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SCIENCE INTEGRATED LEARNING MODEL TO ENHANCE THE SCIENTIFIC WORK INDEPENDENCE OF STUDENT TEACHER IN INDIGENOUS KNOWLEDGE TRANSFORMATION

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ABSTRACT

The scientific work independence is the core competency of student teacher of science. In this research, the effectiveness of the Science Integrated Learning Model (SIL) was measured in term of the scientific work independence of student teacher of science in changing the society's original knowledge into scientific knowledge. The changing was measured through Ethnoscience learning. The experimental method was used with the control group and experimental group in three different universities. The result of the t-test shows a correlation coefficient significance value at 0.000 < 0.05. Therefore, it concludes that there is not any difference between the experimental and control group. However, there is an effect of model application on the independence of the scientific work of student teacher of science.

Keywords: Science Integrated Learning Model; scientific work independence; science student teacher

INTRODUCTION

The quality of science teachers depends on the achievement of the graduate core competencies from the study program where they study for. Also, the determination of the graduate core competencies is based on the carrying capacity of the study program and the graduate end users. The Science Education Study Program and Science Educators Forum in Indonesia agree that the graduate of science teacher program must have the scientific work independence and able to integrate the original knowledge in society as the nation's identity in learning. The independence in scientific work includes the ability in planning, implementation, and evaluation. Moreover, strong scientific work independence means that every graduate is capable of designing and implementing the science learning based on the results of scientific work (Tahar & Enceng, 2006; Zion, 2008; Topaloglu & Kiyici, 2015).

The scientific work independence can be achieved individually through the activity of planning, discovery, exploration, and finding the knowledge from integrated information sources to obtain a thorough knowledge of science. Besides, based on the Indonesian curriculum, there is a requisite to deliver the science learning material in an integrated way. Therefore, the skill in knowledge integration is necessary for science teacher candidate. The students of science teacher candidate have to master this skill and how to teach it (Lang & Olson, 2000; Lee, & Songer, 2003; Parmin et al. 2016; Purwoko et al., 2017). After

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mastering this skill, they can apply it through learning activity by developing community-based learning resources that are contextually analyzed to produce integrated teaching materials (Robert et al., 1998; Lang & Olson, 2000; Sun & Chee, 2013). According to Ankiewicz & Estelle (2006), the use of community-based integrated learning resources can develop the high curiosity, critical thinking activity, responsible attitude of students in science learning. The community-based learning resources can be obtained from the indigenous knowledge. Moreover, it requires a learning strategy to explore indigenous knowledge to be a scientific knowledge or it is usually called as the Ethnoscience.

Furthermore, the independence of scientific work is oriented for the Science Integrated Learning (SIL) model (Parmin et al., 2016). The SIL model using the independence of scientific work is developed from an open inquiry model which has six stages of learning. The stages are exploration, concept integration, experiment, analysis, action and reflection. According to Dettrick (2001), the open inquiry of students is ranging from identifying problems and designing process investigations which are conducted by themselves. In addition, the student must have a finding ability in the learning activity (Zion, 2008). Also, the scientific work through experiment can give the students way to plan and analyze the results in an integrated way (Carol et al., 2013). Science integrated learning towards the learning activities begins with the use of a variety of learning resources to explain the science phenomena (Novi & Parmin, 2012).

In order to achieve the competence on the scientific work independence, a learning material which leads to students' learning activity and has the learning strategy with a principal of integrated science is needed. The result of the previous preliminary study on the students' scientific work independence in Science Education Study Program, Universitas Negeri Semarang shows that the students tend to have the dependency on their lecturer when they do the experimental work; also, they have not shown any original knowledge in local society. These problems represent that there is a necessity for a learning instrument development which is oriented in the achievement of graduate core competencies. According to SIL model, the appropriate way to teach science in order to achieve the independence of scientific work can be conducted through an experiment to test the indigenous knowledge of the community to be a scientific knowledge. Therefore, this study aims to test the effectiveness of the SIL model implementation to the independence of scientific work in student teacher of science, especially in designing, conducting, and evaluating an experiment. Also, in this research, the independence of scientific work in student teacher of science in terms of changing the indigenous knowledge to be the scientific knowledge through SIL model was assessed.

