Improving Students’ Science Process Skills and Critical Thinking Skills in Physics Learning through FERA Learning Model with SAVIR Approach

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Abstract. This study aimed to determine the effectiveness of FERA learning model (Focus, Explore, Reflect and Apply) with SAVIR approach in improving students’ science process skills and critical thinking skills in physics learning. The method used in this research was Quasi-Experiment with non-equivalent control group design. The subject of this research was students in one of the senior high schools in Lampung District. MANOVA test (Multivariate of Variance) in SPSS 20 was used as a hypothesis test. The analysis result showed that there were differences in science process skills and critical thinking skills between the experimental class and the control class. The effectiveness of FERA learning model with SAVIR approach in improving students’ science process skills and critical thinking skills in physics learning was tested by Effect Size test. The results showed that FERA learning model with SAVIR approach was more effective in improving students’ science process skills and critical thinking skills than using discovery learning model.

Keywords: critical thinking skills, FERA learning model, SAVIR approach, science process skills

1. Introduction

Physics is a lesson about facts, concepts, theories, principles and natural laws [1]. In learning physics, there are three aspects, attitudes, processes and scientific products [2,3]. When studying physics, students should not learn the finished product or the end result [4] they need to do some experimental activities that will lead to the product discovery process [5]. Because in learning physics, students should not just memorize the lesson but must understand and be able to apply the concepts [6]. Students will more easily understand the lesson if they practice what they learn. Students need to do a series of activities for improving their knowledge, so that they have to practice more and building their science process skills.

Science process skill is a directed skills (cognitive and psychomotor) that is used to discover concepts and theories and develop existing ones [7]. Science process skill is the basic abilities that students must have to be able to do several scientific activities [8,9]. Science process skills are also a process of searching and discovering, where students will experience the learning process directly and they will also take steps in scientific work [10]. So that they can understand, develop and discover new knowledge [11].

Science process skills are divided into two: basic science process skill and integrated science process skill [12,10]. Basic science process skills consist of observing, classifying, measuring,
communicating, interpreting, predicting, using tools, conducting experiments and concluding [13], while integrated science process skills consist of formulating problems, identifying variables, describing the relation between variables, controlling variables, obtaining and presenting data, analyzing data, formulating hypotheses, applying concepts, designing research and conducting experiments [14,15]. Learning by using science process skills will make students more appreciate the processes or activities they do, so that they can more understand what they learn [16]. For this reason, it is very important for students to practice their science process skills.

Student’s science process skill can be trained in various ways, one of which is through observation activities or scientific activities such as practice [17,18]. Apart from being able to practice science process skill, it is also believed to improve student's thinking ability [19]. This is because students become active in using their minds to find various concepts or principles of material they learn [20]. So, it can improve the ability to think, one of which is the ability to think critically [21].

The minimum thinking ability of a person that must be mastered to understand a problem and to solve it is the ability to think critically (critical thinking) and the ability to solve problems (problem solving ability) [22,23]. Critical thinking is a mental activity that helps people understand problems, formulate and get the answers [24]. Critical thinking can increase objectivity towards something, so it helps in seeing from a different perspective [25]. To make students use to think critically, can be done by giving instructions and opportunities to discuss their opinions according to the content and also by using critical thinking assessment [26].

Basically critical thinking skills are developed into several indicators: giving a simple explanation (elementary clarification), building basic skills (basic support), concluding (inference), providing further clarification (advanced clarification), and implementing strategies and tactics (strategies and tactics) [27]. In learning process, it is very important to develop critical thinking skill, because this ability is used to solve problems effectively and efficiently [28]. Students who have the ability to think critically can pay close attention to the other opinions, so, without hesitation they can decide which opinions are right and which are wrong [29]. This ability can affect students’ intelligence, so they are able to create, formulate, identify and plan for themselves how to overcome the problem [30]. Therefore, students must possess this ability.

Based on the results of pre-research at one of the senior high schools in Lampung District, during learning activities, educators still dominate the learning process and be the source of information (teacher center). Students tend to be passive and only accept the knowledge provided by educators without being actively involved in gaining knowledge or searching for that by themselves. Students rarely conduct observational or experimental activities, so they cannot develop their scientific process skills. Even though physics learning will be more meaningful if students look for and experience what they have learned [31].

Besides observation and interview, researchers also conducted tests to determine students' critical thinking skills. Based on the test results, students had not been able to think critically. This was caused by learning activities that merely convey concepts. Students were not invited to discuss solving a problem that can practice their critical thinking skills. For this reason, a learning model is needed to help to improve students’ science process skills and students' critical thinking skills. One of learning models that can be used is FERA learning model.

