog Based, the highest of each value were nominal 60% and functional 40%. Before thematic – integrated E-Portfolio media based

on web blog is implemented, the highest percentage was on the level functional 40%, and after the implementation of thematic – integrated E-Portfolio media web blog based, the highest percentage reached was multidimensional level 20%. The measured scientific literacy indicators are: identify scientific question and explain scientific phenomena. Meanwhile, the scientific literacy sub indicators used for the question number 2 are diagnosing scientific investigation features and using scientific knowledge in the situation given.

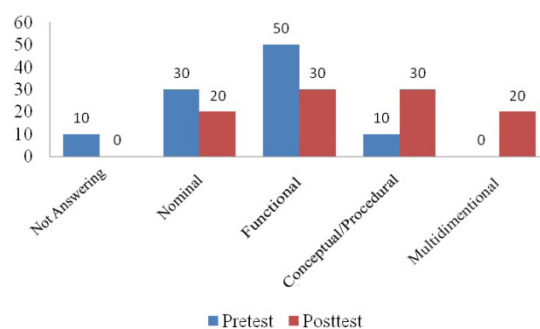
**Figure 3.** Level of Scientific Literacy Percentage Before and After the Implementation on Question No. 3.

Figure number 3 shows the Level of Scientific Literacy Percentage Before and After the Implementation of Thematic – Integrated E-Portfolio Media web blog based, the highest of each value were functional 50 % and procedural 30%. Before thematic – integrated E-Portfolio media based web blog based was implemented, the highest percentage was on the conceptual level 10%, and after the implementation of thematic – integrated E-Portfolio media web blog based, the highest percentage reached was multi-dimen-

sional level 20%. The measured scientific literacy indicator is explaining scientific phenomena. Meanwhile, the scientific literacy sub indicators used for the question number 3 are identifying and describing precisely, and giving explanation and prediction precisely.

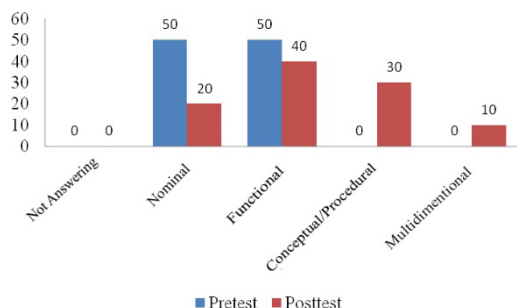


Figure 4. Level of Scientific literacy Percentage Before and After the Implementation on Question No. 4.

Figure 4 shows level of scientific literacy percentage of students before and after the implementation of thematic-integrated e-portfolio media web blog based, the highest of each value were 50% functional and 40% functional. Before the implementation thematic-integrated e-portfolio media web blog based, the highest level on functional was 40%, meanwhile after the implementation of thematic-integrated e-portfolio media web blog based, the highest level reached was 10% of multidimensional. The measured scientific literacy indicator is: explaining the scientific phenomenon. Meanwhile scientific literacy subindicators on the test no. 4 are: identifying and describing appropriately, and giving explanation along with the prediction appropriately.

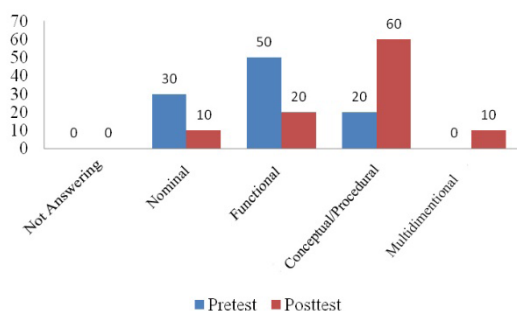


Figure 5. Level of Scientific literacy Percentage Before and After the Implementation on Question No. 5.

Figure 5 shows shows level of scientific literacy percentage of students before and after the implementation of thematic-integrated e-portfolio media web blog based, the highest of

each value were 50% functional and 60% procedural. Before the implementation of e-portfolio thematic integrated media based on web blog, the highest level on conceptual was 20%, meanwhile after the implementation of thematic-integrated e-portfolio media web blog based, the highest level reached was 10% of multidimensional. The measured scientific literacy indicators are: identifying scientific question and using scientific evidence. Meanwhile the scientific literacy subindicators on the test no. 5 are: knowing the question that is possibly investigated scientifically, communicating, giving conclusion and reasoning evidence.

Generally, the Figures above show that the early scientific literacy skill of students is bigger than nominal level. Functional level gets small percentage in the test no. 2 which is not more than 40%, and the highest are on no. 3 and 5 with 50%. Meanwhile in conceptual level, the lowest percentage is 0% on no. 1 and 2, and the highest is 20% on no. 5. Multifunctional level has 0 percentage. The Figures above also show the percentage of students who are not be able to answer the questions of the test, in which the percentage is quiet big that is 10% on no. 1 and 3. This shows the students inability in giving the answer based on the skill of science process which is the main part of scientific literacy. From the five numbers of questions that has been given, the question no. 5 has the biggest percentage of the one which is not answered by the students. There are two matters which are focused on the scientific literacy subindicators, they are: scientific question and communicating trial result.

In the end of the learning process, generally, the significant increasing level of scientific literacy happened on the students, especially in conceptual/procedural level with the highest value 60% in the question no. 5. This showed that students start to be able to identify scientific questions and use scientific evidence. The achievement of scientific literacy as the indicator to identify scientific issue had been good. It is related to the learning process that has been done in class. In the step of observing and asking, the students had been trained at identifying scientific issue like making question related to scientific phenomenon that had been showed by the teacher. The ability of students to identify the scientific issue was also given in the step of collecting information/experiment. It is seen from the ability of student in researching the problem and hypothesis in the trial that had been done.

