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Focus, Explore, Reflect and Apply (FERA) Learning Model: Developing Science Process Skills for Pre-Service Science Teachers

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Abstract: The purpose of this study is to describe the application of Focus, Explore, Reflect, and Apply (FERA) learning model in improving science process skills for a pre-service science teacher in primary school. The stages of learning using the FERA learning model consist of four stages, namely focus, explore, reflect, and apply. The sample of this study was the students in the Primary School Teacher Education Study Program at STKIP Sebelas April Sumedang. This research was conducted using Quasy-Experimental method with Non-equivalent Control Group Design. The effectiveness of the treatment was obtained by giving the pretest and posttest to each class one time. The research data was processed by analyzing N-gain, normality test, and average difference using the Wilcoxon and Man Withney U tests. The results showed that the experimental class and the control class had significant mean differences between the science process skills data on pretest and posttest. This shows that learning using the FERA model is more effective in improving science process skills for pre-service primary school science teachers.

INTRODUCTION

Science learning has evolved from year to year from teacher-centered to the student-centered (Basonggo, Tangkas, & Said, 2014; Nurfaidah, 2017; Prawindaswari, 2015). The view of science learning by memorizing a number of terms, concepts, theories, and others is outdated (DepDiknas, 2013; Isdaryanti, Rachman, Sukestiyarno, Florentinus, & Widodo, 2018; Sugianto, Ahied, Hadi, & Wulandari, 2018; Sumaedi, Dantes, & Suma, 2015). This is in line with the principle of learning activities carried out in universities that are student-centered and provide opportunities for students to develop their potential (Kemendikbud, 2012). Learning activities in universities that serve as the educational institution not only provide students with an understanding of teaching materials but must consider students' competency standards in accordance with their education level. At the primary school level, the National Education Standards Agency reveals that science learning in primary schools must emphasize direct learning experiences through the use and development of scientific attitudes and process skills (Badan Standar Nasional Pendidikan, 2006).

The importance of process skills for primary school education has an impact on the educational institutions' efforts through lecture activities in equipping students with a number of qualified science process skills so that during their service, primary science teachers can apply these skills to their students (Anita, Jalmo, & Yolida, 2015; Muliyani, Kurniawan, & Sandra, 2017; Purwandari, 2015). How is it possible for an educator to develop the science process skills if the educator himself does not master the skills to be trained.

Given the importance of science process skills for pre-service science teachers in elementary school, the science learning activities in universities must use effective learning models in training and developing these skills (Alfarizqi Nizamuddin Ghiffar, Nurisma, Kurniasih, & Bhakti, 2018; Cahye, 2018; Muliyani et al., 2017; Nasution, 2018). One learning model that can be applied in science learning is the FERA learning model which consists of four learning stages, namely Focus, Explore, Reflect, and Apply (National Science Resources Center, 2008). The FERA learning model is a constructivist learning model that provides opportunities for students to build their knowledge with a number of work activities in the form of experiments so that they can train students' understanding and various skills (Sprague, 1995). This model is not in sequential steps but rather a cycle process (Center for Inquiry Science at the Institute for Systems Biology, 2006). This model of learning is student-centered. It is in accordance with the demands of the university principles which requires students to actively develop themselves through learning, mastering, and practicing branches of science to become professional education practitioners. FERA learning was developed in California.

But in Indonesia, FERA learning is still rarely applied, even almost nonexistent, especially at the primary school level. Therefore, the researchers wanted to know the effectiveness of FERA learning in developing science process skills for the pre-service science teachers in elementary school.

THEORETICAL SUPPORT

The FERA learning model is cycled learning developed through constructivist learning. This learning model was developed by the National Science Resources Center in California in 2008 (National Science Resources Center, 2008). The name of the FERA learning model is taken from four important stages carried out during the learning activities; namely, Focus, Explore, Reflect, and Apply.

Implementation of the FERA model in science learning for the pre-service science teachers in elementary school can be carried out by starting the focus stage where students are asked to clarify initial knowledge about a concept. Then in the explore stage, the students will be give given problems to be solved by carrying out activities that involve experiments. In the reflecting stage, the students process data to conclude in answering the problems. In the last stage, apply, the students apply concepts that have been discovered in daily-life situations.

