Massive Open Online Simulation (MOOS) of physics concepts microscopic for improving creative thinking

I M Astra¹, F C Wibowo¹, D Susanti¹ and D R Darman²

¹Department of Physics Education, Universitas Negeri Jakarta, Jl. Pemuda 10, Rawamangun, Jakarta 13220, Indonesia
²Department of Physics Education, Universitas Sultan Ageng Tirtayasa, Jl. Ciwaru 25, Banten 42127, Indonesia

*imadeastra@unj.ac.id

Abstract. Physics consists of concepts that are macroscopic and microscopic, physics concepts that are microscopic or Physics concepts that are invisible or unobservable. If the phenomenon that is microscopic can be understood then the macroscopic phenomenon will also be easy to understand. This research aims to produce a Massive Open Online Simulation (MOOS) online course on microscopic concepts that enhances creative thinking. The research method used was Embedded Experiment Design with research subjects being 60 high school students at one campus in the province of Jakarta, Indonesia. The results showed MOOS of Physics Concepts Microscopic for Improving Creative Thinking with average normalized gain score <g> creative thinking increased by 0.54 with the medium category. These results indicate that MOOS on microscopic concepts increases students' creative thinking.

1. Introduction

The current trend in online learning is experiencing a significant change towards a student-centered approach with the aim of being a new challenge for independent and autonomous learning [1]. The main characteristics of online courses using connectivism principles are autonomy, diversity, participants, openness, connectedness and interactivity. Therefore, learning is no longer limited to the individual aspects, but is also considered a collaborative process in social and connected spaces. In addition, many researchers advocate that the most significant research ideas on MOOCs are related to the theoretical approach and pedagogical design of MOOCs, interactions between participants [2] their involvement patterns and self-regulated learning, and the learning outcomes achieved [3,4].

Higher education should build a mindset of students and their academic community in preparing students to face challenges in the 21st Century [5]. Other challenges include global issues with the birth of the ASEAN Economic Community (AEC) and the transformation of the education sector towards the industrial revolution 4.0 [6]. This demand is in line with the target of learning achievement in higher education curriculum, especially in learning physics which explains natural phenomena [7]. For example, in everyday life there is an observed phenomenon that is the increase in temperature of substances when heated [8]. If microscopic phenomena can be understood then macroscopic phenomena will also be easy to understand. Unfortunately, because it is invisible or unobservable, it is very difficult to understand this microscopic phenomenon so that understanding is not comprehensive [9]. The results
of a preliminary study of low creative thinking obtained information that the low creative thinking of students on concepts in the low category [10].

Physics consists of concepts that are macroscopic and microscopic, physics concepts that are microscopic or Physics concepts that are invisible or unobservable. If the phenomenon that is microscopic can be understood then the macroscopic phenomenon will also be easy to understand. The development of various unobservable and microscopic visualization media physical phenomena to date has been carried out for the sake of learning physics, including; Simulation of the laws of virtual laboratory motion [9,11]; Simulations about Optics [12]; Simulations about electricity and magnetism [13] and Simulation of climate change [14].

However, the simulation that has been developed has not shown microscopic phenomena and through Online simulations provide one intriguing way to engage students in the study of abstract, complex physical phenomena. Thus, referring to the findings and study results above, it is considered important to develop designing MOOS. In addition, the MOOS model developer must be able to provide solutions to the limitations of practicum equipment and can reduce the time of practicum implementation. This research aims to produce a Massive Open Online Simulation (MOOS) online course on microscopic concepts that enhances creative thinking.

2. Methods
The research method used was Embedded Experiment Design with research subjects being 60 high school students at one campus in the province of Jakarta, Indonesia. The type of mixed method design chosen in this research is embedded design with embedded experimental one group pretest posttest design [15]. The design scheme is shown in Figure 1 Embedded design is a mixed method design where one data set provides support for another data set which is the role of the main study. Development of Massive Open Online Simulation (MOOS) on microscopic concepts to improve Creative Thinking (CT) a new construct in 21 centuries.

