The effectiveness of OrDeP2E learning model to train the natural science problem-solving skills of primary school students

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Abstract. The OrDeP2E learning model (Problem Orientation, Problem Definition, Hypothesis Submission, Hypothesis Testing, and Evaluation) is a natural science learning model that refers to a scientific approach to train the students’ natural science problem-solving skills. The purpose of this study is to analyse the effectiveness of OrDeP2E model to change the problem-solving skills of primary school students. This study used one group pre-test and post-test design toward the primary school students of 2017/2018 academic year. The students’ problem-solving skills were measured by using the Natural Science Problem-solving Skills Assessment Sheet (NSPSSAS) and Student Response Questionnaire. The indicators of natural science problem-solving skills include identifying problems, formulating problems, making hypothesis, conducting experiment, and drawing conclusions. The data analysis technique used Paired test, n-gain, and Independent test. The result of the research proves that: 1) There is an improvement on the primary school students’ natural science problem-solving skills on = 5%; 2) The average n-gain score of students’ natural science problem-solving skills were in high category; 3) there is no significant difference (consistent) n -gain on students’ natural science problem-solving skills in all groups; and 4) Students responded very positively. Therefore, the OrDeP2E learning model has proven to be effective to solve the natural science problem-solving skills of primary school students.

1. Introduction
The qualified human beings are people who have scientific creativity, critical thinking, scientific collaborative skills, have science literacy in solving problems that is caused by the impact of science and technology development [1-7]. The 21st century skills are required to become a quality human being. One of the skills that are developed in the 21st century is problem-solving skills [3-4]. Problem-solving skills are skills that are used to find answer of a problem [3-4, 8]. Problem-solving skills have several important roles; it is including acing the industrial revolution 4.0. The natural science learning process really needs the problem-solving skills, especially when conducting an investigation. In accordance with
the opinion [9], which states that at the time of investigation activities, students use the knowledge that they have to solve the given problem? Therefore, primary school students as the successor of the Indonesian nation must be trained to have the natural science problem-solving skills to be able to excel in global competition. The indicators of natural science problem-solving skills in this study include identifying problems, formulating problems, making hypothesis, conducting experiment, and making conclusions. Based on the results of literature studies and preliminary studies by researchers, these five indicators are still low and need to be improved by primary school students in natural science subjects.

The natural science problem-solving skills of primary school students are still low because teachers do not maximally train students to apply problem-solving skills [10]. This is reinforced by the preliminary observational study results at SDN I Wiyung (Surabaya, Indonesia) which showed that (1) the learning is still teacher-cantered (2) teacher do not invite students to find the concept of their own material at the time of natural science learning, and (3) the students still have difficulties when completing the natural science problem-solving skills test. This is reinforced by the results of the study [11-14] that most teachers still apply lecture methods that cantered on the teacher, science process skills and problem-solving are not maximized in natural science learning.

Training the problem-solving skills toward students requires a learning model whose syntax is consistent with the problem-solving skill indicators. The suitable learning model is OrDeP2E. This learning model has five syntaxes; they are problem orientation, problem definition, hypothesis submission, hypothesis testing, and evaluation. The advantages of OrDeP2E learning model is to invite students to interact directly with the environment, invite students to solve a problem, invite students to find the concept of the material. In this learning model students are invited to conduct an inquiry to improve problem-solving skills [15,16]. In accordance with the results of the study [17] that if students are able to participate actively in the laboratory, the students will be successful in the learning process.

The OrDeP2E learning model is well suited to primary school students because according to Piaget [18] children in 7 to 12 years old enter the concrete operational stages that still require concrete objects in the learning process. The application of the OrDeP2E learning model [16] is capable to enhance creative thinking and have companion impact to improve problem-solving skills. In addition, the study is supported by research conducted by [4,13,17,19] which stated that scientific inquiry-based learning can improve problem-solving skills and learning achievement. The focus of this study is to follow-up study based on recommendations [16] to see the effectiveness of the OrDeP2E learning model to improve the natural science problem-solving skills on different study materials and levels; it is the properties of objects in grade IV of primary school students. The results of this study are expected to be an empirical evidence of the OrDeP2E learning model effectiveness to improve students' natural science problem-solving skills.

2. Method

2.1 General Background of Research

This research was conducted at SDN I Wiyung (Surabaya, Indonesia). The scope of this study is the fourth grade primary school students who take natural science subjects in academic year 2017/2018. The objective is to analyse the effectiveness of the OrDP2E learning model by analysing the improvement of problem-solving skills of primary school students before and after the application of OrDP2E learning model. The effectiveness of the OrDP2E learning model was determined based on: 1) Significant increase in the score between pre-test and post-test of the primary school students’ natural science problem-solving skills; 2) The average n-gain is determined at least on the low improvement criteria; and 3) The consistency of average n-gain scores of the primary students’ problem-solving skills.

