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Implementation of PDEODE (*Predict, Discuss, Explain,Observe, Discuss, Explain*) Supported by PhET Simulation on Solubility Equilibrium Material

Implementation of PDEODE (*Predict, Discuss, Explain, Observe, Discuss, Explain*) Supported by PhET Simulation on Solubility Equilibrium Material

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Abstract. This study aims at describing students' activities, analyzing students' learning outcomes at each stage of PDEODE learning supported by PhET simulation, and analyzing students' learning outcomes after PDEODE learning supported by PhET simulations. The method used is classroom research with one-shot case study research design. The subject of this study consists of 37 students from class XI IPA 1 of SMAN 1 Rengasdengklok – West Java. The instrument used was in the form of observation sheets of the activities of both researchers and students, worksheet, and higher-order thinking skill test. The results of this study show that students' activities are included in the *very good* category with an average percentage of 93%. Student learning outcomes ability at each stage of PDEODE learning supported by the PhET simulation on solubility equilibrium material obtain an average value of 91, and the highest average value was at the prediction stage with the indicator of analyzing and at the observation stage with the indicator of creating and analyzing with an average value of 95 while the lowest value was at the final discussion stage with the indicator of analyzing and evaluating with an average value of 83. The higher-order thinking skill of students after PDEODE learning improves with an average value of 89 included in the *very good* category. High, medium, and low groups achieve very good average values of 91, 89, and 87 respectively. Thus the implementation of PDEODE supported by PhET simulation can improve students' higher-order thinking skill.

1. Introduction

Chemistry is a subject related directly to applications in everyday life. One of the materials in chemistry is the solubility material and the solubility product that are abstract and complex, in which concepts and calculations are discussed [1]. The abstract characteristic of this material is the submicroscopic form in solution [2]. Solubility equilibrium is a difficult concept to understand. Students at school are still confused about this material because in the concept of chemical equilibrium there are difficult concepts such as solubility, Le Chatelier's principle, solution chemistry, and chemical equations [3].

In the high school curriculum, chemistry learning is performed both in the classroom and in the laboratory. Although learning chemistry in the laboratory plays a very important role in the learning process, there are still problems in its implementation, such as expensive and inadequate tools and materials, a long time taken to prepare the lab, and crowded condition of the laboratory full of students so that teachers sometimes find it hard to monitor [4]. In fact, a practicum can be done not only in the laboratory but also through a virtual lab [5]. PhET simulation is one of virtual labs that can be used in the chemistry learning process [6]. PhET simulation is an application widely used in physics, chemistry, and biology learning, online or offline, offering virtual demonstrations using tools and materials like in the real world [7].

In addition to choosing the right learning media, choosing the right learning model capable of developing students' learning outcomes in terms of a higher-order thinking skill, is also important, namely PDEODE (Predict, Discuss, Explain, Observe, Discuss, Explain) learning model. PhET simulation is developed with PDEODE learning model since this learning model can help students to connect concepts learned for a long time with concepts newly acquired [8]. PhET simulation has been used by Farida in a web-based learning to develop students' multiple representation skills on solubility equilibrium material [9].

This study discusses the learning process of solubility equilibrium material using worksheet based on PDEODE stages supported by PhET simulation, therefore, the purpose of this study is to obtain information about: (1) students' activities at PDEODE stages supported by PhET simulation, (2) students' learning outcomes at each stage of PDEODE learning supported by PhET simulation, and (3) students' higher-order thinking skills after the PDEODE learning supported by PhET simulation.

2. Experimental Method

Research method used is a classroom research with one-shot case study research design. A research with one-shot case study design is a study only conducted once with no control and comparison class nor initial test [10]. The subject of this study consists of 37 students from class XI IPA 1 of SMAN 1 Rengasdengklok West Java. These 37 students are grouped based on their learning achievement consisting of high, medium and low groups. The research stages begin with problem identification, preparation, implementation and reporting. The data of students' activities are obtained through observation during the learning process by observers. The data of students' learning outcomes at each PDEODE stage are obtained through students' worksheets. While the data of students' higher-order thinking skill after the PDEODE learning are obtained through a higher-order thinking skill test.

3. Result and Discussion

Based on the research results, overall the implementation of PDEODE (Predict, Discuss, Explain, Observe, Discuss, Explain) supported by PhET simulation on solubility equilibrium material obtains a very good result, hence, it can be said that the implementation of PDEODE can help to improve students' conceptual understanding. It can be seen from the development of students' higher-order thinking skills when completing worksheets with the help of PhET simulation as stated by Savander-Ranne & Kolari [11].

Before starting learning, students are given worksheets stage by stage. At the *predict* stage, students develop an ability to analyze. Students are asked to analyze salt in the PhET simulation and then write down their prediction in their worksheet. At the *discuss* stage, students develop an ability to evaluate. Students are asked to discuss with their friends in their group in accordance with the findings obtained at the PhET simulation. At the *explain* stage, students develop an ability to evaluate. Representatives from each group are asked to explain the results of their discussion in front of the class, then other group representatives give opinions about the results. At the *observe* stage, students develop an ability to create and analyze. Students perform two activities. The first activity is doing a practicum on precipitation reaction and the influence of namesake ions and conducting observations through PhET simulation. At the *discuss* stage, students develop an ability to evaluate. Each group is asked to discuss their respective findings. at the *explain* stage, students develop an ability to evaluate. Each group representative is asked to explain their respective result in front of the class and linked it to the findings at the initial *discuss* stage, then each group gives their own opinions. Students are also asked to make a practicum report. Thus, during the learning process using PDEODE stages, PhET simulation is used at the *predict* and *observe* stages only. It is in accordance with Wieman's suggestion [12]

Students' activities at each stage of PDEODE are observed by observers. According to Hasanah, observers are persons who observe an activity, in charge of seeing, noting, but not being involved in the activity [13].