Based on Figure 1. The research procedures consist of field studies, literature studies, instrument development, MOOS development of microscopic concepts to enhance creative thinking, expert judgment on research designs and instruments, field trials, MOOS.

3. Results and discussion
3.1. MOOS development
The display will be seen after clicking the game tab on the previous screen. The screen contains sub menus of MOOS 1, MOOS 2 and MOOS 3 which each have different game simulations. There is a home button if clicked it will return to the main menu and X button to exit the media. The moos are on the page: http://moocsvms.com/. MOOS development flowchart on melting and freezing material contained in the concept of changing the form of matter in Figure 2.
Based on figure 3. Games or commonly called games are one of the things that are liked by teenagers today, especially if the game is able to explain the concept of physics. With the development of existing technology then came computer games [1]. Many points out that by placing players in the world of this game, where they can freely move and act, games can offer problem solving, goal-oriented behavior,
involvement and motivation and in the case of multi-player games, social networking. Cooperative learning with games is chosen because it can increase individual and group accountability. Others argue that games help to develop strategic thinking, group decision making, and higher cognitive. Computer games on learning in addition to increasing student achievement can reduce cognitive load. The other hand, the teacher has a positive perception by using technology in learning to provide added value and experience, playing or making games to motivate learning.

![Figure 4. Display MOOS 1.](image)

Based on figure 4, the tab key is melting and freezing. There are several components of the image in the middle, namely the thermometer shows the temperature during the simulation process, the test tube as an ice cube container, the stove, the buffer tube and the image of ice cube particles. On the side of the screen there is a heat column that will display the numbers after clicking the start button. After the user clicks start the simulation process will run where the stove will light and the heating process takes place, the heat column will display a number where the amount of heat is received. When heating occurs, the temperature will rise displayed on temperatures up to 1000°C, the precursor begins to move so fast a change in form. After the shape changes the simulation is complete and the stove goes out, click repeat if you want to repeat the simulation.

The display above shows a freeze screen that appears to have a melting and freezing tab key. In addition, there are several images, that is, an open refrigerator as a place for the process of changing forms, thermometers, test tubes filled with water, thermometers and movements of water particles. If the user has clicked start, then the cooling process will occur, the heating value will be displayed particle movements begin to slow and arranged. The temperature value will change not show on the thermometer, when it reaches the temperature of 0°C there will be a change of shape into ice stone and simulation is complete.

3.2. MOOS for Improving Creative Thinking (CT)

Creative thinking is part of higher order thinking that are specifically focused on the search for many ideas, the emergence of various abilities and many correct answers to a problem in melting and freezing material found in the concept of changing matter. The creative thinking are meant to think abilities using various mental operations, namely fluency, flexibility, authenticity, and the expression of ideas to produce something original, new and valuable. This is intended when initiating new ideas, the brain thinks to produce many ideas (fluency), ideas that vary, vary (flexibility), unique ideas (original), with detailed and useful exposure [16]. The results showed that the average normalized gain score $g$ creative thinking increased by 0.54 with the medium category. These results indicate that MOOS on microscopic concepts increases students' creative thinking.
Based on figure 5. The information about average normalized gain score $g^*$ creative thinking increased by 0.54 with the medium category. The average normalized gain score $g^*$ of this magnitude if confirmed with the $g^*$ category of Hake [17] is included in the medium category. This shows that the creative thinking in each student activity on the concept of physics increases to the moderate category after the application of the MOOS for improving creative thinking students.

4. Conclusion

Learning achievement in higher education curriculum, especially in learning physics, which explains natural phenomena. Interesting findings from the development of MOOS in melting and freezing material contained in the concept of changing the form of substances is an observed phenomenon can be understood through visual activities, it will be easy to understand. The application of the application of the MOOS for improving creative thinking students of the concept of heat in high school students. This is indicated by the average normalized gain score $g^*$ of 0.54 which is included in the medium category. In general, there is an average increase in the normalized gain score $g^*$ in each creative thinking activity. These results indicate that MOOS on microscopic concepts increases students' creative thinking.

