Designing MOOCS with Virtual Microscopic Simulation (VMS) for increasing of student’s levels of understanding

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Abstract. The purpose of this research is effect of MOOCS with Virtual Microscopic Simulation (VMS) for students' levels of understanding. The research method used is the Embedded Experiment Design with the research subjects as many as 45 high school students in one campus in Banten, Indonesia. The results showed that the Level of Comprehensive Understanding (CU) was 76.67%, Level of Understanding of Partial Understanding (PU) was 15.56%, and Level of Understanding Misunderstanding (MS) was 5.56%, Level of Understanding Does Not Understand (NU) of 2.22% and the lowest level of understanding at the 0% level of No Answered (NA). It was concluded that the average level of understanding experienced a significant increase with learning through MOOCS with VMS on phase transition.

1. Introduction
Translation of competencies in learning physics which explains natural phenomena formed when there is an interaction between matter and energy. For example, in everyday life there are observed phenomena, namely the increase in the temperature of the substance when heated [1]. The microscopic system is able to easily help macroscopic systems [2]. If microscopic phenomena can be understood, macroscopic phenomena will also be easily understood. Unfortunately, because of its unobservable nature, it is very difficult to understand this microscopic phenomenon. This limitation will lead to an understanding of non-comprehensive physical phenomena [3]. In detail the results of the preliminary research related to students' understanding of physics learning are shown in table 1.

Table 1. Results of the preliminary research.

| Levels of Understanding            | Number of Students | %   |
|------------------------------------|--------------------|-----|
| Comprehensively Understanding (CU) | 10                 |     |
| Partial Understanding (PU)         | 25                 |     |
| Misunderstanding (MS)              | 30                 |     |
| Not Understanding (NU)             | 25                 |     |
| Not Answering (NA)                 | 5                  |     |

Based on table 1. Information was obtained that the low level of understanding of students in basic physics learning that fully understood was only 10%. The total number of students and can be categorized as low. The development of various visualization media of abstract and microscopic physical phenomena has so far been carried out for the benefit of physics learning, including; Simulation
about the law of virtual motion laboratory [4,5]; Simulation of Optics [6]; Simulation of electricity and magnetism [7].

MOOCS (Massive Open Online Courses) the current trend in online learning experiences significant changes towards a student-centered approach with the aim of being a new challenge for autonomous and independent learning [8,9]. In addition, the main characteristics of the online course using connectivity principles are autonomy, diversity, participation, openness, connectedness and interactivity. Therefore, learning is no longer limited to individual aspects but is also considered a collaborative process in social spaces and connected. In addition, many researchers suggest that the most significant research ideas in MOOC are related to the theoretical and pedagogical approaches of MOOCs, interactions between participants, patterns of their involvement and self-regulated learning, and learning outcomes achieved [10-12]. Mixed or hybrid MOOCs offer increased opportunities for students to shape their own learning. In addition, MOOCs have recently been suggested as an alternative to teacher professional development and learning in peer communities [11,13].

Virtual Microscopic Simulation (VMS) comes from 4 syllables namely "Simulation", "Virtual", "Phenomenon", and "Microscopic". The word "simulation" has the meaning of showing something in the form of an imitation that is similar to the real situation. Virtual "is interpreted (real)," Phenomenon "has the meaning of events and" Microscopic "defined the nature of a very small size and cannot be seen with the naked eye so that a microscope is needed to see it clearly. So that Virtual Microscopic Simulation is defined as Demonstration (means) to visually visualize the physical mechanism model of an object from an abstract (microscopic phenomenon) that is not possible using real computer-assisted props. Software that can be used to make simulations, namely Macromedia Flash 8.0. Macromedia Flash 8.0 is a professional application authoring tool that can be used to combine text, graphics, animation, sound, and color. The advantages of Macromedia Flash 8.0 that can combine elements of text, graphics, animation, sound and color can be used as a medium to visualize material and physical processes that are abstract and microscopic, so that it helps in achieving learning goals [11].

The level of students' understanding of the concept of physics after participating in the learning process will be different, some will understand it in full, some will understand it in part, and some will misunderstand. Categorize the level of student understanding of the concept. To measure the level of depth of understanding in the construction of the microscopic phenomenal conception by using virtual simulations using understanding tests and the results categorized into understanding levels according to table 2.