Based on the data analysis results, the overall students' activities during the implementation of PDEODE learning supported by PhET simulation on solubility equilibrium material are done very well. The results of the implementation data analysis at all stages of students' activities obtain an average

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percentage of 93%. The average value shows that students play an active role at the stages of PDEODE learning supported by PhET simulation on solubility equilibrium material and are included in the *very good* category. It is in line with the results of Kolari & Viskari's research stating that the implementation of PDEODE can improve students' activities, including increasing students' activeness, deepening students' conceptual understanding, improving students' learning outcomes, and increasing students' self-confidence [14].

Students' learning outcomes at the stages of PDEODE learning supported by PhET simulation on solubility equilibrium material are very good. During the learning process, students fill out their worksheets with the PDEODE stages to help them in the learning process. Based on the observation results, students' learning outcomes during the learning process at each stage of PDEODE obtain an average value of 91 included in the *very good* category.

The research results of the implementation of PDEODE learning supported by PhET simulation on solubility equilibrium material are developed based on the indicator of higher-order thinking skill. According to Moore & Stanley, higher-order thinking skill itself has three cognitive aspects referring to the Revision of Bloom's Taxonomy, namely analyzing, evaluating, and creating [15].

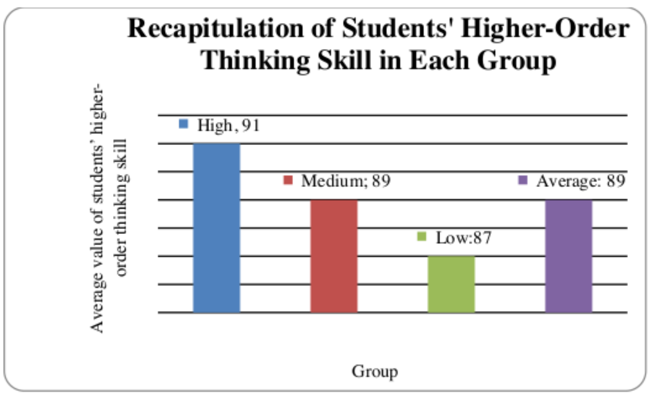

Figure 1 Recapitulation of Students' Higher-Order Thinking Skill in Each Group

Figure 1 shows the observation results of students' higher-order thinking skill. These learning outcomes refer to 8 indicators, namely: 1) Designing an experiment on common ions effect from the text, 2) Analyzing common ions effect from the text, 3) Comparing insoluble with soluble salts according to their solubility in water (solvent) based on the figure, 4) Organizing insoluble and soluble salts from the data, 5) Executing molar solubility from the data, 6) Executing Ksp values from the data, 7) Executing solubility in pure solvents from the data, 8) Giving an argument about the relationship between solubility and solubility products (Ksp).

Based on Figure 1, students' higher-order thinking skill reaches an average of 89 included in the *very good* category. The highest achievement of the high group is 91. According to the analysis, some students still cannot write the experimental design of the effect of namesake ions. They cannot write down the materials used. They seem to be confused when faced with different contexts, namely determining solubility in a solution containing common ions. It is in line with a research by Olensia [16].

Some students also have not yet understood the concept of distinguishing insoluble salt from soluble salt. This is in line with a research by Subarkah & Winayah [17]. Some students make mistakes in sorting salt types from soluble to insoluble salts based on the data of Ksp values. It shows that they do not understand the relationship between Ksp value and solubility. Similar findings are also obtained in Lay & Osman's research [18], as stated by Akkuzu & Uyulgan that understanding the relationship between various concepts is one of the important aspects of gaining new knowledge [19]. The last prediction is that students are not careful in calculating molar solubility. They write the way correctly but are wrong in writing the results. This is in line with Rebecca's research stating that students are not careful to solve the problem of calculating solubility [20].

This implementation of PDEODE is supported by PhET simulation. PhET simulation is an application that can be installed on a computer/notebook so that after students have learned a material in the classroom, they can re-learn the material at home. As stated by Wieman that PhET simulation has several advantages, namely it can be used in the classroom, can be used to conduct experiments, can be arranged according to the questions given, and can be used at home to repeat the material that has been learned in the classroom [12]. In addition, the implementation of PDEODE supported by PhET simulation can improve students' learning outcomes. It is in line with Dewi & Suhandi's research stating that the implementation of PDEODE can help students to understand concepts deeper as well as to improve their learning outcomes [21]. In addition, a research conducted by Clark & Chamberlain states that the use of PhET simulation can improve students' conceptual understanding [22].

4. Conclusion

Based on the results of the research conducted at SMAN 1 Rengasdengklok-West Java concerning the implementation of PDEODE supported by PhET simulation on solubility equilibrium material, it can be concluded that PDEODE learning can help to improve students' conceptual understanding with new understanding so that their understanding becomes deeper, enhance their ability to memorize a material longer, foster their learning motivation, and increase their confidence. The implementation of PDEODE is supported by PhET simulation. PhET simulation itself is an application that can be installed on a laptop so that after students have learned a material in the classroom, they can re-learn the material at home.

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