When the students were doing the review of related literature, they focused in using the

e-portfolio media training the skills of scientific process so that the students were used to the things related to the activity, such as: identifying scientific question, giving an explanation about a phenomenon scientifically and using scientific evidence. As the assessment tool, it is more authentic, because the students could rely on more than one evidence, this showed the development of the idea, and more accurate in representing the students' ability (Abrami & Barrett, 2005; Chang, 2001; Kimball, 2005; Ma & Rada, 2005).

CONCLUSION

The result of media and evaluation experts recommend that e-portfolio which has been developed gets 96.55% of eligibility percentage which means that it is very decent to be used in learning process. The conclusion of this research is, there has been e-portfolio media which is decent-tested and can develop the scientific literacy of elementary teacher education program's students.

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IDENTIFY SCIENTIFIC LITERACY FROM THE SCIENCE TEACHERS' PERSPECTIVE

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ABSTRACT

Scientific literacy is considered as a benchmark of high and low quality of science education in a country. This study aims to identify the scientific literacy of teachers and learning science relation to the issues from the perspective of a science teacher. This descriptive study involved 25 science teachers who are members of MGMP IPA in Bogor. The instrument used in this study consisted of scientific literacy tests and interviews. The results showed that 20% of teachers have scientific literacy ability in the low category, 65% in the moderate category and 15% in the high category. The problems of teaching science based on teacher perspective are 1. having difficulty to teach Integrated Science; 2. having limited knowledge related to learning models of Integrated Science; 3. lack of motivation in teaching integrated science consistently. The results of these studies form the basis that the professional trainings for junior high science teacher need to be conducted in a sustainable manner and related with the needs of their proficiency.

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Keywords: Scientific Literacy, Science Learning

INTRODUCTION

Scientific literacy is defined as the ability to use scientific knowledge, identify questions and draw conclusions based on the evidence, in order to understand and make decisions regarding the nature and its changes through human activity (Rustaman, 2003). Scientific literacy is strongly associated with a person's ability to read and write, as well as the use of language fluently, effectively, and critically (Alwasilah, 2012). Scientific literacy is related to the public in preparing for the future to make a decision on the issue of personal and collective socioscientific. Scientific literacy is considered as the root of the progressive change science education (Sadler & Zadler 2005, 2009).

Results of The Program for International

Student Assessment (PISA) in 2000, showed that Indonesia ranked 38 of 41 countries participating in the literacy skills of science, in 2003 Indonesia ranked 38 of 40 countries, while PISA 2006 Indonesia ranked 50 of 57 countries, and in 2009 Indonesia ranked 60 of 65 countries. Meanwhile, PISA 2012 Indonesia occupied 64 place from 65 countries participating in the ability of science literacy. Indonesian Students gained scientific literacy scores in 2000, 2003, 2006, 2009, 2012, they were respectively 393, 395, 393, 383, 382 with an average score of all participant countries of 500 (Balitbang, 2012).

Related research of scientific literacy conducted by Rubini & Ardianto (2014) about the achievements of scientific literacy in Bogor junior high school students showed that the same acquisition with the achievements of the students' scientific literacy in national. Data showed the achievements of students' scientific literacy in

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Bogor was quite low, with an average of 30% for all aspects, consisting of 29% for the content, 30% for the process, and 31% for the context. Aspects of the context for the application of science have proved that almost students were not able to link the learned scientific knowledge with the phenomena that occur in the world, because they did not gain the experience to be linked. In line with Sadler et al. research, (In Sobard and Rannikmae 2011), it reveals that the lack of scientific literacy of students due to the difficulty of students to evaluate evidence and make decision, as well as less critical in responding to issues related to people's lives.

Related research on the development of students' scientific literacy has been done by many practitioners of science education. The studies have been done previously related to the application of the model/method/strategy of potential science learning in improving scientific literacy of students. Research conducted by Ardianto & Rubini (2015) that examined the application of guided discovery and problem based learning models in science learning process towards junior high school students' scientific literacy ability. Results showed that guided discovery and problem based learning models can improve students' scientific literacy skills but its improvement was in the medium category (41%). The findings are consistent with Brickman et al. (2009), Alfieri et al. (2010) and Nbina (2103) researches that state that science learning based on constructivism (inquiry, discovery, PBL, practicum) can improve students' scientific literacy in the medium category.

Some researches previously described indicate that the model/method/strategy of science learning has been trialed and can overcome the problem of low scientific literacy ability of students, however the improvement of students' scientific literacy is not satisfactory (gain of 0.4 in average category). The problem about the low scientific literacy ability of students can not only be solved by applying the model/method/strategy of science learning based on constructivism. The classroom environment and climate is an important component to the students' literacy skills. Likewise, the school infrastructure, human resources, organization and management bring a very significant influence to students' achievement literacy. Other factors affecting the ability of students' scientific literacy is teacher. Therefore, this study aims to identify the scientific literacy and problem in science learning in the perspective of science teachers regarded as essential component in addressing the issue of students' scientific

literacy skills.

METHODS

This research used descriptive method that aims to describe a situation in its natural condition comprehensively and exactly (Fraenkel et al. 2012). Researcher did not give treatment, but measuring, analyzing, and describing the aspects that are analyzed in natural conditions. This research involved 25 science teachers who joined the MGMP (teacher association) of science in Bogor. Instruments consisted of scientific literacy tests adopted from PISA 2013 and interview guidelines for teacher to find out the weaknesses of teachers in teaching science. The data were analyzed descriptively, the teachers' scientific literacy scores were analyzed by using the following mathematical equation.

$$\text{Nilai} = \frac{\sum X}{K} \times 100\% \dots \dots \dots (1)$$

Where,

$\sum X$: obtained score

$\sum X_t$: maximum score

Teachers' scientific literacy is measured by using the criteria of :

Table 1. Teachers' scientific literacy category

Criteria	Kategori
Teachers' Score $> \bar{X} + SD$	High
$\bar{X} - SD \leq \text{Teachers' Score} \leq \bar{X} + SD$	Moderate
Teachers' Score $< \bar{X} - SD$	Low