METHODS

The research used an experimental method with aims to measure the independence of scientific work of student teacher of sciences in Ethnoscience learning through Science Integrated Learning (SIL) model. The dependent variable was the students' scientific work with the provision of pre-test and post-test in the experimental group and the control group to evaluate the Ethnoscience knowledge. The independence of the scientific work was determined based on the calculation of the ideal mean and ideal standard deviation in the experimental group with SIL model. The research was conducted in the Science Education Program of Study in three colleges (Universitas Negeri Semarang, Universitas Negeri Yogyakarta, and Universitas Negeri Surabaya). Each study program has two classes in each student level. The total of student teacher of science involved in this study was 86 students.

In this research, the data collection was conducted to obtain the effectiveness of SIL model implementation in Ethnoscience learning material. Also, this study aimed to obtain the data of pre-test and post-test in experimental and control groups. Moreover, the independence of scientific work in student teacher of sciences in designing, implementing, and evaluating an experiment after Ethnoscience learning with SIL model application was studied. Further, the indigenous knowledge transformation to scientific knowledge with SIL model application was investigated; and finally, the attitude of student teacher of sciences' student was examined after Ethnoscience learning with SIL model application.

The independence of the scientific work of students has been analyzed using descriptive techniques with ideal criteria namely; ideal mean and ideal standard deviation (Arikunto, 2015). Based on the results of calculation of the classification of ideal mean and ideal standard deviation is referring to Table 1.

Table 1. The Classification of Ideal Mean and Ideal Standard Deviation

Category	Range
Very high	> Mi + (1.5 × SDi)
High	Mi to Mi + (1.5 × SDi)
Moderate	Mi – (1.5 × SDi) to Mi
Low	< Mi - (1.5 × SDi)

The factors that affect the students' independence of scientific work used quantitative descriptive analysis with percentage techniques. Questionnaire responses of students used the Likert scale with four levels, i.e. strongly agree, agree, quite agree, and disagree.

RESULTS AND DISCUSSION

In this research, the assessment of the Science Integrated Learning (SIL) model implementation on the students in Ethnoscience learning showed a varied maximum score for each stage according to the number of indicators. The maximum score for each stage, i.e. Exploration (20), Concept Integration (8), Experiment (24), Analysis (8), Action (12) and Reflection (8) as shown in Table 2.

Table 2. The Effectiveness of The Stage of SIL Model

SIL syntax	Average Score	Criteria
Exploration	19	Highly effective
Concept Integration	6.90	Effective

Highly effective criteria were shown in the stage of exploration, experiment, action, and reflection; while effective criteria were found in concept integration and analysis. In summary, the average of the score was 73. The score represents the application of SIL model in Ethnoscience learning in three universities was effective. The understanding of students to Ethnoscience learning material was also evaluated using test.

The results of pre-test and post-test in experimental and control groups are presented in Figure 1. There is a difference in the results between pre-test of the experimental group and the control group, meaning that there is a difference in the understanding level of Ethnoscience learning material. The experimental group with SIL model application tended to have a better understanding of the learning material comparing with the control group.

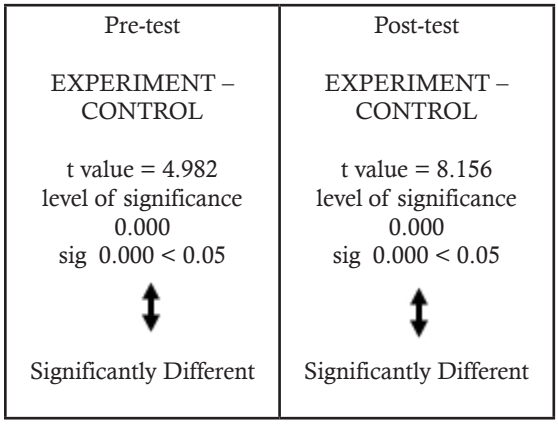

Figure 1. The Difference of Ethnoscience Knowledge in The Experimental and Control Groups

