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The effectiveness of CPI model to improve positive attitude toward science (PATS) for pre-service physics teacher

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Abstract. In the previous research, learning material based Construction, Production, and Implementation (CPI) model has been developed to improve scientific literacy and positive attitude toward science for pre-service physics teacher. CPI model has 4 phases, included: 1) Motivation; 2) Construction (Cycle I); 3) Production (Cycle II); and 4) Evaluation. This research is aimed to analyze the effectiveness of CPI model towards the improvement Positive Attitude toward Science (PATS) for pre-service physics teacher. This research used one group pre-test and post-test design on 160 pre-service physics teacher divided into 4 groups at Lambung Mangkurat University and Surabaya State University (Indonesia), academic year 2016/2017. Data collection was conducted through questioner, observation, and interview. Positive attitude toward science for pre-service physics teacher measurement were conducted through Positive Attitude toward Science Evaluation Sheet (PATSES). The data analysis technique was done by using Wilcoxon test and n-gain. The results showed that there was a significant increase in positive attitude toward science for pre-service physics teacher at α = 5%, with n-gain average of high category. Thus, the CPI model is effective for improving positive attitude toward science for pre-service physics teacher.

1. Introduction

Learning physics offers a way of thinking about a world that has real-life applications and rational explanations of the world in order to be easily understood, to support open, objective and fair thinking, and to rely on empirical evidence [1]. Physics education can prepare the competence of physics teacher graduate to master science literacy and have a positive attitude toward science [2]. Attitudes toward science determine the success rate of pre-service physics teacher in studying physics [3]. Pre-service physics teacher can give more attention to the learning process that lecturers do and more scientific participation in scientific investigation like a scientist in searching and finding science.

[4] Describes how to improve positive attitudes toward science in physics learning, namely: (1) increasing motivation or interest in learning science, motivation is an important construct in physics learning. Lecturers can increase their motivation in physics learning by making pre-service physics teacher passionate in physics subject discussion, happy to solve physics problems, enjoy reading physics lessons, enjoy acquiring new knowledge in physics, feel physics study influence career prospects in the future, there is a desire of career in physics or physics projects, (2) increasing confidence in physics learning, pre-service physics teacher' beliefs about their own ability can make
them more willing to support the success of the learning process and to alert the quality of their performance. The lecturer always assures the pre-service physics teacher that being able to study the ever-expanding physics can provide the best answers to test scientific questions, easily understand new ideas in physics, be sure to plan and carry out experiments well, and be sure to draw conclusions based on experimental data or reference studies, (3) support of scientific inquiry, the pre-service physics teacher feel the direct experience of conducting scientific investigations like a scientist in searching and finding physics material. Lecturers encourage the role of pre-service physics teacher in supporting imitative investigations to understand the environment, solving physics problems in life, developing science and technological innovation, and being responsible for resources and the environment. Pre-service physics teacher conditioned to assess the environmental situation and demonstrate willingness to act to preserve natural resources, as well as demonstrate a sense of personal responsibility for maintaining a sustainable environment.

In fact, the positive attitude toward science of pre-service physics teacher is still far from expectations. The results of the preliminary study of [5] found that most pre-service physics teacher of Unesa physics education program is less able to show a positive attitude toward science. Pre-service physics teacher found it difficult to learn physics, are less interested and less confident in learning physics, less participant and less convinced in group investigation activities, less daring to make decisions in using physics materials to solve real life problems, and have less responsibility for environmental problems. The results of previous research indicate a serious problem related to the positive attitude toward science of pre-service physics teacher.

In the previous research, Construction, Production, and Implementation (CPI) model has been developed to improve scientific literacy and positive attitude toward science for pre-service physics teacher. The CPI model has been specially designed to increase scientific literacy and positive attitude toward science for pre-service physics teacher. CPI model has 4 phases, namely: 1) Motivation; 2) Construction (Cycle I); 3) Production (Cycle II); and 4) Evaluation. The previous research developed a device of learning physics as an operational form of CPI model developed. The CPI model and learning tools developed by researchers have filled the needs of 21st Century skills. Therefore, it is hoped that the implementation of the CPI model that have been developed quality of pre-service physics teacher.

A model is said to be of high quality when fulfill the criteria of validity, practicality, and effectiveness [6]. Indicator of positive attitude toward science for pre-service physics teacher is motivation in science, belief in learning science, support in scientific investigation, and responsibility for resources and environment [4]. Fundamental physics materials used in physics learning. The purpose of this research is to analyze the effectiveness of the CPI model to increase the positive attitude toward science for pre-service physics teacher. The focus of the problem in this study included: (1) whether there was a significant increase (statistically) of positive attitude toward science for pre-service physics teacher before and after the CPI model was applied, (2) how much level of positive attitude toward science for pre-service physics teacher increased before and after applied CPI model.