(Suharsimi Arikunto in Febrian Andi Marta, 2010)

RESULTS AND DISCUSSIONS

Teachers' scientific literacy test was conducted for 25 junior high science teachers who have taught science and have experienced in teaching science in the last 5 years. However, the educational background of those teachers is not from integrated science major. 92% of teachers who joined the teacher qualification test were majoring in Physics, Biology or Chemistry. While, 8% of science teachers more qualified S1 were majoring in computer and engineering fields. The result of the scientific literacy competency test data is presented in Figure 1.1

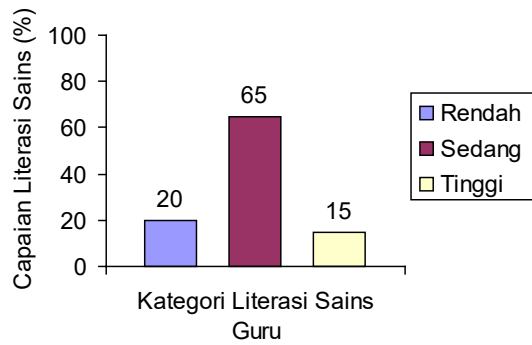


Figure 2. Profile of Junior High School Teachers' Scientific in Bogor.

Figure 2 indicates that even though some teachers have low level mastery of science, but the overall mastery of science teachers shows the middle category. Teachers' scientific literacy in the low categories was 20%, in the medium category was 65%, and in the high category was 15%. These data indicate that there were still major problems in science learning process in junior high school. With a relatively easy test material, all teachers are supposed to be able to solve it. But this fact encourages the research team to investigate the core problem.

Test material of scientific literacy is also used to identify science teachers' understanding of content and science process skill teachers indicated by significant achievements in scientific literacy process of each indicator. Science content in this consisted of 11 contents of acid rain, greenhouse effect, exercise, pollution, fluid, cloning, biodiversity, fuel, biotechnology, photosynthesis, and pesticides. Data analysis of the correct answers percentage of science content can be seen in Figure 3. While the ability of science process skill identified in this research consisting of three indicators adjusted to the PISA 2013 scientific literacy indicators. Those indicators are; 1. identifying scientific issues, 2. explaining scientific phenomena and 3. using scientific evidence. Data analysis of the correct answers percentage of each indicator on science process skill can be seen in Table 2.

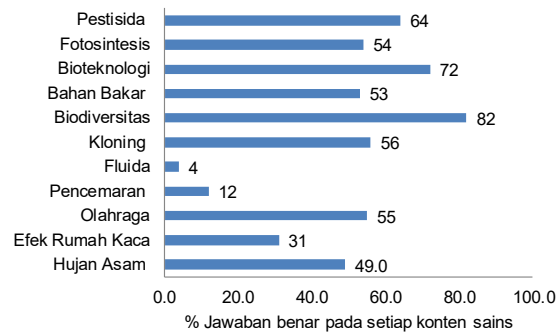


Figure 3. Diagram of the correct answers percentage of science content

Figure 3 shows that teachers obtained the highest percentage of correct answers on biodiversity content is 82% and the lowest correct answer on the fluid content of 4%. This study proves that the educational background of teachers greatly affects the understanding of science content. The study involved 23 science teachers with educational expertise of Physics, Biology or Chemistry, 15 of them were majoring in Biology. Biodiversity content is relatively close to Biology material, so it might affect their performance in the test because it would be easier for them to answer the questions since their conceptual structure has been built up through their daily teaching experience. Vosniadoun and Loannides (1998) also state that the conceptual structure derived from everyday experiences continually restructured will make the existing concept reach consistent conceptual as scientist conceptual. The results also show if the material does not match with their expertise, the percentage of correct answers will be relatively low. This can be seen in the percentage of correct answers on fluid content of 4%, so it was only 10 teachers who answered correctly to that content.

Figure 3 also shows that the teachers' knowledge level of content related to environmental issues is still low. The environmental issues are represented by the content of acid rain, pollution and the greenhouse effect. The achievement of those contents is below 50%, meaning that only 12 teachers were able to answer correctly

Table 2. Teachers' achievement of each science process indicator

Dimension process of scientific literacy	Number of Items	Total number of items	% Correct answer
Identifying scientific issues	3, 7, 8, 10, 11, 13, 14, 17, 21, 23, 25	11	47
Explaining scientific phenomena	1, 6, 9, 15, 18, 19, 20,	7	41
Using scientific evidence	2, 4, 5, 12, 16, 21, 24	7	75
Average			54

associated with contents related to environmental issues. The finding is reinforced by the facts obtained through interviews with teachers who stated that they felt confused and had misconceptions about environmental issues such as global warming, destruction of ozone layer, acid rain, radioactive pollution and others.

The result of this research is reinforced by Spiropoulou et al. (2007) that states 188 teachers in Greece had limited knowledge when they were asked to discuss environmental issues. Another research also reveals that students and teachers had limited understanding about environmental issues and alternative conceptions about it. One of the main difficulties is when explaining the greenhouse effect and global warming (Acikalin, 2013). Some researches also support that on students (Koulaidis and Christidou, 1999; Rebich and Gautier, 2005) and pre-service teacher (Groves and Pugh, 1999; Kahlid, 2001) that still had a misconception of greenhouse effect concept.

Based on the data in table 1.1, it shows that only 47% of teachers answered correctly to the indicator of identifying scientific issues. For the indicator of explaining scientific phenomena (7 questions), the percentage of teachers who answered correctly is only 41% whereas for using scientific evidence (7 questions) is 75%. Overall average percentage of correct answer in the aspects of the scientific literacy process is about 54%. Scientific literacy material used to measure the indicators by explaining the phenomena is short constructed responses and open-constructed response type and the majority of teachers cannot answer it correctly. It shows that they tend to use memorization as strategy to acquire knowledge and instead of the ability to think.