2.2 Sample of Research

The samples of research were 20 students at SDN I Wiyung (Surabaya, Indonesia) using purposive sampling technic; which is in the two groups, namely: group-1 (class IVA) and group-2 (class IVB) have homogeny of science problem-solving skills. Each group consists of students on science subject in academic year 2017/2018.
2.3 Instrument and Procedures

The natural science problem-solving skills of primary school students were measured by using the Science Problem-solving Skills Assessment Sheet (NSPSSAS), which has been declared valid and reliable [15]. NSPSSAS is prepared based on the measurable natural science problem-solving indicators, they are (1) identifying problems, (2) formulating problems, (3) hypothesis submission, (4) hypothesis testing, and (5) drawing conclusions [4,15]. The subjects of science lesson that was selected in this study was in accordance with the characteristics of the OrDP2E learning model, it was the properties of light. This study used one group pre-test and post-test design, O1 X O2 [8,20]. The learning began by giving pre-test (O1). Every primary school student is required to complete NSPSSAS. After the pre-test, the teacher applied the OrDP2E learning model and the natural science learning instruments in each group (X). The implementation of OrDP2E learning model had been conducted for four meetings on science subjects. The learning of science by using OrDP2E learning model has five syntaxes: (1) problem orientation, (2) problem definition, (3) hypothesis submission, (4) hypothesis testing, and (5) evaluation. The natural science learning instruments consisted of syllabus, learning implementation plan, student activity sheet, textbook, NSPSSAS, and student's response questionnaire (valid and reliable) [15]. Each phase of the OrDP2E learning model by design trains the natural science-problem-solving skill indicators: (1) identifying problems, (2) formulating problems, (3) hypothesis testing, (4) conducting experiment, and (5) drawing conclusions. The implementation of OrDP2E learning model was ended by post-test (O2) that used CTSAS. Every primary school student was required to complete NSPSSAS on post-test.

2.4 Data Analysis

The natural science problem-solving skills of primary school students were analysed based on the assessments that was determined before and after the application of OrDP2E learning model. Pre-test, post-test, and n-gain of primary school students’ problem-solving skills were further analysed by using the inferential statistics with the help of SPSS software. The N-gain was determined by using the equation: $n \text{-gain} = (\text{maximum score} - \text{pre-test score}) / \text{pre-test score}$ [21], with criteria: (1) if $n \text{-gain} \geq .7$ (high), (2) if $.3 \leq n \text{-gain} < .7$ (medium), and (3) if $n \text{-gain} \leq .3$ (low). The choice of statistical testing methods relies on fulfilling the assumptions of normality and homogeneity of variants for the pre-test, post-test, and n-gain of the problem-solving skills of primary school students. The inferential statistical test with Paired t-test or Wilcoxon test (analysis of statistical improvement) and n-gain consistency analysis of all primary school students after the application OrDP2E learning model used Anovatest or Kruskal-Walls test.

3. Result and Discussion

The study results are presented in Table 1, Table 2, Table 3, Table 4, and Figure 1, which will be described as follows.

Table 1. The average pre-test, post-test and n-gain of primary school students’ problem-solving skills

| Group       | The natural science problem-solving skills of primary school students’ problem-solving skills | Pre-test | Post-test | N-gain |
|-------------|---------------------------------------------------------------------------------------------|---------|----------|--------|
|             |                                                                                             |         |          |        |
| 1 (Class IVA)|                                                                                             | 43.30   | High     | 0.72   | High   |
| 2 (Class IVB)|                                                                                             | 45.40   | High     | 0.74   | High   |

Table 1 describes the mean pre-test, post-test and n-gain of the primary school students’ problem-solving skills. The low pre-test score was because the students have not had natural science problem solving skills yet. According to Piaget [18], the adaptation process can be through the process of assimilation and accommodation. The process of assimilation means that if students gain new knowledge or experience, then the new experience fits the scheme. While the accommodation process is the process of adaptation that occurs if students gain new knowledge, then the students change the schemes to be in accordance with the new knowledge. As the adaptation process proceeds, students’ interest in learning by using the OrDeP2E model increases, so students’ problem solving skills can be improved, it was
known through the n-gain of Class IVA and Class IVB which fell into the high category, which means an increase in pre-test score and post-test in both groups. The results of this study prove that the implementation of OrDP2E learning model is effective to improving the problem solving skills of primary school students. This is because the developed OrDP2E learning model meets the validity (content and construct), practicality, and effectiveness to improve the natural science problem-solving skills of primary school students [1,4,15]. This is supported by the results of the study [1,5,8,22-24] that the model which is declared feasible by fulfilling the validity (content and construct), practicality, and effectiveness will be able to improve and achieve the learning objectives. The results of the normality and homogeneity test of variance suggested that the pre-test, post-test, and n-gain of students' problem solving skills are homogeneous and normally distributed for the whole group. Therefore, the impact of the OrDP2E learning model implementation in improving students' natural science problem solving skills for all groups used Paired t-test and consistency test by using Independent t-test. The Paired t-test and Independent t-test results are presented in Table 2 and Table 3.