FERA is a learning model based on constructivism learning theory [32]. Constructivism learning is learning that helps students build their own knowledge by carrying out several activities or experiments [33]. This learning model is centered on students (student center). The FERA learning model consists of 4 learning stages, Focus, Explore, Reflect and Apply. These four stages can support students in developing their science process skills. The four stages of FERA can be implemented in the form of learners' activities during the learning process[32].

Students have different learning styles, there are 3 kind of learning styles that students may have, auditory, visual and kinesthetic [14]. To make the learning process work effectively, a learning approach is needed [34]. Learning approaches can optimize the differences in learning styles possessed by students. One approach that can be used is SAVIR learing approach. SAVIR learning
approach is a learning approach consisting of somatic, auditory, visual, intellectual, and repetition [2]. Learning by using SAVIR approach can make students use all of their senses [35]. SAVIR approach is a combination of elements found in SAVI and AIR learning. SAVI is a learning approach that uses all three learning styles accompanied by intellectual activities [36]. While AIR learning is a learning activity where students actively build their own knowledge [37]. In AIR learning there is no element of seeing and doing but has an important dimension that is not found in the SAVI approach, it is repetition.

FERA learning model with SAVIR approach is believed to be able to improve science process skills and critical thinking skills of students, because during learning process, students will do several exploration activities that can improve their science process skills. Besides, students will also be given a number of problems that they must solve, educators will ask students to apply the concepts they have learned into their daily lives. So that it can train students' critical thinking skills [38].

There are several studies that use the FERA learning model and SAVIR approach. One of them stated that the FERA learning model can improve students' science process skills. Research that uses SAVIR learning is research [32], other also stated that SAVIR learning approach can maintain student retention [2]. The difference between this research and previous research is, in this research, we combined FERA learning model with SAVIR approach and there are two variables in this research, science process skills and students' critical thinking skills. So far there are only 2 studies used FERA learning model with SAVIR approach, one of which was used FERA model to improve science process skills [32] and the other one used SAVIR approach to maintain student retention [2]. For this reason, this research was carried out to find out the effectiveness of FERA learning model with SAVIR approach in improving science process skills and students' critical thinking skills.

2. Research Method

This study used a Quasi-experimental with Nonequivalent Control Group Design. This design was chosen because in this study the experimental group or the control group were not chosen randomly [39]. The population in this research were all students of class X in the 2018/2019 school year at one of the senior high schools in Lampung District. The sample used in this study is divided into 2 classes, class X MIA 1 as an experimental class and class X MIA 2 as a control class. Sampling using a purposive sampling technique. Purposive Sampling is a technique for determining samples based on specific objectives or certain criteria, not randomly chosen [40]. This technique was used because in the selection of experimental and control classes, we looked for classes that have equal student abilities.

Data collection in this study was carried out by observation and tests. The instruments used in this research were:

a. Science Process Skills (SPS) Observation Sheet. This observation sheet was used to assess students' scientific process skills based on SPS indicators.

b. Critical Thinking Skill (CTS) Test. This test used two-tiered questions. Two-tier test is a kind of test that consists of 2 levels. The first level is multiple choice while the second level is the reason for the answer in an essay form.

c. Observation Sheet to measure the Implementation of Learning Models. This observation sheet was used to assess the feasibility of FERA learning model with SAVIR approach during learning activities. The assessment used a Likert scale with a rating scale 1-4 [39].

Before the instrument was used, the instrument was validated to the validator (expert) and tested with validity and reliability test. Validity test used the product moment correlation formula [41]. Reliability test used Cronbach’s Alpha formula [42]. The reliability test result of r11 was 0.719, so the research instruments were reliable with the high category [43].

Data analysis techniques for science process skills and critical thinking skills in this research used this formula:

\[ N = \frac{\text{score obtained}}{\text{maximal score}} \times 100 \]
Science process skills and critical thinking skills analyzed by Multivariate of variance (Manova) test. But before testing the hypothesis, the n-gain test, normality test and homogeneity test were done. To test the effectiveness, we used the effect size equation. Effect size test used Hake formula. The analysis technique of the feasibility of FERA learning model with SAVIR approach can be calculated with:

\[ N = \frac{\text{score obtained}}{\text{maximum score}} \times 100\% \]

3. Results and Discussion

Based on research that has been done, the results are:

3.1 Science Process Skills

Based on Figure 1, the average value of SPS (both, pretest and posttest) in the experimental class was higher than the control class. The details of the percentage of science process skills in the experimental class can be seen in the table below:

| No | Indicator                          | Percentage | Experimental Class |
|----|------------------------------------|------------|--------------------|
| 1. | Formulate the Problem              | 80         |                    |
| 2. | Identifying Variables              | 83         |                    |
| 3. | Describe the Relation Between Variables | 78       |                    |
| 4. | Controlling Variables              | 70         |                    |
| 5. | Formulate Hypothesis               | 78         |                    |
| 6. | Designing Experiments              | 77         |                    |
| 7. | Investigate/Experiment             | 80         |                    |
| 8. | Obtaining and Presenting Data      | 74         |                    |
| 9. | Analyzing Data                     | 77         |                    |
| 10.| Applying the Concept               | 87         |                    |
3.2 Critical Thinking Skill (CTS)

Based on figure 2, the average of critical thinking skills of the experimental class was higher than the control class. The details of the percentage of critical thinking skills of the experimental class can be seen in the table below:

| No | Indicator                  | Experimental Class Percentage |
|----|----------------------------|------------------------------|
| 1  | Building Basic Skills      | 81.5%                        |
| 2  | Provide a Simple Explanation | 85.5%                       |
| 3  | Provide Further explanation | 71.5%                        |
| 4  | Conclude                   | 70%                          |
| 5  | Strategy and Tactics       | 76%                          |

3.3 Implementation of Learning Models

Based on the table above, it can be seen the average percentage of the implementation of FERA learning model from 3 meetings got 89.58% with a very good category. So, it can be concluded that the implementation of Focus, Explore, Reflect and Apply (FERA) learning model in the experimental class worked very well.
3.4 N-Gain Test

| Class      | N | Average of Pre-Test | Average of Post-Test | N-Gain | Classification |
|------------|---|---------------------|----------------------|--------|----------------|
| Experimental | 30 | 42.5                | 77.3                 | 0.60   | Medium         |
| Control    | 30 | 39.5                | 71.75                | 0.53   | Medium         |

| Class      | N | Average of Pre-Test | Average of Post-Test | N-Gain | Classification |
|------------|---|---------------------|----------------------|--------|----------------|
| Experimental | 30 | 31.53               | 76.73                | 0.65   | Medium         |
| Control    | 30 | 29.67               | 71.2                 | 0.58   | Medium         |

Based on the n-gain data above, it can be seen that the improvement of science process skills and critical thinking skills of students in the experimental class is greater than students in control class.

3.5 Normality Test

|         | Science Process Skill (SPS) | Critical Thinking Skill (CTS) |
|---------|-----------------------------|-------------------------------|
| Sig.    | .149                        | .200                          |
| Eks_Pre_Test | 1.08                       | .181                          |
| Eks_Post_Test | .085                       | .084                          |
| Control_Pre_Test | .071                       | .200                          |

Based on the normality test table above that the value of sig> 0.05. This means that science process skills and critical thinking skills were normally distributed.

3.6 Homogeneity Test

|         | F     | df1 | df2 | Sig.   |
|---------|-------|-----|-----|--------|
| SPS     | 3.916 | 1   | 58  | .053   |
| CTS     | .377  | 1   | 58  | .541   |

Based on the homogeneity test table above, it appears that the value of sig> 0.05. This means that the sample was declared homogenous.
3.7 Hypothesis Test

Table 8. Hypothesis Test

| Source            | Dependent Variable | Type III Sum of Squares | df | Mean Square | F    | Sig.       |
|-------------------|--------------------|-------------------------|----|-------------|------|------------|
| Corrected Model   | SPS                | 525,104                 | 1  | 525,104     | 27,851 | ,000       |
|                   | CTS                | 763,267                 | 1  | 763,267     | 16,092 | ,000       |
| Intercept         | SPS                | 337125,104              | 1  | 337125,104  | 17880,669 | ,000      |
|                   | CTS                | 321201,667              | 1  | 321201,667  | 6771,809 | ,000       |
| Class             | SPS                | 525,104                 | 1  | 525,104     | 27,851 | ,000       |
|                   | CTS                | 763,267                 | 1  | 763,267     | 16,092 | ,000       |

Based on the hypothesis test table above, it can be seen that the sig. value <0.05, this means that H₀ is rejected and H₁ is accepted. This means that there is an influence of FERA learning model with SAVIR approach on students’ science process skills and students' critical thinking skills.