The result also shows that teachers have low science process ability in explaining scientific phenomena indicator with the average percentage of 41%. It indicates that teachers do not have the habit to think critically and have reasoning according to their knowledge. Though Osborne et al. (2001) shows that the reasoning ability and argument in explaining scientific phenomena can be stimulated and trained through a process of argumentation in a debate over the socio scientific issue. The process of argumentation would foster self-openness, which is a requisite for obtaining a high reasoning power. In line with (Newton et al., 1999, in Yang and Tsai, 2010), they state that the individuals involved in the argument will form the basis for building knowledge because it is through the evaluation of the claim and also the process of observation or evidence that scientific estimation can be knowledge general.

Klahr et al. (Varma, 2014) also reveals that the habit of students to reveal evidence, reason, and other supporting factors that are correct and logical can be trained mainly through inquiry activity. Inquiry is a proper process to develop individual ability to explain scientific phenomena (reasoning). Chen and She (2014) mentions that the reasoning ability of individuals involve the whole inquiry process, such as asking questions scientifically, controlling variables, planning a way to answer questions, designing an experiment to test the hypothesis, analyzing data, and interpreting the results (Chen & She, 2014),

The results of interviews with some teachers reveal that some key issues that should be concerned are background of the specific expertise field of causing difficulties in managing integrated learning. They generally master only biology, but not physics or chemistry, and vice versa. Currently, the government has made electronic school books labeled as integrated. However, the implementation is limited especially related to examples. Generally, teachers do not comprehend integrated learning models even though they have joined some trainings in integrating science learning, the implementation is still limited. A lack of motivation from school to organize an integrated learning makes them implementing it inconsistently.

CONCLUSION

This study gives us a picture that not only students have scientific literacy problem but teachers who act major component in the learning process also performed unsatisfactory. Their content mastery is strongly related with the educational background. Their ability in explaining scientific phenomena related to the material that connects to the concept of environmental problems is still low. It indicates teachers do not get used to think critically and have reasoning according to their knowledge. The results also reveal that the problems based on their perspective are 1. having difficulty to teach Integrated Science; 2. having limited knowledge related to learning models of Integrated Science; 3. lack of motivation in teaching integrated science consistently. The results of these studies form the basis that the professional trainings for junior high science teacher need to be conducted in a sustainable manner and related with the needs of their proficiency.

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VALIDATION OF SCIENCE ACHIEVEMENT TEST WITH THE RASCH MODEL

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ABSTRACT

The purpose of this study was to validate the test items of science achievement, which were used as a test at Pancasakti Science Competition, in order to obtain enough valid test items with the Rasch model application. Validation model used in this research is Messick validity covering aspects such as (1) content, (2) substantive, (3) structural, (4) external and (5) consequential. To achieve these objectives, this study investigates the quality of the items that include matching items, Person-Items Folder, Person/Item Folder, Information Function Tests, Person Fit Statistic, Collapsed Deviance, Casewise Deviance, Hosmer-Lemeshow, accuracy, sensitivity, specificity, unidimensional, invariance, separation and DIF. The test was given in the form of multiple choice as many as 40 items consisting of 15 items of physics, 10 items of chemistry, and 15 items of biology. The participants were 85 biology students who were given 60 minutes to do the test. Item analysis was conducted by using R 3:12 Program, eRm package version 0.15-6. The study results showed that the test items of science achievement were proven valid by the application of Rasch Model. The test items have met construct validity according to Messick (1996) which includes such aspects: (1) content, (2) substantive, (3) Structural, (4) External and (5) consequential.

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Keywords: validation, Messick, Rasch model, science achievement test

INTRODUCTION

Measurement is one of the initial steps in the evaluation program, which is a process for determining the characteristics of a number of attributes of the students, especially their learning achievement. In relation to student achievement, measurement is the process of giving the numbers that are expected to demonstrate the ability of students about a subject. To perform measurements, a measuring instrument is needed. Measuring tool that gives information about a person's position in the measured attribute. A good measurement tool would ensure valid and reliable results in order to accurately quantify the ability of students. Validity indicates the degree of evidence and theory that supports the inter-

pretation of test scores as the intended use of the test (APA, 1999). Thus, validation is basically a collection of evidence to provide the scientific basis of test scores interpretation. The validation process used by the association of education and psychology in the United States (AERA and APA) can be divided into five types: (1) evidence based on the content of the test, (2) evidence based on the response, (3) evidence based on the internal structure, (4) evidence based on the linkages with other variables, and (5) evidence based on the consequences of the test (APA, 1999). Reliability is the coefficient which shows the degree of regularity or consistency of the measurement results of a test (Mardapi, 2012). Therefore, the reliability is not related to the test, but rather to the level of errors in the results of a test in the form of a score.

Messick (1996) argues that validity is a

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single concept which is expressed as the validity of a construct composed of six elements each: (1) content, (2) substantive, (3) structural, (4) generalizability, (5) external and (6) consequential. The validity of the suitability contents answers to all test items or tasks that involve cognitive processes and areas of the construct being measured. The content aspect of construct validity is at least associated with the suitability of the content, the representation, and the technical quality. The technical quality of test items is related to the issue of the level of reading accuracy, language ambiguous and the answer key accuracy. The substantive aspect refers to the substance of the content. This is achieved by investigating empirically in order to ensure that the test taker really involves the measured ability in answering the test items. For example, in the multiple-choice test, the test taker who chooses the wrong answer (distractor) has a low ability.

Structural aspect is linked to scoring, which is due prior to the priority of knowing the test structure before continue to scoring. Scores on multidimensional tests should be reported separately for each dimension. Generalization aspect assesses the extent of scores obtained that depict the actual capabilities of the test taker. External aspect reviews the extent of the scores obtained from the test correlated with other appropriate tests. Consequences aspect is merely associated with the meaning of the score obtained in the test or the implications of the score.