2. Methodology of Research

2.1. General Background of Research

This research was conducted at Lambung Mangkurat University and University of Surabaya State (Indonesia). The scope of this research is on pre-service physics teacher in academic year 2016/2017. This research is emphasized on the analysis of the fulfillment of the effectiveness of CPI model by analyzing the improvement of positive attitude toward science for pre-service physics teacher before and after following the CPI model. The effectiveness of the CPI model was determined based on a significant increase in scores (statistically) between pre-test and post-test of positive attitude toward science for pre-service physics teacher, as well as the mean of n-gain determined by criteria: low, medium and high.
2.2 Sample of Research
The samples in this study were 160 pre-service physics teacher of Lambung Mangkurat and University of Surabaya State, Indonesia; which is in the four groups, namely: group-1 (class VIA Lambung Mangkurat University), group-2 (class VIB Lambung Mangkurat University), group-3 (class VIA Surabaya State University), and group-4 (class VIB Surabaya State University). Each group consists of 40 pre-service physics teacher in academic year 2016/2017.

2.3 Instrument and Procedures
Positive Attitude toward Science Evaluation Sheet (PATSES) is an instrument used to measure Positive Attitude toward Science [4]. PATSES includes motivation in science, belief in science learning, support in scientific inquiry, and responsibility for resources and environment [4]. Fundamental physics materials used in physics learning. This research uses one group pretest-posttest design, which is O1 X O2 [7]. The learning process begins by giving pre-test (O1). Each pre-service physics teacher is required to complete the PATSES. After the pre-test, the lecturer applies the CPI model and learning tool in each group (X). Learning science is consisting of: motivation in science, belief in learning science, support in scientific investigation, and responsibility for resources and environment at each learning phase. The process of physics learning ends with post-test (O2). Every pre-service physics teacher is required to post-test of positive attitude toward science by filling PATSES.

2.4 Data Analysis
Positive attitude toward science pre-service physics teacher is analyzed based on the assessments obtained by pre-service physics teacher before and after learning using the CPI model. The pre-test, post-test, and n-gain data of positive attitude toward science of pre-service physics teacher were further analyzed using inferential statistical tests with the help of SPSS and reinforced by qualitative descriptive analysis. The score level for positive attitude toward science pre-service physics teacher is based on indicators of motivation in science, belief in science learning, support in scientific inquiry, and responsibility for resources and environment [4]. The n-gain value is determined by the equation: 
\[ n\text{-gain} = \frac{\text{score post-test} - \text{score pre-test}}{\text{maximum score} - \text{pre-test score}} \] [8]. According to the following criteria: (1) if n-gain ≥ .7 (high), (2) if .3 < n-gain < .7 (moderate), and (3) if n-gain ≤ .3 (low).

3. Result of Research
The learning outcomes of all groups related to the positive attitude toward science of pre-service physics teacher are presented in Figures 1 and Table 1. Vertical bar represent the mean of pre-test, shape bar scores represent the mean post-test scores, and black bars scores represent the n-gain scores. Figure 1 shows the average post-test scores of positive attitude toward science of pre-service physics teacher for all groups is greater than the pre-test score. The average pre-test, post-test, and n-gain scores associated with positive attitude toward science of pre-service physics teacher indicators for all groups are presented in detail in Table 1. Figure 1 shows the average n-gain value of positive attitude toward science for group-1, group-2, group-3, and group-4 are respectively .75; .73; .73; and .72. The average n-gain value of positive attitude toward science of pre-service physics teacher for all groups is in the high category.
Figure 1. The average pre-test, post-test, and n-gain scores of positive attitude toward science of pre-service physics teacher in all groups.

Table 1. The average score of pre-test, post-test and n-gain of positive attitude toward science of pre-service physics teacher in all groups.

| School                | Groups | Scores | Positive Attitude Toward Science Indicator |
|-----------------------|--------|--------|------------------------------------------|
|                       |        |        | Motivation in science | Belief in science learning | Support in scientific inquiry | Responsibility for resources and environment |
| Lambung Mangkurat University | 1      |        | Pre-test: .14 | .15 | .26 | .25 |
|                       |        |        | Post-test: .75 | .77 | .84 | .83 |
|                       |        |        | n-gain: .71 | .73 | .78 | .77 |
|                       |        |        | Pre-test: .74 | .67 | .76 | .77 |
|                       |        |        | n-gain: .71 | .66 | .75 | .76 |

Table 1 shows that the positive attitude toward science test scores of each indicator include: motivation in science, belief in science learning, support in scientific inquiry, and responsibility for resources and environment are low for all groups and the post-test score of positive attitude toward science in each indicator is high for all groups. The n-gain of positive attitude toward science score of each indicator includes: motivation in science, belief in science learning, support in scientific inquiry, and responsibility for resources and environment in all groups are moderate or high.
Table 2. Wilcoxon test result of positive attitude toward science for all groups.

| University               | Group | Data     | N  | Z      | p     |
|--------------------------|-------|----------|----|--------|-------|
| Lambung Mangkurat University | 1    | Pretest-Posttest | 40 | -4.10  | <.01  |
|                          | 2    | Pretest-Posttest | 40 | -4.11  | <.01  |
| Surabaya State University  | 3    | Pretest-Posttest | 40 | -4.11  | <.01  |
|                          | 4    | Pretest-Posttest | 40 | -4.10  | <.01  |

Table 2 shows the improving in pre-test and post-test positive attitude toward science tested using Wilcoxon test. The Z score gives a value of -4.10; -4.11; -4.11 for group-1; group 2; group 3; group 4. Each score is considered significant, because p < .05. Because Z the result of the calculation is negative so it shows that there is an increase of positive attitude toward science of pre-service physics teacher after applied learning with CPI model for all groups.