Science process skills is a process of carrying out activities related to science. Rustaman et al. Mentioned that all skills, including intellectual skills, physical skills, and social skills, need to be acquired, developed and applied of its concepts, principles, laws, and theories which referred to as science process skills (Rustaman et al., 2005). Science process skills can be divided into two levels, namely basic science process skills and integrated science process skills. The basic science process skills consist of several skills (Muliyani et al., 2017), the first is observing skills by utilizing all five senses, making qualitative and quantitative observations, and observing changes. Second, communication skills by explaining the results of observations, compiling, and submitting reports systematically, and describing data by using graphs, tables, or diagrams. Third, classifying skill done by looking for similarities and differences and looking for the basis of grouping. The fourth is the measuring skill which is done using appropriate tools to obtain the right data and to measure the appropriate units. The fifth is the concluding skill to make conclusions based on the results of observations and to determine the pattern of observations. The sixth is predicting skills which are done by predicting something that has not happened based on existing trends or patterns and then uses the patterns for observation.

In this study, the science process skills refer to the six basic skills indicator. Through the FERA learning model, each indicator of the science process skills was then trained in a number of activities to the students directed by the teacher as a facilitator (Koksal & Berberoglu, 2014). For example, communication skills can be trained through a process of clarifying the concepts to be learned (Lin, Chiu, Hsu, Wang, & Chen, 2018; Rauschert, Dauer, Momsen, & Sutton-Grier, 2011) where the students are stimulated to communicate their initial knowledge about the concepts to be learned.

FERA learning has four phases that the students must go through in the learning process; namely, Focus, Explore, Reflect, and Apply. These four phases can bridge students in instilling science process skills. These four phases can be implemented in the form of student activities while carrying out the learning.

Table 1. The Framework of FERA Learning Model in Training the Science Process Skills

Stages	Students	Science Process Skills
Focus	Linking experience with what will be learned Considering the concepts to be explored Gaining interest and motivation of the contextual phenomenon	Observing
Explore	Testing the students' ideas through experiments Comparing the ideas among peers in a group discussion Demonstrating the understanding through discussion Group	Measuring Communicating Classifying Concluding
Reflect	Developing an explanation through the obtained results Using scientific language to represent what is obtained in the experiment	Communicating Concluding
Apply	Applying and transferring acquired knowledge into different contexts Connecting experiences with the concepts obtained Communicating ideas in a different context	Communicating Concluding Predicting

METHOD

This study used a quasi-experimental method with Non-equivalent Control group Design. The pretest and posttest were conducted once to measure the science process skills. The design of the study can be described as follows (Fraenkel & Wallen, 2008).

O_1	X	O_2
O_3		O_4

Figure 1. Non-Equivalent Pretest-Postest Control Group Design

The population in this study were all Primary School Education Study Program students of STKIP Sebelas April Sumedang, West Java Province. The samples in this study were two classes of the entire population selected by Purposive Sampling due to the characteristics of the experimental and control groups are suitable with the research variables.

The instrument used in this study was a test of science process skills. Before it was used, it was tested for its validity and reliability. The data collected in this study is in the form of science process skills data obtained from the results of the pretest and posttest in both the experimental class and the control class. The data was then tested whether it is normally distributed or not by using the Shapiro-Wilk test. After knowing the data distribution, the next step was to test the difference in the average score of pretest and posttest in both classes using Independent Samples T-Test and Paired Samples T-Test for the normally distributed data. The data that was not normally distributed, the Wilcoxon and Man Withney-U test were used.

The average difference between the data of the pretest and posttest in two classes was tested three times. (1) Test the average difference of the pretest between the experimental class and the control class. This test was intended to describe the initial conditions of both classes before treatment. (2) Test the average differences of the pretest and posttest score between the experimental class and the control class. These steps were done to find out whether there were changes in the condition of each class after treatment. (3) Test the average difference of the posttest between experimental class and control class. This step was done to find out whether there are differences in the final conditions of the two classes. All data processing was carried out using SPSS 16 software. After the average difference test was done, then the normalized gain <g> of the data was calculated to determine the effectiveness of the treatment in both classes manually by using the Microsoft Excel. The formula used was:

$$< g >= \frac{S_{post} - S_{pre}}{S_{ideal} - S_{pre}}$$

Once the score was obtained, the interpretation of the normalized gain was made by comparing the criteria set out in Table 2 (Hake, 1999).

Table 2. Gain Criteria

Gain	Criteria
$<g> < 0.3$	Low
$0.7 > <g> \geq 0.3$	Moderate
$<g> \geq 0.7$	High

The FERA learning model is shown in Figure 2 (Center for Inquiry Science at the Institute for Systems Biology, 2006).