Classical test theory uses mathematical models that are very simple in showing the relationship among the score of observation, the actual score, and the score of error. This model was followed by a number of assumptions to simplify the formula in order to estimate the index of reliability and validity of an instrument. Although it has grown rapidly, classical test theory actually has several drawbacks. The weaknesses are: (1) the estimation of the test taker's ability depends on the characteristics of the test used; (2) the item parameter estimation depends on the ability of the test taker; and (3) the measurement error can only be sought for the group, not the individual (Mardapi, 2012). Moreover, the assumption of parallel tests are commonly used to search the index reliability tests, which are very hard statistically.

Some weaknesses in classical test theory are addressed by developing the Item Response Theory (IRT). There are three assumptions underlying the IRT. According to Hambleton et al (1991), the three assumptions are unidimensional, local independence and invariance param-

ter. Unidimensional means tests only measure one's ability. Unidimensional assumption can be proven by using either explanatory factor analysis and confirmatory. Local independence means in response to an item will not affect the other grains. Local independence assumption can be tested through the formula of probability and Chi-square dependence test. Parameter invariance means that the item characteristics are not dependent on the ability of participants and of the test parameter. This assumption is evidenced by estimating the parameters of each item in the participant group of different tests, such as the group based on gender, place of residence, socio-economic status, and others. With the implementation of IRT, the weakness of the application of classical test theory can be resolved, namely: (1) the estimation of the test taker's ability does not depend on the characteristics of the tests used; (2) the item parameter estimation does not depend on the ability of the test taker; and (3) the measurement error can be searched for each individual.

A model that is often used in IRT (Item Response Theory) is the logistic model. There are three logistic models namely one parameter model (1P), 2 parameter model (2P) and 3 parameters model (3P). 1P models only use the parameter level of difficulty of the grain. 2P model covers the level of difficulty and distinguishes grain, while 3P model covers 1P's and 2P's parameters summed up with the parameter for pseudo guessing. One of 1P models widely used is the Rasch model. Due to the existing logistics model, Rasch is the simplest one, which only uses one point and constant parameter scale (D) of 1. Rasch links the opportunities of correct answer to each item (P(θ)) as a function of ability (θ) with a constant level of difficulty (b) through a relationship as in equation 1.

$$P_i(\theta) = \frac{e^{(\theta-b_i)}}{1 + e^{(\theta-b_i)}}$$

Rasch model has been developed separately from the IRT and even more widely to polytomous scoring. With only involving one item, parameter estimation grain or participants in Rasch model needs less than the estimated data in other models. Application of the Rasch model in learning achievement, since being introduced by Georg Rasch in 1960, now extends not only in the world of education but also in the world of medicine and public health. The Rasch model application include: (1) the science and math education and attitudes towards science (Zain et

al, 2010), (2) the students' understanding of the philosophy of science (Neumann et al, 2010), (3) the opinion of math teachers towards the practice of teaching (Grimbeek & Nisbet, 2006), (4) the model's influence towards the law of science (Sjaastad, 2012), (5) and physics education (Oon & Subramaniam, 2012). Rasch model is also applied to formulate educational measurement as well as the Programme for International Student Assessment (PISA), Trends in International Mathematics and Science Study (TIMSS) and other comparative tests (Schulz & Fraillon 2011; Stubbe, 2011; Wendt et al, 2011, Glynn, 2012). Rasch model is also used in the validation of a scale of attitudes toward science among countries compiled by TIMSS (Sabah et al, 2013). Likewise, reported by Long et al (2014) and Bansilal (2015), Rasch model can be applied either at the middle school math literacy tests in South Africa and measurement capabilities of science inquiry (Lou et al, 2015). The application of the Rasch model in the health sector includes: (1) Measurement of Oswestry Disability Index (ODI) (Lu et al, 2013), (2) Measurement of the General Health Questionnaire (GHQ) (Smith et al, 2010), (3) Measurement of the Malaria Diagnostic Test (Ayele et al, 2014).

Rasch analysis is basically aimed to meet the construct validity as described by Messick (1996). Compatibility of grain is used to check the item contents and the construct being measured. Meanwhile, fit test item is an item indicating that the contents have been relevant to the construct being measured. Person items folder and Person / Item Folder are two indicators the extent to which the test can measure the construct region to be measured (Baghai, 2008).

To examine the substantive type, testee and model compatibility test may be applied. Testee compatibility test (Person fit statistic) reveals the extent to which the testee's consistency in answering the questions. Person fit statistics empirically produces guides to what extent the pattern of testee's answers / responses can be predicted accurately by the model (Smith, 2001: 296). Consistent or fit testee answers all of the items that have the level of difficulty under their capabilities, and does not answer the items that have the level of difficulty above their ability. Inconsistent testee (Person Misfit) may be caused by carelessness, guessing, or dishonesty (cheating) (Wolfe & Smith, 2007: 209). Model capability test included the value of Collapsed Deviance, Casewise Deviance, Rost Deviance, Hosmer-Lemeshow, accuracy, sensitivity, and specificity (Mair et al., 2008). The validity of the structural type can be

achieved by two methods, namely with unidimensional test and item parameter invariance test. Person separation or stratum is a measure of the construct validity of external type (Wright and Stone, 1999). DIF identification (differential item functioning) is used to test the consequential validity (Baghaei & Amrahi, 2011). Table 1 is a summary of the criteria for a valid viewed from various aspects and criteria.

The purpose of this study was to validate the test items of science achievement, which were used as a test at Pancasakti Science Competition, in order to obtain enough valid test items with the Rasch model application. Validation model used in this research is Messick validity covering aspects such as (1) Person-Items Folder, (2) Person/Item Folder, (3) Information Function Tests, (3) Person Fit Statistic, (4) Collapsed Deviance, (5) Casewise Deviance, (6) Hosmer-Lemeshow, (7) the value of accuracy, sensitivity and specificity, (8) the unidimensional test, (9) the Invariance test (LRtest), (10) the value of Person strata separation and (11) DIF according to the testee's gender.