4. Discussions

The effectiveness of the CPI model on improving positive attitude toward science of pre-service physics teacher can be seen from (1) an increase in pre-test and post-test scores and (2) n-gain positive attitude toward science value, as shown in Figure 1, Table 1, and Table 2. Before the CPI model is applied; pre-service physics teacher less mastery the positive attitude toward science, average score of pre-service physics teacher is under the standard score (minimum score .20 in score range 0-1), that is the average score of positive attitude toward science for group-1, group-2, group-3, and group-4 respectively are .20; .19; .15; and .10. All this time, pre-service physics teacher are not used to motivation in science, belief in scientific inquiry, and responsibility for resources and environment. This is supported by [5] found that most pre-service physics teacher of Unesa physics education program is less able to show a positive attitude toward science. Pre-service physics teacher find it difficult to learn physics, are less interested and less confident in learning physics, less participant and less convinced in group investigation activities, less daring to make decisions in using physics materials to solve real life problems, and have less responsibility for environmental problems. The results of previous research indicate a serious problem related to the positive attitude toward science pre-service physics teacher.

After the CPI model was applied to the pre-service physics teacher, the mastery of positive attitude toward science rises above average and becomes high; the average score of positive attitude toward science for groups-1, group-2, group-3, and group-4 respectively to .80; .78; .77; .72 (well beyond the minimum score of .75 in the 0-1 score range). The increase in positive attitude toward science is allegedly influenced by design of scenario in phase of the CPI model. Each phase emphasizes positive attitude toward science in scientific activities. Lecturers are able to cultivate pre-service physics teacher 'positive attitude in constructing their own science literacy (phase 1 of CPI model), improving positive attitude toward pre-service physics teacher' science through scientific investigation, problem solving, and involvement in decision-making process related to science issues and solutions (phase 2 of CPI model) space to establish positive attitudes toward their own science by assigning responsibility for drafting the scientific literacy lesson plan well (phase 3 of CPI model), and involving them in the evaluation and reflection of well-executed outcomes and learning processes (phase 4 of CPI model). Reinforced interview data and observation that pre-service physics teacher feel lecturers can inspire pre-service physics teacher to grow and apply a positive attitude to science well. Pre-service physics teacher find it easy to apply self-motivation in science, feel confident in learning science, active in scientific inquiry, and responsible for resources and environment. Application of CPI model is able to facilitate positive attitude toward science not only accept, but also apply it to support pre-service physics teacher's success in constructing science literacy and designing science literacy learning well. Supported with other research results that Physics education can prepare the competence of physics teacher graduate to master science literacy and have positive attitude toward science [2].
Attitudes toward science determine the success rate of pre-service physics teacher in studying physics [3]. The increase of positive attitude toward science of pre-service physics teacher score in all groups was significant at the 5% significance level with n-gain of .75 for group-1; .73 for group-2; .73 for group-3; and .72 for group-4. This means that there is an increase in positive attitude toward science of pre-service physics teacher after the implemented CPI model. Increased positive attitude toward science is supported by the availability of positive attitude toward science of pre-service physics teacher learning needs as suggested in phase of the CPI model. It is supported by metacognition theory that capable pre-service physics teacher are aware of how they learn and take steps in maximizing their efforts to achieve better results [9]. Another support of Bandura's modeling theory is that the cognitive, affective, and behavioral changes that result from observing others' behaviors and explanations [10]. Self-regulated learning theory that pre-service physics teacher learn when engaged in the process of setting personal goals, combined with motivation, thought processes, strategies, and behaviors leads to the achievement of goals [9]. Theory of distributed cognition learning that pre-service physics teacher share ideas with others to improve their understanding, being encouraged to clarify and organize their own ideas, elaborate what they know, find weaknesses in reasoning, and enjoy alternative views that are just as valid as which they have known by the term [10]. Reflection as deepening comprehension including interrelation between the essential concepts of lecture materials can foster awareness of pre-service physics teacher attitude, provided that the lecturer exemplifies [11]. Application of CPI model is able to facilitate positive attitude toward science not only accept, but also apply it to support student's success in constructing science literacy and designing science literacy learning well [12-14]. Based on the above description, the implementation of CPI model is able to develop the role of positive attitude toward science of pre-service physics teacher.

5. Conclusions
This research shows that there was a significant increase in positive attitude toward science for pre-service physics teacher at α = 5%, with n-gain average of high category. Thus, the CPI model is effective for improving positive attitude toward science for pre-service physics teacher. It can be concluded that CPI model is effective to improve positive attitude toward science for pre-service physics teacher. This positive attitude toward science is clearly by design in every phase of the CPI model. The implication of this research is that CPI model can be used as an alternative to overcome the low of positive attitude toward science for pre-service physics teacher. To improve the result of this research, it is necessary to do further generalizations in various education levels and countries.

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