Table 3 shows the difference of the test results value. In Table 3 there is a difference in the value of the test results pre-test and post-test control group. The pre-test and posttest result of the difference between experimental and control group show that there is a difference between the treatment groups with t value at 37.22; a significance level at 0.000, and sig 0.000 < 0.05. Furthermore, the independence of scientific work of student teacher of science was measured in the application of SIL model.

Table 3. The Value Difference of Pre-Test and Posttest Results

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair Pre-Test Control 1 Post Test Control	-8.71	7.31	.77	-30.24	-27.18	-7.22	89	.000

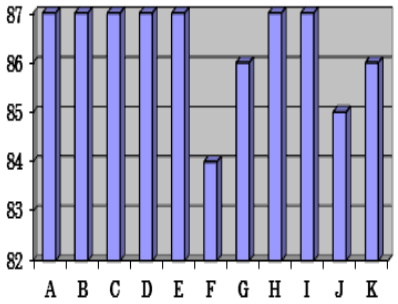

Figure 2. The Independence of Scientific Work of Student Teacher of Science Student on Ethnoscience Learning

Description:
A = Problem statement formulation
B = Hypothesis statement formulation
C = Develop the practical worksheets
D = Instrument preparation
E = Material preparation
F = Practical work
G = Report preparation
H = Presentation
I = Analysis of laboratory work results by integrating the data and facts
J = Analysis of laboratory work results by integrating with the latest findings in the journal
K = Communicating

According to Figure 2, the independence of the scientific work was in a very high category. Based on the analysis of 11 aspects of the independence of scientific work, there were 81 students who obtained very high category and 7 students showed high category. The independence of scientific work of students in this study resulted as the effect of the SIL model application. The test results of SIL model effectiveness on the independence of scientific work showed t value at 4.419 with significance at 0.000 and sig 0.000 < 0.05 as shown in Table 4.

This result represents that SIL model application was effective to improve the independence of scientific work of student teacher of science students. Also, the results reveal that the students' independence work has transformed the indigenous knowledge to be scientific knowledge. The exploration of the indigenous knowledge was performed in 5 tribes in Java Island as shown in Figure 3.

Figure 3. Map Location of Indigenous Knowledge Exploration in Java Island

Some of the indigenous knowledge of the community has already proved scientifically in the laboratory experiment. Some examples of the experimental results are presented in Table 5. The student teachers of science are capable of changing the indigenous knowledge of the communities through experiments. The experimental results show that the tradition of the community in 5 tribes in Java Island inherits from their ancestor habit. Based on the result in Table 5, the indigenous knowledge has shown the value of scientific knowledge. The students were also asked to fill in the questionnaire after learning the Ethnoscience subject with the application of SIL model. The results of students' response are shown in Table 6.

Ethnoscience means of science knowledge owned by a nation or more precisely, a tribe or a particular of the ethnic group. Ethnoscience is given to student teachers of science to integrate indigenous knowledge as an integral part of the science learning. According to Wang & David (2002), the quality of human dignity is achieved through an appreciation of the potentials that exist in the environment.

Table 4. The effectiveness of SIL model on the independence of scientific work of students

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
1(Constant)	22.904	4.196		5.459	.000
The effectivity of SIL model	.254	.057	.432	4.419	.000

Table 5. The Indigenous Knowledge of Communities in 5 Tribes of Java Island which are Transformed to The Scientific Knowledge through Laboratory Experiment

