Enhancing elementary teachers’ science process skills through participatory scientific approach training

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Abstract. Science learning emphasizes providing direct experience to students through the process of experimental discovery. For this reason, teachers must have scientific process skills in order to design 21st Century science learning that is able to foster scientific attitudes and scientific products in elementary students. This study aims to improve the science process skills of elementary school teachers through Participatory Scientific Approach Training. This study involved 35 teachers who are actively teaching in Surakarta. The study was conducted in two cycles with each cycle consisting of plan, observe, and reflect stages. Data collection techniques are done using observation and performance tests on integrated science process skills. Performance test indicators include variable control skills, data interpretation, hypothesis formulation, operationally defining variables, designing experiments. Data analyzed descriptively and content analysis. The results showed that the application of Participatory Scientific Approach Training had a positive impact on improving the quality of processes and results. The improvement in the process is shown in the increase in the activities of the teachers in the experimental activities. As for the increase in results shown in the increase in scores of all aspects of the science process skills of teachers in the first cycle by 13.04%, and in the second cycle again increased by 12.23%. The smallest improvement was in the aspects of designing experiments, where the teacher had not been able to make experimental designs that were procedural and had parameters.

1. Introduction

Quality science learning emphasizes providing direct experience to students through the process of experimental discovery, so they can develop themselves in understanding the natural environment scientifically. Learning is directed at inquiry to help students gain a deep understanding of the natural surroundings. Active science learning is given since students in primary school education [1]. This implies that students can understand science as early as possible, and produce science products [2].

Science is seen as a process where scientific investigation skills play an important role in obtaining scientific products [3]. Science process skills are demanded in science learning and have become an inseparable part of science learning [4]. Science process skills encourage students to think rationally and objectively through scientific investigation [5]. Therefore, the teacher plays an important role in designing learning, including science experiments. In this case, the science process skills are very important to be mastered by the teacher [6].

Science process skills of teachers in schools shows unsatisfactory results. Teachers still experience difficulties in variable control skills, data interpretation, hypothesis formulation, operationally defining variables, designing experiments. In the design of learning plans, teachers are not yet skilled in preparing teaching materials. This was also revealed by previous research showing that aspects of SPS
have actually been applied but have not been maximized due to lack of student worksheets (LKS) [9]. For this reason, teachers must have scientific process skills in order to design 21st Century science learning that is able to foster scientific attitudes and scientific products in elementary students. Participatory training is needed that trains the teacher to see science in a scientific perspective, so that it is not only a collection of facts and concepts, but also requires science process skills.

Science process skills (SPS) is the basis for scientific thinking and research, so scientists have found something new [7] [8]. Science process skills consist of basic skills and integrated skills. Basic process skills are skills to be able to observe, reference, measure, communicate, classify, and be able to predict, while the process referred to as integrated process skills is a skill that is able to control variables, provide operational definitions, can formulate hypotheses, interpret data, and can do experiments [6] [7]. These integrated science skills are useful for teachers to design good practices in learning science in elementary schools.

This study aims to improve the science process skills of elementary school teachers through Participatory Scientific Approach Training. Training participatory training methods emphasize the learning process, where learning activities in training are built on the basis of the active participation (participation) of trainees in all aspects of training activities [10]. The research uses a scientific approach that has been proven to be able to improve science process skills [11] [12]. With this, this participatory training applies the syntax of the scientific method, consisting of making observation, asking a question, forming a hypothesis, performing an Experiment, analyzing data, forming a conclusion, explaining result.

2. Method
This study uses a qualitative approach to the type of action research. The study was conducted in the form of a cycle using the Kemmis and Taggart Model [13]. The action in this study took the form of participatory training involving 35 teachers who were actively teaching in the Surakarta City Elementary School. The study was conducted in two cycles with each cycle consisting of plan, observe, and reflect stages. Data collection techniques are done using observation and performance tests on integrated science process skills. Performance test indicators include variable control skills, data interpretation, hypothesis formulation, operationally defining variables, designing experiments. Data were analyzed descriptively and content analysis.

3. Results and Discussion

3.1. Teachers Activities through Participatory Scientific Approach Training
Participatory Scientific Approach Training is carried out with a strategy of providing an understanding of concepts about learning science in elementary schools and science process skills; analyzing the syllabus and learning resources available in elementary science; then design scientific learning based on scientific work. The activities of the teachers in this activity follow the syntax of the scientific approach. The study of teacher activities in this activity can be seen in table 1.

In table 1, it can be seen that there was an increase in the activities of the teachers in cycle 1 to cycle 2. In the first cycle of Participatory Scientific Approach Training, the teachers still experienced difficulties in observation. The level of concentration and focus on this process must be high, otherwise this can make what you want to learn unclear. The teachers still do not see the emphasis of observation related to the variables to be observed. In cycle 2, the teacher is better at observing objects as variables that must be observed carefully.
### Table 1. Teachers Activities through Participatory Scientific Approach Training

| Stage                | Percentage of Performance (%) | 1st Cycle | 2nd Cycle |
|----------------------|--------------------------------|-----------|-----------|
| Making observation   | 71,50                          | 88,35     |           |
| Asking a question    | 54,35                          | 75,00     |           |
| Forming a hypothesis | 51,70                          | 73,50     |           |
| Performing an Experiment | 47,50              | 70,35     |           |
| Analysing data      | 45,25                          | 74,00     |           |
| Forming a conclusion | 55,15                          | 74,15     |           |
| Explaining result    | 70,00                          | 85,10     |           |

In the asking a question stage, the teacher is still difficult to make good questions and attract students' interest and make students think critically about a study. Questions that are presented are still quite shallow, for example in the experiment of making magnets in the rub technique, questions made are still quite shallow, such as "What is the correct technique in making magnets by rubbing?". However, in the second cycle the questions made by the teacher were deeper, namely "Why can the technique of unidirectional rubbing produce higher magnetic strength than the alternating rubbing?"