METHOD

This research was carried out on the test items of science learning achievement that were used for the first stage of the junior high school competition in Pekalongan on March 20, 2016 at the Pancasakti University. The test was given in the form of multiple choice as many as 40 items consisting of 15 items of physics (numbers 1-15), 10 items of chemistry (numbers 16-25) and 15 items of biology (numbers 26-40). The test was attended by 85 junior high school students with the time allocation of 60 minutes. To achieve the objectives of the study, item analysis was conducted by using the Rasch model application with R 3:12 software program, eRm package, version 0.15-6. The program was selected as it is open source and has more than 3,000 packages for a specific purpose (Nettekoven, & Ledermüller, 2012). Extended Rasch model (ERM) is the application of Rasch model analysis with parameter estimation techniques using Conditional Maximum Likelihood (CML). R Program eRm-Package is more widely used because it has a lot of facilities and with the Maximum Likelihood estimation techniques, it does not require a prerequisite normal distribution, which results more consistent items (Mair, & Hatzinger, 2007). While for the unidimensional test, explanatory factor analysis with SPSS version 17.0 was used (Reise, et al, 2000).

Table 1. Criteria for a valid test viewed from various aspects and criteria

Construct Validity Aspect	Indicator	Criteria
Content	Fit item test	$P < 0.05$ $0,5 < MNSQ < 1,5$ $-2,0 < ZSTD < 2,0$
	Person-item Map	All level of item difficulties are in the testee's domain capability
	Person/Item Map	The level of item difficulties are is at or near tester's ability
	Information function test	Information function test has maximal values on the testee's domain capability
Substantive	Person fit statistic	$P < 0.05$ $0,5 < MNSQ < 1,5$ $-2,0 < ZSTD < 2,0$
	Collapsed Deviance / Casewise Deviance / Hosmer-Lemeshow	$P < 0,05$
	Accuracy, sensitivity, and specificity	Close to 1,0
Structural	Unidimensional test	There is one main factor that is pictures through Screen Plot's factor analysis result
	Invariation test (LRtest)	$P < 0,05$
External	Person strata separation test	Close to 1,0
Consequential	DIF	No significant DIF found

RESULT AND DISCUSSION

Item Characteristic Curves (ICC) on the Rasch model simply connects two variables: the testee's ability (latent dimension parameter) and the probability of answering correctly. The difficulty level (b) is the capability where the testee has a chance to answer correctly by half (0.5). All items of science learning achievement test can be described well as logistics functions ICC as can be seen in Figure 1.

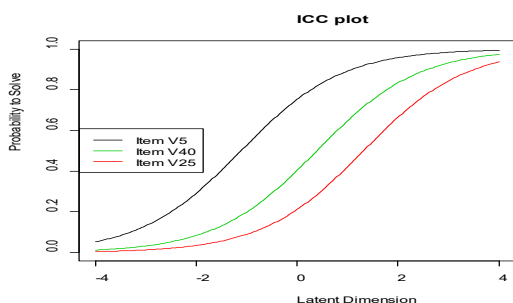


Figure 1. Item Characteristic Curva (ICC) untuk nomor 5, 25 dan 40

The analysis results of the difficulty level of the science learning achievement test with the Rasch model application are shown in Table 2.

Test match items in Table 3, Person-Item folder in Figure 2 and Person / Item Folder in Figure 3, whereas function test and item information in Figure 4. Of the 40 test items, all have difficulty values between -2 level up to +2. It is something that is ideal due to the learning achievement test based on the norm reference test, just like in a test competition, the difficulty level should be in accordance with the testee's ability and away from an extreme value of difficulty level. It is seen that items measuring the ability of physics are more difficult compared to what of chemistry and biology. The most difficult item is number 7 (physics), while the most convenient is number 27 (biology).

Table 3 shows, of all the 40 test items, all qualifies as suitable items for measuring science learning achievement test, as seen from the MNSQ and ZSTD. When viewed from a significance test with Kai Square, it appears items number 7 and number 34 still have a chance (P) below 0.05 that therefore both of these items are declared as less suitable to be a measuring tool. However, if we take a significance of 1% (0.01), then the two points are still appropriate to describe the testee's response. From Figure 2 and 3, it is shown all levels of item difficulties are in the domain of testee's capabilities except item number 7

Table 2. The difficulty level of the science learning achievement test with the Rasch model

No	Difficulty level	Deviation Standard	No	Difficulty lever	Standard Deviation
1	0.228	0.228	21	-0.633	0.224
2	-0.081	0.223	22	0.175	0.227
3	0.020	0.224	23	0.742	0.247
4	-0.633	0.224	24	0.336	0.231
5	-1.113	0.236	25	1.316	0.286
6	0.020	0.224	26	-1.289	0.244
7	2.382	0.419	27	-1.350	0.247
8	2.212	0.391	28	-1.171	0.238
9	1.928	0.351	29	0.391	0.233
10	0.175	0.227	30	0.228	0.228
11	0.282	0.230	31	0.336	0.231
12	-0.031	0.223	32	-0.432	0.222
13	0.620	0.242	33	-1.229	0.241
14	1.493	0.302	34	0.871	0.254
15	0.806	0.251	35	-0.482	0.222
16	-1.413	0.250	36	-0.132	0.222
17	-0.031	0.223	37	-0.947	0.231
18	-0.282	0.222	38	-2.806	0.390
19	0.071	0.225	39	-0.232	0.222
20	-0.736	0.225	40	0.391	0.233

and number 38. Figure 4 also shows the test will provide information of high value in the range of -2 to + 2 capability.

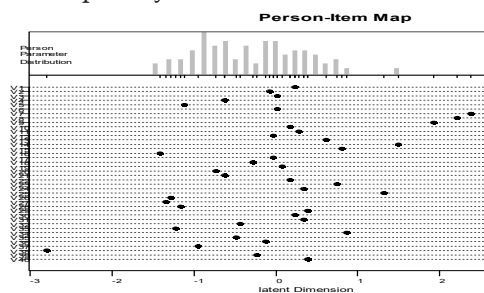


Figure 2. Person-Item Map test of science learning achievement test with the Rasch model.