Tribe	Indigenous Knowledge	Scientific knowledge
Samin	Potion for exorcist blocker in Sawan disease.	The potion is made from 11 herbal ingredients. After laboratory examination, the herbs are containing saponin which serves as a medication.
Jawa	The production of salty egg in Brebes using brick dust and ash.	Brick dust and ash were proved to be the medium of salt bonding into the egg shell.
	Solanum leaves for sore throat medication in Bantul.	The color changing of the leaf extract after HCl and NaOH addition shows the flavonoid compounds.
Tengger	Putting the red onion on the infants' bed.	Red onion has alliin and allicin that neutralize the toxic compounds.
Sunda	The mixture of curcumin, salt, fish skin, and whiting to cure diarrhea.	Essential oil and curcumin, mineral and salt can substitute mineral loss of body during diarrhea condition.
	Coconut water for reducing the menstrual dysmenorrhea.	Coconut water contains electrolytes such as potassium and sodium which are useful to prevent dehydration caused by blood loss during menstruation.
Madura	Lime water for acne removal.	Lemon extract is known to contain essential oils to eliminate Staphylococcus aureus bacteria that cause infections, especially skin infections such as acne.
	Betel leaves to stop nose bleeding.	Betel leaf contains saponin that can stop the bleeding of the nose (nosebleeds).

Indigenous knowledge is part of the cultural life or society that is still maintained and believed to be true. The tradition is maintained because the people believed in the truth of genuine knowledge. Indigenous knowledge that has been converted into a science or science can enrich teaching materials (Wang & David, 2002; Lee et al., 2012; Kidman et al., 2013; Dwianto et al., 2017).

In the context of Ethnoscience as part of science learning, the learning materials and learning procedure have to be organized into a meaningful sequence in sections depending on the depth and difficulty level (Kabba, 2009; Hewitt et al., 2013; Topaloglu & Kiyici, 2015). Science learning is oriented to the development of caring and responsible attitude towards the social and natural environment (Kabba, 2009; Hewitt et al., 2013). In learning, the material acts as the relationship among separated data sources (Morrison et al., 2007; Adam & Carl, 2010; Azarpira, 2012). There are two main characteristics in providing learning materials to help students acquire scientific literacy, i.e. the organization of the main ideas and clear integration (Silberman, 2006; Gregory, 2007; Trefil & Hazen, 2007; Widowati et al., 2017).

Table 6. Students' Response after Ethnoscience Learning by SIL Model Application

Statement	Average	Category
Learning materials are in accordance with the basic competencies	3.2	High
Learning materials of Ethnoscience are interesting	3.3	Very high
Learning materials of Ethnoscience encourage the testing of indigenous knowledge into scientific knowledge	3.7	Very high
Indigenous knowledge exploration activities stimulate the problem statement	3.2	High
Students are able to create the laboratory practicum worksheet independently	3.1	High
Students need to prepare the tools and experimental materials independently according to worksheet	3.1	High
The collection of lab results data is an integration between data and facts which are collected objectively	3.3	Very high
The problem is easily solved by analyzing the practical results which have been obtained by integrating data, facts, theories and findings of the latest issue from the scientific journal	3.3	Very high

Learning science aims to understand the history and culture of scientific developments and the evolution of knowledge along with its discipline (NSTA, 2003; Osborn, 2003; Tosun & Taskesenligil, 2011). Indigenous knowledge is a part of the original culture in the community which the source that can be obtained directly by observation, textbook, printed and electronic media. Disclosure of genuine knowledge society is done by applying scientific investigation to avoid mythical beliefs into science learning. According to Hsu et al. (2009), scientific inquiry is an authentic experience that shows the active involvement and has similarities with that done by scientists.

The average score of 8 items of the question after Ethnoscience learning by SIL model application is 3.28. This score represents the very high capability of students the implementation SIL model in Ethnoscience learning. SIL model is proved to be effective to improve the ability of students in integrating data, facts, and theories to transform the indigenous knowledge into scientific knowledge, especially in Ethnoscience subject. In general, SIL model has six stages of learning, namely; exploration, concepts integration, experimentation, analysis, action and reflection. In exploration stage, the students explore the information of indigenous knowledge in the community by observation, reading in printed and electronic media. The obtained information is briefly described. Students formulate problems and establish hypotheses for a further test through scientific work. Next, concept integration stage which maps the results of the exploration stage was performed.