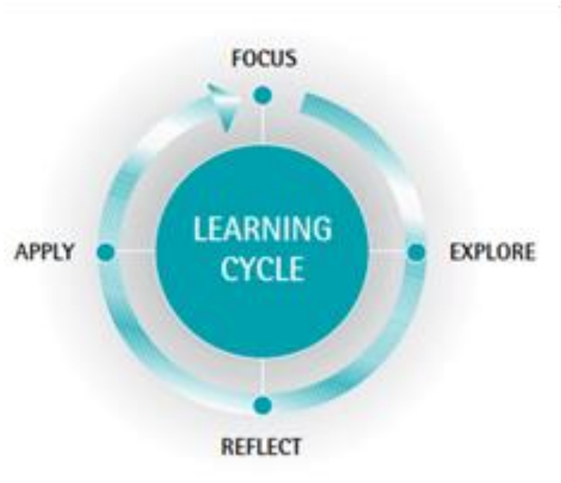

Figure 2. FERA Learning Model

RESULT AND DISCUSSION

The significant differences in the improvement of the science process skills of the primary school pre-service science teacher between the experimental and control classes can be tested statistically using the SPSS 16 software. The steps taken for this statistical test consisted of a normality test using the Shapiro-Wilk test and the mean difference test using Independent Samples T-Test and Paired Samples T-Test for the normally distributed data, while data that was not normally distributed, the Wilcoxon and Man Withney U were used.

The results of the normality test using the Shapiro-Wilk formula in the experimental class and the control class can be seen in the following table. The data is said to be normally distributed if the significance is greater than the confidence level set at 95% (sig > 0.05).

Table 3. Normality Test Results Using Shapiro-Wilk

Group	Shapiro-Wilk	df	Sig
Experiment (pre)	0.898	27	0.012
Experiment (post)	0.901	27	0.014
Control (pre)	0.918	23	0.060
Control (post)	0.891	23	0.017

Based on Table 3, the data of pretest and posttest score has varied distribution. Data on pretest in the control class is normally distributed while other data such as the pretest and posttest in the experimental class and the posttest in the control class have abnormal data distribution. This can be seen from the significance of the pretest score in the control class that is 0.060 (sig > 0.05) while the data of pretest and posttest in the experimental class and the data of posttest in the control class have values smaller than 5%, or precisely 0.012; 0.014; 0.017 (sig < 0.05). To test the average difference in the data of pretest and posttest for both classes was done using non-parametric statistics, namely the Wilcoxon and Man Withney U test because there were no data pairs that were both normally distributed. The results of the test can be seen in Table 4.

Table 4. Average Difference Test Results Using Wilcoxon and Man Withney-U Average

Average Difference Test	Whitney-U		Wilcoxon	
	z	Sig	Z	Sig
Pre-pre *	-0.994	0.32		
Post-post *	-5.046	0.00		
Pre-post **			-4,57	0,00
Pre-post ***			-4,23	0,00

Description:
* = The average score of experimental class and control class
** = Experimental class average score
*** = control class average score

Based on Table 4, it was revealed that the initial condition of both classes before given the treatment was not significantly different. This is known from the results of the average difference test between both classes with a significance value of 0.32 (sig > 0.05). The result of the average difference test of the pretest and posttest in both classes shows that there is a significant difference in the mean for both classes with a significance value of 0.00 (sig < 0.05). This implies that the learning process by implementing the FERA model and without implementing the FERA model can significantly improve the science process skills of the pre-service teachers. However, the result of the average difference test of the posttest between both classes shows a significant difference in mean with a significance value of 0.00 (sig < 0.05). This shows that the final conditions between the two classes have significant differences.

Furthermore, to find out which class is more effective in improving science process skills, the normalized gain <g> test was performed using Microsoft Excel. The results of the comparison of the average normalized gain of science process skills between the experimental class and the control class are shown in the following Figure 3.

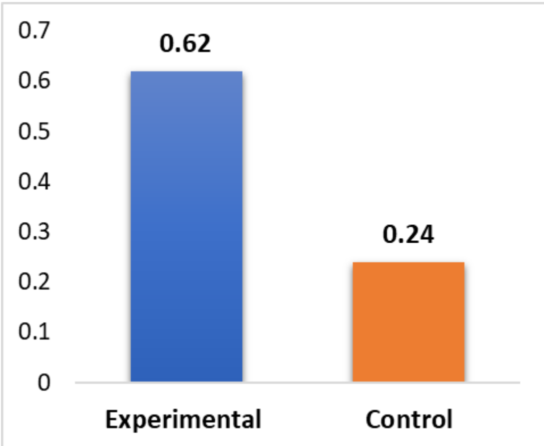

Figure 3. Science Process Skill Improvement

Based on Figure 3, it is known that the average score of normalized gain for the experimental class is 0.62 and for the control class is 0.24. In other words, the difference in the average score of the normalized gain of the two classes is 0.38. The improvement of the science process skills in both classes is in a different category. The experimental class is in the moderate category while the control class is in a low category. This reinforces the results of previous data calculation which states that the final conditions of the two classes have significant differences. So, it can be concluded that learning using the FERA model is more effective in improving science process skills.