3.8 Effectiveness Test

Table 9. Test Effect Size for Science Process Skills

| Class     | Average of Gain | Deviation Standard | Effect Size (d) | Category |
|-----------|-----------------|--------------------|-----------------|----------|
| Experimental | 0,61            | 0,09               | 0,92            | High     |
| Control   | 0,54            | 0,07               |                 |          |

Table 10. Test Effect Size for Critical Thinking Ability

| Class     | Average of Gain | Deviation Standard | Effect Size (d) | Category |
|-----------|-----------------|--------------------|-----------------|----------|
| Experimental | 0,63            | 0,10               | 0,87            | High     |
| Control   | 0,54            | 0,11               |                 |          |

The table above shows that FERA learning model with SAVIR approach is effective in improving science process skills and critical thinking skills.

Based on the results of the analysis of the data above, the results of the n-gain test and the effectiveness test in the experimental class that used FERA learning model with SAVIR approach get greater results than those in the control class. So, it can be concluded that learning by using FERA model with SAVIR approach is more effective in improving science process skills and critical thinking skills.

Science process skills and critical thinking skills in the experimental class increase even further because during learning activities through FERA learning, science process skills and critical thinking skills continued to be trained. In the Focus stage of FERA learning, the indicator of science process skills that were trained were formulating problems, determining variables, and describing the relationships between variables. At this stage, students asked to classify their initial knowledge of a concept. Educators conducted demonstrations, provided questions or problems in daily life that are relevant to the material. Students asked to solve problems, to formulate problems, to determine variables and to find the relation of each variable. They also had to express their opinions and ideas. By
giving examples of phenomenon in daily life that are relevant to the material they are learning. Through this stage, students became more understand the lesson they have learned. These activities can train students' critical thinking skills on indicator of building basic abilities and providing simple explanations. In the focus stage, students will learn by seeing (visual), listening and speaking (auditory) and by thinking (Intellectual).

The Explore stage, at this stage the science process skill that was being trained were: formulating hypotheses, designing experiments and conducting investigations or experiments. At this stage students are divided into several groups. Teacher asked them to discuss the material they were learning. Students also conduct experiments related to the concept, so that they can understood and proved their own concepts. But before conducting experimental activities, students formulated a hypothesis and designed an experiment. Besides science process skill, students' critical thinking skill was also trained, in the indicator of giving further explanation. By conducting exploration activities, the understanding of the concept will be deeper, so they can provide further explanation about the concept. In the explore phase, students learned by listening and speaking (auditory), by acting and moving (somatic), by seeing (visual) and by thinking (Intellectual).

The reflect phase, at this stage the science process skill that was being trained were: obtaining and presenting data and analyzing data. After doing the exploration activities, students obtained data for their analysis. Data from the analysis results were then compared with existing concepts. They also looked for links between the data they found and concepts to get facts and to draw conclusions correctly. At the reflect stage, students learned by listening and speaking (auditory) and by thinking (Intellectual).

The apply phase, at this stage the science process skills being trained are applying concepts. At this stage students will be trained to apply the concept they have obtained and proven into mathematical equations and also into events that occur in daily life. Students also been asked to work on questions so they can solve problems related to what they have learned. It can also train students' critical thinking skills on indicators of strategy and tactics. At the application stage students will learn by repetition (repetition) and by way of thinking (Intellectual).

Based on the results of the study, there are several causes of FERA learning model with SAVIR approach providing a better improvement in the experimental class compared to discovery learning model in the control class. First, this is because during teaching and learning activities using FERA model, learning activities become student-centered. Student-centered learning will get them actively involved [44]. Student who is more active during learning activities will more easily capture and understand the lesson[20].

Second, FERA learning activities contain an important component in science, which is practice. With practice it will give students meaningful lessons, this is because they learn not only limited to knowing but they can prove the theory by themselves [17]. By proving the truth of the theory, besides their understanding of the lesson be much better, the teaching and learning process also become not boring.

Third, in FERA learning, after getting and understanding the concept, students then apply the concept into their daily lives. They know the application of the concept in their lives. So, the ability to remember the concept will be better and last longer.

Four, FERA learning model with SAVIR approach. By using SAVIR approach, students can optimize their abilities through various learning styles, like visual learning style, auditory and kinesetic learning style. This approach can also make students learn by doing physical activities, so that it will be easier to accept the lesson. Learning with physical activity will be more effective because it can fully involve their limbs and senses [45].

Based on the results of this research, it is proven that FERA learning model with SAVIR approach is effective in improving students’ science process skills and students' critical thinking skills.
4. Conclusions and Suggestions

Based on the findings and data analysis in this study, it can be concluded that FERA (Focus, Explore, Reflect and Apply) learning model with SAVIR approach is effective in improving science process skills and students’ critical thinking abilities.

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