Then, continue by the experiment stage which involves the student to prepare the practicum worksheet independently. In this stage, the students conduct the experiment in the laboratory. Phase experiment, experiment plan was drawn up independently in the form of worksheets practicum. Students prepare and conduct experiments. After experiment, the analysis stage was performed by integrating data, facts, theories, the recent findings (journal). After that, the action stage brings the student to draw the solution to solve the problems. Finally, the reflection stage is performed to let the students express their experiences from the exploration to reflection of learning activities into a reflective journal.

In fact, a pre-test result of the students on their Ethnoscience knowledge shows the low category of prior knowledge. In particular, students do not understand the methods to explore indigenous knowledge in the community, the concept of the knowledge and how to transform into a scientific knowledge. In this study, the learning materials of Ethnoscience were delivered in the form of a soft file and hand out. Also, the materials learning activity applied SIL model in order to improve the students' understanding. By using this handout, the students can study everywhere and prepare themselves before learning in the classroom.

The learning material given to students has also been validated by the science teaching evaluation expert who has the record in the development of Ethnoscience learning material. According to the students, the Ethnoscience learning materials encouraged them to test the transformation of indigenous knowledge into scientific knowledge. In accordance with the opinion of Gondwe & Nancy (2014) and Meyer & Crawford (2011) who stated that learning materials with the integration of indigenous knowledge in it, can affect the students to learn science.

Moreover, SIL model application could lead the independence of the student in scientific work. Independence is a standalone, self-learning, independent, and initiative in learning and behavior do not cleave to another person, is required to have its own activity and initiative in learning and behavior (Depdiknas, 2008; Tahar & Enceng, 2006; Munthe, 2009). Learning independence is an attitude leads to awareness of own learning and consideration related to independent in learning activity and process. The higher education learning design is based on four assumptions, namely; the concept of independence to regulate themselves, the experience of adults is the repertoire, readiness to learn, and learn life-centered orientation (Pannen et al. 2001; Malcolm in Munthe, 2009).

By the application of SIL model, the students have explored the community's indigenous knowledge by the observations and analysis of information in printed and electronic media. In addition, the students of prospective science teachers are also able to formulate the problem and determine a hypothesis. The experiment plan is independently arranged in the form of practicum worksheets. Also, students have analyzed the results of the experiment by integrating data, facts, theories and recent findings (journal). Meanwhile, the follow-up of the original testing of indigenous knowledge organized in the form design and preparation of science learning materials. In fact, an independent experience of scientific work is effective after the application of SIL model. It is proved by coefficient t-test result with a significance value at $0.000 < 0.05$ means that SIL model leads to the independence of prospec-

tive teachers in scientific work. This result is in accordance with the result of the study by Crone (2011); Novi & Parmin (2012) and Hewitt et al. (2013). The independence in direct experience effects on strengthens the students to accept, store, and apply the concepts they have learned.

The result of this study proved that student teacher of science is capable of changing the indigenous knowledge of five tribes in Java Island. The laboratory experiment to test the validity of indigenous knowledge was performed in the integrated science laboratories of three different universities. After the laboratory experiment, the obtained results show that the indigenous knowledge is scientifically proved and is now used by modern society as the product of technology. The experimental results are in accordance with the opinion of Cimer (2007); Schonborn & Bogeholz (2009). They stated that the indigenous knowledge of local communities has the scientific secret that can be verified through the application of scientific methods. By the stages of learning experiments conducted by student teacher of science insist that the traditional experiment conducted by tribe, ethnic, or traditional communities have the scientific truth.

CONCLUSION

Science Integrated Learning (SIL) model affect the independence of scientific work in student teachers of science. The students have the independence of scientific work by showing their ability in planning, performing, concluding and communicating the experiment with its results in Ethnoscience learning. This study confirms that ethnic and cultural diversity has the potential of great scientific knowledge to be explored to enrich the learning resources.

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