A person will have a skill if someone is training it through activity. Similarly, the science process skills in students will increase if he has the experience to do or practice these skills (Wenning, 2006). If we look at the distribution of science process skills trained in learning, in general, the application of the FERA model more often practice science process skills than without applying the FERA model, so it is very reasonable if in general, the improvement of science process skills in the experimental class is more significant than the control class.

In the **Focus** stage, the science process skills trained are observing, predicting, drawing conclusions, and communicating. The researchers gave a question with the intention to stimulate the students to communicate their ideas. In addition, at this stage, the researchers conducted demonstrations related to the material to be studied. The aim was to stimulate the observing, predicting, and concluding skills. The results of the demonstration activities will ultimately confirm the results in the next stage. The students made predictions after drawing conclusions about the relationship between concepts obtained by observing the phenomena carried out during demonstration activities (Saregar & Sunarno, 2013).

In the **Explore** stage, science process skills trained was observing and measuring skills. They measured the electric current namely the potential difference and the strong electric current. It was carried out in collaboration with each group member, and the results were recorded in the student worksheet. This measurement process was strongly influenced by the functioning of the tools and observation skill. The frequency of training in measuring skills in the control class is less than in the experimental class. As a result, the increase in measuring the skill of the students in the experimental class was higher than the control class.

In the **Reflect** stage, science process skills trained are the skills to draw conclusions and communicate the results of experimental activities. This skill in making conclusions is a preliminary skill that is quite often trained in learning activities in the experimental class. In addition, based on the data of the instruments used for the test, there are similarities in the characteristics of ways to make conclusions. In learning activities and also instruments used. The conclusion made was based on quantitative data to find the relationship between electrical current. The similarity in characteristics enabled them to answer correctly.

In the **Apply** stage, the science process skills trained was communication skill. They were trained to communicate the application of the concepts learned everyday life. Based on the results of the study, there are several causes for the FERA learning model to provide a better improvement for the experimental class compared to the control class related to the science process skills, namely, the learning stages bridge the science process skills indicators. The activities in learning stages instill meaningful learning, and the stages also strengthen the students' motivation during the learning process (Kosasi, 2015; Nor, Noprina, & Zuhdi, 2013).

First, the FERA learning model is the form of learning cycle that can bridge the students to instill science process skills. A number of student activities in exploring the science process skills indicators are facilitated through lecturing activities contained in FERA learning stages. In other words, the FERA learning model can provide broad opportunities to strengthen science process skills (Muliyani et al., 2017; Özgelen, 2012; Susilawati, Susilawati, & Sridana, 2015). For example, when students practiced observing and measuring skills, they can conduct experimental activities related to the concepts learned.

Second, FERA learning activities contain important components in science, namely hands-on and mind on activities. Every activity is able to encourage students to make hands-on and minds to contribute to meaningful experiences (Koksal & Berberoglu, 2014; Satterthwait, 2010). This is because the students creatively and independently construct knowledge from what they know in the initial process of FERA learning, to be specific, in the focus stage. Constructing new knowledge structures is strengthened through experimental activities and analysis of what has been done (Widayanti, Yuberti, Irwandani, & Hamid, 2018). Indirectly, this meaningful activity will strongly instill the science process skills (Lin et al., 2018; Muliyani et al., 2017; Rauschert et al., 2011; Susilo & Atun, 2017).

Finally, it cannot be denied that every learning activity that emphasizes student-centered learning will encourage students' interest or motivation in conducting the learning process. When these interests and motivations are formed, the students will automatically have the awareness to do the right learning according to the design directed by the lecturer. This process will strengthen the students' science process skills.

CONCLUSION

Based on the findings and analysis of data in this study, it can be concluded that the application of the FERA learning model in the basic concepts of science can improve science process skills for primary school pre-service science teacher compared to without applying the FERA learning model. The research using different material and even different fields of science need to be conducted. In addition, the explore and reflect stage should be given special attention by researchers when conducting learning using the FERA model. This is based on the findings that most students are still not used to doing both phases of learning.

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