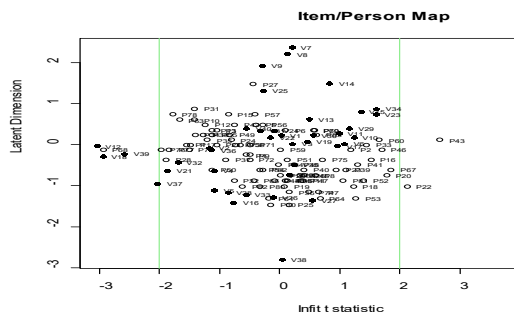


Figure 3. Person/Item Map test of science learning achievement test with the Rasch model.

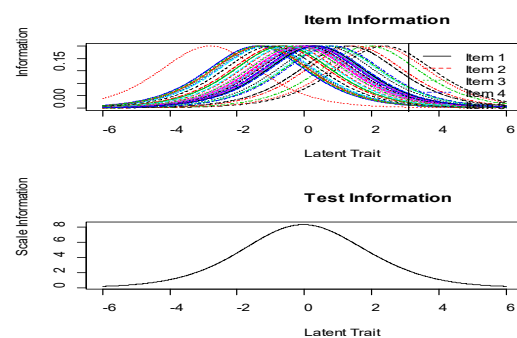


Figure 4. Information function of science learning achievement test with the Rasch model.

The analysis result of Good-of-Fit with the help of eRm model version 0.15-6 shows different parameters as shown in Table 4.

According to the 6 parameter values of Good-of-Fit Tests as described in Table 4, except the value of Collapsed Deviance, it is indicated that science learning achievement tests meet Substantive validity. Nevertheless, Deviance Collapsed parameter is significantly affected by the sample. By taking a 10% error, these tests still fulfill the prerequisites value of Collapsed Devian-

Table 3. Compatibility item of science learning achievement test with the Rasch model

No Item	chisq	df	p-value	Outfit MSQ	Infit MSQ	Outfit t	Infit t
1	84.955	84	0.450	0.999	1.000	0.03	0.02
2	76.969	84	0.694	0.906	0.924	-1.29	-1.17
3	88.310	84	0.353	1.039	1.013	0.51	0.21
4	77.485	84	0.679	0.912	0.927	-1.11	-1.10
5	73.152	84	0.795	0.861	0.899	-1.16	-1.09
6	93.686	84	0.220	1.102	1.074	1.27	1.07
7	120.042	84	0.006	1.412	1.031	0.99	0.20
8	91.508	84	0.270	1.077	1.009	0.32	0.13
9	62.437	84	0.962	0.735	0.903	-0.77	-0.30
10	94.298	84	0.207	1.109	1.095	1.20	1.23
11	93.118	84	0.233	1.096	1.080	0.97	0.98
12	66.584	84	0.919	0.783	0.807	-3.03	-3.05
13	93.421	84	0.226	1.099	1.049	0.76	0.49
14	120.795	84	0.005	1.421	1.158	1.56	0.83
15	115.222	84	0.013	1.356	1.167	2.12	1.34
16	72.338	84	0.814	0.851	0.909	-0.95	-0.76
17	90.716	84	0.289	1.067	1.064	0.88	0.96
18	68.710	84	0.886	0.808	0.826	-2.92	-2.96
19	89.568	84	0.319	1.054	1.031	0.67	0.45
20	84.753	84	0.456	0.997	1.009	0.00	0.15
21	72.475	84	0.811	0.853	0.879	-1.90	-1.87
22	81.841	84	0.546	0.963	0.985	-0.39	-0.17
23	104.432	84	0.065	1.229	1.192	1.50	1.60
24	83.187	84	0.505	0.979	0.989	-0.17	-0.10
25	79.209	84	0.627	0.932	0.942	-0.23	-0.28
26	85.370	84	0.438	1.004	0.984	0.08	-0.12
27	93.546	84	0.223	1.101	1.057	0.70	0.54
28	74.277	84	0.767	0.874	0.915	-0.99	-0.87
29	98.243	84	0.137	1.156	1.104	1.40	1.16
30	89.014	84	0.333	1.047	1.041	0.52	0.54
31	80.694	84	0.582	0.949	0.970	-0.46	-0.32
32	75.892	84	0.724	0.893	0.896	-1.53	-1.70
33	75.293	84	0.740	0.886	0.941	-0.84	-0.56
34	119.844	84	0.006	1.410	1.214	2.28	1.61
35	85.641	84	0.430	1.008	1.013	0.13	0.23
36	77.071	84	0.691	0.907	0.927	-1.30	-1.14
37	68.361	84	0.892	0.804	0.840	-1.96	-2.04
38	88.647	84	0.343	1.043	0.981	0.24	0.04
39	70.784	84	0.848	0.833	0.845	-2.50	-2.59
40	80.438	84	0.590	0.946	0.949	-0.46	-0.55

ce. Value Accuracy, Sensitivity and specificity are also close to 1 or more than 0.6 so that science learning achievement test is considered suitable in describing the testee's response. Table 5 contains the majority of the test Person's match. At the significant of 5 percent, there are 5 testees who are inconsistent and rejected by the model, and there are 80 testees who are considered consistent. As a conclusion, 94 percent of the population meets the substantive validity. The inconsistent five testees are testee number 22, 41, 43, 60, and 67.

Table 4. Good-of-Fit Tests Parameter

Parameter	df	Value	P Value
Collapsed Deviance	878,187	820	0,078
Hosmer Lemeshow	30,027	800	0,00
Casewise Deviance	3958,932	3425	0,00
Accuracy		0,714	
Sensitivity		0,638	
Specificity		0,776	

Figure 5 shows scree plot, which is the analysis results of unidimensional with the help of SPSS version 17,00.