At the stage of forming a hypothesis, the teachers have been able to compile an experimental hypothesis, but it is still not scientifically structured. In the second cycle, the teachers are trained to observe objects and see them closely with related variables, and only form predictions by not leaving the experimental context. At the experimental stage, the teachers are still not confident to do it. This is the answer to the discovery of experimental tools that are still stored intact (never used for experiments). The teachers confess that they are having difficulties and are afraid of using tools to do the practicum.

In the analysis phase, the teachers are involved in small groups (5 people in each group) to discuss the observations. It aims to familiarize it in the scientific community by critiquing experimental findings. In cycle 1, only 45.25% of the performance was measured effectively. In the second cycle, the teachers are separated into smaller groups, namely 3 people per group. In this way, teacher confidence increased and resulted in better data analysis in the second cycle, amounting to 74.00%.

The stages of drawing conclusions are made after the analysis activities have actually been completed. In the first cycle, the teachers draw conclusions yet to provide a scientific path. In cycle two, teachers are more trained on how to draw conclusions by paying attention to the formulation of the problem that was made at the beginning. This provides meaningful experience for the teacher that the experiment is a single unit that is not separated and consistent flow. This has a better impact on the second cycle. As for the explanation phase, the teachers were able to provide input and comments to the teachers with different experiments.

#### 3.2. Elementary Teachers’ Science Process Skills through Participatory Scientific Approach Training

Science process skills to teachers is measured through performance tests that include integrated science process skills indicators. Measurements were made at the end of each cycle with the following results. As seen in Figure 1, it can be seen an increase in SPS in the first cycle and second cycle. At the pre-cycle stage it can be seen that the average SPS is still unsatisfactory with an average of 53.72. In the first cycle increased by 13.04% to an average of 66.76. In the second cycle, again increased to 78.99, with an increase of 12.23%.
In the aspect of variable control skills, the teachers identify the variables that affect the results; identification of variables changed in the experiment; and identification of the controlled variables in an experiment. In these three activities, most teachers had difficulty in identifying the variables that were changed. This is because the teachers are not used to the environment of scientific experimentation and investigation. In the second cycle, the teachers are better at mastering the concepts of dependent and independent variables, and their implications in influencing the results of experiments [14].

The ability of data interpretation is the best ability for teachers. The teacher is able to interpret the data, both qualitative and quantitative. In addition, the teachers are also able to present data in the form of tables and diagrams. In the aspect of the hypothesized formulation, the teachers had difficulty in its preparation. However, a small number of teachers still cannot provide a hypothesis even though they have been given extra time to develop it. In cycle two, the teachers are still given extra time and are trained to see the problems of the experiment comprehensively. Through the identification of good variables, in the second cycle, the teacher is able to arrange hypotheses more precisely [15].

Operationally defining variables also increased. Operationally defining variables related to the formulation of a definition based on what is done or what is observed. An operational definition tells how an action or event takes place. In the first cycle, teachers still find it difficult to do it (an average of 73.25), while in the second cycle teachers are better trained to define operational aspects of a variable by determining what actions are taken and what observations will be recorded. Teachers are given the freedom to make operational definitions of their own variables, meaning that the same variable operational definition can vary depending on what is determined by each teacher. With this active involvement, the ability of operationally defining variables increases to 82.25 [14].

This aspect of designing an experiment is the most difficult for teachers. This is because teachers rarely implement experiments in the classroom. In the first cycle the acquisition of this aspect only obtained an average score of 64.15. The main difficulty for teachers is designing their teaching materials. In this training given the opportunity to compile working papers ranging from the purpose of the experiment, tools and materials, work steps, observations, and the use of experimental parameters. In the second cycle, a better score is obtained, amounting to 72.25. The teacher’s active involvement in designing experiments gives its own meaning to the teacher so that it is better in designing experiments with diverse experiment goals [16]. However, the camps need to be trained to get used to it in daily science learning activities.

4. Conclusion
The results showed that the application of Participatory Scientific Approach Training had a positive impact on improving the quality of processes and results. The improvement in the process is shown in the increase in the activities of the teachers in the experimental activities. The increase in results shown in the increase in scores of all aspects of the science process skills of teachers in the first cycle.
by 13.04%, and in the second cycle again increased by 12.23%. This study found that the smallest improvement was in the aspects of designing experiments, where the teacher had not been able to make experimental designs that were procedural and had parameters. Thus, the improvement of the science process skills of the teacher is further directed at increasing the ability to design experiments.

The contribution of this study to science education in primary schools can be seen in the improvement of the science process skills of teachers who have improved through observable and measurable experimental activities.

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