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References

[1] Conole G 2014 A new classification schema for MOOCs. *International Journal for Innovation and Quality in Learning* 2 (3) pp 65-77
[2] Laurillard D 2016 The educational problem that MOOCs could solve: professional development for teachers of disadvantaged students. *Research in Learning Technology* 24 pp 29369
[3] Littlejohn A, Hood N, Milligan C and Mustain P 2016 ‘Learning in MOOCs: Motivations and self-regulated learning in MOOCs’ *Internet and Higher Education* 29 pp 40-48
[4] López-Meneses E, Vázquez-Cano E and Román P 2015 ‘Analysis and implications of the impact of MOOC movement in the scientific community’ *Comunicar* 22 44 pp 73-80
[5] Houseal A K, Abd-El-Khalick F and Destefano L 2013 Impact of a student-teacher-scientist
partnership on students’ and teachers’ content knowledge, attitudes toward science, and pedagogical practices. *Journal of Research in Science Teaching* **51** (1) pp 84–115

[6] Sjoer E and Meirink J 2015 Understanding the complexity of teacher interaction in a teacher professional learning community. *European Journal of Teacher Education* **39** (1) pp 110–125.

[7] Zacharias Z, Olympiou G and de Jong T 2013 Making the Invisible Visible: Enhancing Students’ Conceptual Understanding by Introducing Representations of Abstract Objects in a Simulation. *Instruction Science* **41** pp 575-596

[8] Wibowo F C, Suhandi A, Rusdiana D, Ruhiat Y, Darman D R and Samsudin A 2017 Effectiveness of Microscopic Virtual Simulation (MVS) for Conceptualizing Students’ Conceptions on Phase Transitions *Advanced Science Letters* **23** (2) pp 839-842

[9] Wibowo F C, Suhandi A, Nahadi and Coştu B 2017 Virtual Microscopic Simulation (VMS) to promote students’ conceptual change: A case study of heat transfer. *Asia-Pacific Forum on Science Learning and Teaching* **18** (2) 1-32

[10] Yusnaeni, Corebima A D, Susilo H and Zubaidah S 2017 Creative Thinking of Low Academic Student Undergoing Search Solve Create and Share Learning Integrated with Metacognitive Strategy *International Journal of Instruction* **10** (2) 245-262

[11] Potkonjak V, Gardner M, Callaghan V, Mattila P, Guetl C, Petrović V M and Jovanović K 2016 Virtual laboratories for education in science, technology, and engineering: A review. *Computers & Education* **95** 309–327

[12] Djænët B, Fouda C and Djamel K 2013 What Thinks’ the University's Students about Propagrarion of Light in the Vacuum? *European Scientific Journal* **9** (24) pp 197-213

[13] Dega B G, Kriek J and Mogese T F 2013 Students' Conceptual Change in Electricity and Magnetism using Simulations: A Comparison of Cognitive Perturbation and Cognitive Conflict. *Journal of Research in Science Teaching* **50** (6) pp 677-699

[14] Mikropoulos T A and Natsis A 2011 Educational Virtual Environments: A ten-year Review of Empirical Research (1999-2009) *Journal Computers & Education* **56** pp 769-780

[15] Cresswell J 2016 *Research Design: Qualitative, Quantitative and Mixed methods Approach* (London: Sage publication, Inc.)

[16] Wechslera S A, Carlos Saizb, Silvia F. Rivasb, Claudete Maria Medeiros Vendraminic, Leandro S, Almeidad, Maria Celia Mundima and Amanda Francod 2018 Creative and critical thinking: Independent or overlapping components? *Thinking Skills and Creativity* **27** pp 114-122.

[17] Hake R R 1999 Analyzing Change/Gain Scores. [Online]. Retrieved from: http://lists.asu.edu/cgi-bin/wa?A2=ind9903&L=aera-d&P=R6855. [18 Maret 2020].