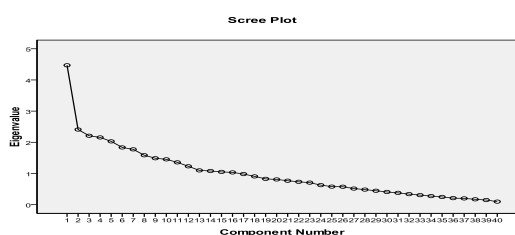


Figure 5. Scree plot of the respond factor analysis of science learning achievement.

Scree plot analysis shows that there is only one line while the others are sharply sloping that they cannot be considered as a factor. Therefore, figure 5 shows that the learning achievement tests can be expressed only consist of one factor or one-dimensional.

Invariance parameters test with Anderson LR-test shows a value of 123.193 with chi-square df by 39 with an opportunity by 0,000. At the 5% significance level can be concluded that there has been invariance parameter estimation. Person se-

Table 5. Person-matching test of science learning achievement test with the Rasch model

NoPerson	chisq	df	p-value	Outfit MSQ	Infit MSQ	Outfit t	Infit t
7	47.462	39	0.166	1.187	1.112	0.66	0.65
8	53.887	39	0.057	1.347	1.082	1.35	0.60
9	34.146	39	0.691	0.854	0.937	-0.72	-0.50
20	52.524	39	0.073	1.313	1.274	1.23	1.78
21	37.668	39	0.531	0.942	0.877	-0.25	-1.05
22	74.578	39	0.001	1.864	1.389	2.48	2.12
23	42.451	39	0.325	1.061	1.128	0.34	0.94
40	40.378	39	0.409	1.009	1.050	0.12	0.41
41	58.429	39	0.023	1.461	1.171	1.94	1.30
42	35.267	39	0.641	0.882	0.897	-0.50	-0.75
43	72.579	39	0.001	1.814	1.345	3.51	2.67
44	36.750	39	0.573	0.919	0.980	-0.22	-0.08
59	38.414	39	0.496	0.960	0.997	-0.15	0.01
60	67.324	39	0.003	1.683	1.205	3.04	1.66
61	34.903	39	0.657	0.873	0.951	-0.27	-0.18
62	36.172	39	0.600	0.904	0.955	-0.35	-0.29
63	26.831	39	0.930	0.671	0.775	-1.56	-1.67
64	54.512	39	0.051	1.363	1.126	1.05	0.67
65	42.689	39	0.316	1.067	1.019	0.35	0.18
66	40.744	39	0.394	1.019	0.928	0.16	-0.42
67	57.210	39	0.030	1.430	1.267	1.73	1.85
68	24.736	39	0.963	0.618	0.690	-2.25	-2.94

Table 6. Wald test according to gender of science learning achievement test.

No item	Z statistics	P Value	No	Z statistics	P Value
1	0.127	0.899	21	0.628	0.530
2	-0.260	0.795	22	0.482	0.629
3	-0.467	0.641	23	1.061	0.289
4	1.125	0.261	24	0.948	0.343
5	1.888	0.059	25	0.216	0.829
6	-0.965	0.335	26	-1.212	0.225
7	0.096	0.923	27	0.827	0.408
8	0.688	0.491	28	-1.408	0.159
9	0.911	0.362	29	1.107	0.268
10	-1.034	0.301	30	-1.883	0.060
11	-1.252	0.211	31	-0.597	0.550
12	0.881	0.378	32	-1.759	0.079
13	-0.361	0.718	33	0.578	0.563
14	0.637	0.524	34	-0.269	0.788
15	0.686	0.492	35	-0.927	0.354
16	0.115	0.908	36	0.586	0.558
17	0.881	0.378	37	0.264	0.791
18	-0.346	0.729	38	-1.745	0.081
19	-0.821	0.411	39	0.294	0.768
20	-0.166	0.868	40	0.072	0.942

paration value reliability or strata, with the help of software version 0.15-6 eRm program, shows the value of 0.6552. Although this value is not ideal but still considered to conform to external validity (Chyi Lo et al, 2014). DIF analyzes by sex is used to determine the validity of the consequential aspects.

lue of Test Wald and everything gets above 0.05. Therefore, it can be concluded that the science learning achievement test used is not gender biased. This is further explained in Figure 6 that describes the LR test for each item between men and women, where all the items show different prices and no coincident. This research result shows science learning achievement test used by Pancasakti Science Competition is consistent without bias.

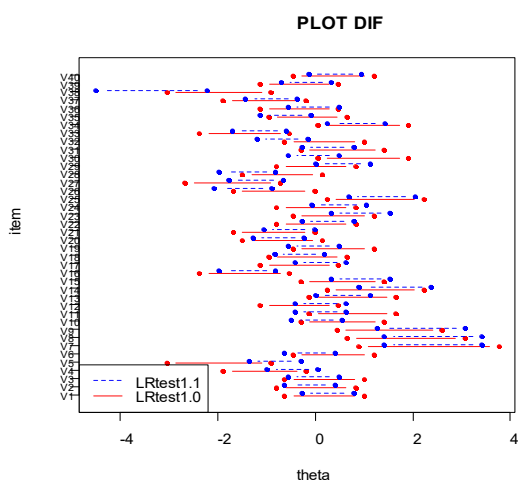


Figure 6. DIF plot of science learning achievement test items.

From Table 6, it is known as much as 40 test items do not contain visible from DIF Va-

CONCLUSION

According to the results of this study, it can be concluded that science learning achievement tests used in Pancasakti Science Competition is proven to be valid by the application of the Rasch model. The science learning achievement test items have met construct validity according to Messick (1996) which includes: (1) content, (2) substantive, (3) structural, (4) external and (5) the consequential. The science learning achievement test items can then be further developed as a standardized test for implementation of Pancasakti Science Competition.

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