Table 2. Level of understanding and assessment criteria [14].

| Levels of Understanding               | Assessment Criteria                                      |
|---------------------------------------|----------------------------------------------------------|
| Comprehensively Understanding (CU)    | Correctly answer all questions on a question              |
| Partial Understanding (PU)            | Correctly answer some questions on a question             |
| Misunderstanding (MS)                 | Answer with all the questions on a question but the answer is unclear or the answer is wrong |
| Not Understanding (NU)                | Answer all questions on a question but the answers given are not relevant with the questions |
| Not Answering (NA)                    | Does not give answers to all questions in an item         |

However, the simulation that has been developed has not shown microscopic phenomena and through Massive Open Online Courses (MOOCS). So, referring to the findings and results of the studies above, it is considered important to develop the MOOCS design with Virtual Microscopic Simulation (VMS). In addition, the MOOCS-VMS model developed must be able to provide a solution to the limitations of practicum equipment and can reduce the time of practicum implementation. In this research the MOOCS-VMS Model will be developed in the form of a virtual experiment. The purpose of this research is effect of MOOCS with Virtual Microscopic Simulation (VMS) for students' levels of understanding.
2. Methods
The research method that will be used is a mixed method research. The type of mixed method design chosen in the research was embedded design with the form of embedded experimental one group pretest posttest design [15]. The research method used as a research project as many as 45 high school students in one campus in Banten, Indonesia. The design scheme is shown in Figure 1. Embedded design is a mixed method design where a set of data provides support for other data sets that are the role in the main research.

Broadly speaking the research procedures consisted of field studies, literature studies, instrument development, MOOCS development with VMS, expert judgment on research models and instruments, field trials, MOOCS with VMS on the concept of Substance Changes pretest, implementation of practicum models, questionnaires and interviews the ease and difficulty of using MOOCS with VMS on the concept of Substance Changes posttest.

3. Results and discussion
Dynamic electric MOOCS with VMS trials were conducted on 45 students using conception construction learning models. Simulation tests that have been developed are intended to test the efficacy and reliability of simulations in building understanding of students’ scientific concepts in phase transition. The following is a description of the research data obtained in detail. Data Quantity Level Understanding of Substance Changes Concept Students Quantity data of student understanding obtained from the posttest results measured using a test instrument of understanding the Substance Changes concept in the form of Essay. Calculate the percentage of students for each level of understanding using the categorization guide in table 2. Results the distribution of levels of understanding and characteristics of the level of understanding is presented in table 3.

Table 3. Distribution of levels of understanding of each phase transition.

| Levels of Understanding | Characteristics of Student Answers | Label Concept | 1  | 2  | 3  | 4  | 5  | 6  |
|-------------------------|-----------------------------------|---------------|----|----|----|----|----|----|
| [7] Comprehensively Understanding (CU) | Correctly answer all questions on a question | 13 (87) | 13 (87) | 12 (80) | 12 (80) | 11 (73) | 10 (67) |
| [15] Partial Understanding (PU) | Correctly answer some questions on a question | 2 (13) | 1 (7) | 2 (13) | 3 (20) | 3 (20) | 3 (20) |
| [8] Misunderstanding (MS) | Answer with all the questions on a question but the answer is unclear or the answer is wrong | 0 (0) | 1 (7) | 1 (7) | 1 (7) | 1 (7) | 1 (7) |
| [10] Not Understanding (NU) | Answer all questions on a question but the answers given are not relevant with the questions | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (7) |
| [16] Not Answering (NA) | Does not give answers to all questions in an item | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
Information:
Σ: Number of students who experience a level of understanding
%: Percentage of students who experience a level of understanding
Concept label 1: Melt
Concept label 2: Freeze
Concept label 3: Yawning
Concept label 4: Condense
Concept label 5: Sublime
Concept label 6: Crystallize

Based on Table 3 Information was obtained that the application of physics concept construction learning using MOOCS with VMS at the highest MSU level of understanding on the concept Melt and Freeze was 87%. Discussion of the level of student understanding is explained in detail in the discussion. Figure 2 shows the percentage of the average level of understanding of electrical concept.

Figure 2. Average percentage of level of understanding of electrical concepts.

Information:
Comprehensively Understanding (CU)
Partial Understanding (PU)
Misunderstanding (MS)
Not Understanding (NU)
Not Answering (NA)

Based on figure 2, Information is obtained that the average level of understanding is from high to low after the application of physics conceptual construction learning using virtual simulations of microscopic phenomena on the concept of Substance Changes. The level of understanding of partial understanding (PU) was 15.56%, and the level of understanding of misunderstanding (MS) was 5.56%, level of understanding, not understanding (NU) of 2.22% and the lowest Level of understanding at 0% level of No Answered (NA).
4. Conclusion
Fundamentally all students gave positive responses to MOOCS with VMS which was developed for constructive oriented physics learning in scientific conception that was carried out. Students state that learning is carried out to help students construct scientific understanding and a significant level of understanding with MOOCS with VMS on the concept of Substance Changes. The recommendations in research are MOOCS can be considered to be applied in constructive-oriented physics learning activities as well as scientific reconstruction at the level of Teacher Training College or University, as well learning activities in the senior high school level with prior adjustments.

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