Table 2. The results of Paired t-test of natural science problem-solving skills at all groups

| Group   | N  | Paired $t$-test, $\alpha = 5\%$ |
|---------|----|---------------------------------|
|         |    | Mean | $t$  | df | p   |
| Group-1 | 10 | -40.65 | -19.60 | 9  | .00 |
| Group-2 | 10 | -40.45 | -12.28 | 9  | .00 |

Table 2 shows the average of science process skills for groups 1 and 2 are -40.65 and -40.45 and the $t$ score gives $t$ value = -19.60 and -12.28 for degrees of freedom (df) = 10 (groups-1 and group-2). Each score is considered significant, because $p < 5\%$. Therefore, the $t$ result of the calculation is negative, so it shows there is an increase in students' natural science problem-solving skills after the application of OrDP2E learning model for all groups.

Table 3. The results of Independent $t$-test of students’ natural science problem-solving skills at all groups.

| Independent $t$-test, $\alpha = 5\%$ | t  | df | Sig. (2-tailed) |
|--------------------------------------|----|----|-----------------|
| N-gain_Group-1_Group-2               | -.530 | 18 | .602 |

Table 3 shows that $t$ arithmetic gives $t < t_{\text{table}}$ with significance level $P > 5\%$. This clearly indicates that there is no difference in the increase of students’ natural science problem-solving skills after the implementation of learning with OrDP2E learning model for all groups.

Table 2 explains that there is a significant difference between pre-test and post-test (there is improvement) of students' problem solving skills. Table 3 shows that there is no significant difference (consistent) of students’ natural science problem-solving skills as the impact of applying the OrDeP2E learning model to all groups. This is because the OrDP2E learning model has been developed by design to improve students' problem solving skills through syntaxes of problem orientation, problem definition, hypothesis submission, hypothesis testing, and evaluation. The results are reinforced with theoretical and empirical support that OrDP2E learning model is a science-learning model that refers to a scientific approach to improve the students’ natural science problem-solving skills [16] that is supported by learning theories, namely motivational theory, cognitive-social constructivist theory and cognitive learning theory [25-27]. Therefore, the OrDP2E learning model is effective for improving the natural science problem-solving skills of primary school students. The improvement of natural science problem-solving skills of primary school students is reinforced by the qualitative data that is presented in Figure 1.
Figure 1. Differences in natural science problem-solving skills of students before and after the implementation of the OrDP2E learning model

Figure 1 explains that the value of students’ pre-test was 47. This score is low. This shows that students’ problem-solving skills are still very low. After the students got the learning by using OrDeP2E model, the problem solving skills of students has increased, it was marked by high post-test score, it was 97. On the pre-test sheet, it can be seen that students have not understand about the concept of light properties. In question number 2 there is a question about the phenomenon of the nature of light that it can be refracted, but students answer "light creeping". After the students are given treatment by implementing the OrDeP2E learning model, students have better understanding about the concept of the lights’ properties. On the post-test sheet about number 2, students have been able to answer the question correctly that it is "refracted". Based on the pre-test and post-test results, it can be seen that the students have been able to reach the problem-solving indicator. In this process, the students are given learning with the OrDeP2E model, and the students adapt to the model at several learning meetings until their learning interest emerges and can improve their problem solving skills. In accordance with the results of the study, [28] the use of inquiry methods can improve students' problem solving and is able to relate problem solving tasks with daily life. According to Bruner, [18] a learning stage in which students do a direct observation to understand the environment is called as enactive, and the learning stage through the process of interpretation or hypotheses about what is observed is called as the symbolic stage. In the OrDeP2E learning model, students also do enactive and symbolic process for example when they make direct observation or do research and do interpretation of what is observed or make hypothesis. Through the learning phase, the students are able to reach the problem-solving indicator that is the hypothetical indicator and the experiment. The improvement of students’ natural science problem-solving skills after the implementation of the OrDeP2E learning model that is supported by students’ response data is presented in Table 4.

| The response of primary school students | Group I (Class IVA) | Group II (Class IVB) |
|----------------------------------------|---------------------|----------------------|
| Sample | Response | Category | Sample | Response | Category |
| 10 | 83.00% | Very Positive | 10 | 85.00% | Very Positive |

Table 4 shows that in general, students responded very positively to the OrDeP2E learning model and learning instruments. The interviews showed that students felt that the natural science problem-solving skills were increased. The results of this study provide empirical evidence of the effectiveness of the OrDeP2E learning model to improve the natural science problem-solving skills of primary school students.
4. Conclusion
The OrDeP2E learning model (problem orientation, problem definition, hypothesis submission, hypothesis testing, and evaluation) is a natural learning model that refers to a scientific approach to solve students’ problem solving skills. The research results prove that: 1) There is an increase in natural science problem-solving skills of primary school students at α = 5%; 2) The average n-gain score of students' natural science problem solving skills was in high category; 3) There is no significant difference (consistent) on the n-gain of problem-solving science skills in all groups; and 4) Students responded very positively. Therefore, the OrDeP2E learning model has proven to be to improve the natural science problem solving skills of primary school students. The implications of this research are used as an alternative in improving the natural science problem-solving skills of primary school students in Indonesia. Further research needs to replicate the OrDeP2E learning model in improving students’ natural science problem solving skills at various levels.

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