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Effectiveness of Microscopic Virtual Simulation (MVS) for Conceptualizing Students' Conceptions on Phase Transitions

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The study aims to increase a microscopic virtual simulation (MVS) for the media in changing physics learning-oriented students' conceptions on the material phase transition. One approach to change students' conceptions is to use cognitive conflict strategy simulation-aided virtual media. However, virtual simulation of changing students' conceptions on the material phase transition is still very limited, so need to be developed. The total sample in this research in 40 students (19-21 years old) and this study was conducted using a mix method with the design of embedded experimental models. The results of this study are the product MVS phase transition in the form of software and the results of the implementation of virtual media on learning physics simulation model shows that the media ECIRR virtual simulation developed in this study could change students' conceptions. It can be seen from a comparison of the average Gain normalized and quantity misconceptions before and after the use of MVS on students who have misconceptions. Judging from the consistency of students' conceptions that are in the category of Self-Consistent, it can be concluded that the misconception of students is completely remediated. MVS expected positive response from the students' they experience that the media developed virtual simulations can help them understand the material phase transition.

Keywords: Microscopic Virtual Simulation (MVS), Conceptualizing Student Conception, and Phase Transitions.

1. INTRODUCTION

One of the functions and purposes of learning Physics is the acquisition of knowledge, concepts and principles of physics, as well as having the knowledge, skills and scientific attitude. The concept is an abstraction that represents a class of objects, events, activities, or relationships, which have the same attributes. All concepts are understood by students grow from the experience of everyday life and changed at any given moment. No two people have exactly the same experience, the conception formed of people may differ. Each student has the preconceptions that they get from events that happened and that concept may be misleading.

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When students define a certain conception is different from scientific concepts, then there was a misconception [1]. The misconception will make students take a different conclusion although given phenomenon or the same problem. Misconceptions experienced by students must be remediated because Hill influence how her understanding of physics concepts. Computer simulations designed to be effective in a conceptual change [2].

Phase transition is one that is close to the physics of matter and is usually found in the daily lives of students. However, the process of phase transition which are microscopic lead many students have difficulty understanding the concept of phase transition that many are experiencing misconceptions. Results of a preliminary study on previous research, many found

students who have misconceptions on the material phase transition. The students had misconceptions in the material phase transition. some misconceptions students were found among other things: (1) Evaporation occurs only when boiling, (2) When the ice turned to water, the volume is not changed, and (3) water can evaporate at any temperature [1]. Also found that many students who have misconceptions on the material phase transition. Misconception found among other things: (1) If the water is heated, then there is only a change temperature and (2) The water just boils at a temperature of 1000 ^{o}C [3]. Misconceptions experienced by the students has been formed from the everyday experience and strong inherent in the minds of students so hard to change. Therefore, we need a learning process that can detected students' knowledge and belief as well as correcting if not in accordance with the scientific context [4]. The learning process is expected to change, improve and reconstruct the students' understanding of concepts early so that the concept of students in accordance with the scientific concept.

The consistency of students' conceptions indicates that the misconception is completely remediation. Based on the background above problems, then the problem in this study is whether the media virtual simulation developed in this study has the characteristic may change conceptions of students at phase transition, which is formulated as follows:

1. What is the effectiveness of media use virtual simulation developed at the physics-oriented learning changing students' conceptions in helping remediate misconceptions students on the material phase transition?
2. How is the consistency of students 'conceptions as the effects of the implementation of virtual simulation media in physics learning oriented towards altering students' conceptions on the material phase transition?

2. CONCEPTUALIZING STUDENTS' CONCEPTIONS

Cognitive conflict strategy can be applied to the model of learning-oriented conception of conversion models (conceptual change model). Proposes applying the model ECIRR (Elicit Confront Identify Resolve Reinforce) to overcome misconceptions in students. The five steps in the model ECIRR interrelated and mutually support successful learning process. At this stage of Elicit (get), teachers dig prior knowledge of students. Confront stage (knock), the teacher denied the students' initial conceptions. Identify Stage (Identification), teachers identify alternative conceptions experienced by students. At this stage of Resolve (break), teachers are helping to remediate misconceptions students. In the final stage, Reinforce (reinforced), the teacher checking changing conceptions on students who have had misconceptions. Thus, it can be seen whether the misconceptions students have remediation or not [7].

Cognitive conflict strategy requires a medium to present the real facts to remediate misconceptions students. Are microscopic phase transition that requires media to visualize the phase transition process. One of them with virtual simulation. However, the use of virtual simulation media for changing students' conceptions still very rare [8]. Virtual simulations can visualize the behavior of macroscopic and microscopic phenomena that can help students observe phenomena that cannot be observed directly, and connect with the phenomena that can be observed directly [4]. Students can explore and construct concepts through observation in accordance with the scientific concept so avoid misconceptions.

Conceptions of students who are already in the remediation needs to be seen regularity or consistency. Conception of students who have been remediated viewable consistency by presenting different problems, but with the same concept. Students may be answered correctly if the concept is applied to the event or phenomenon they know every day, but it would be wrong if the concept is applied to a phenomenon that is not familiar to them. Students' conceptions can be said to be consistent if students can apply to conception in the event or phenomenon vary. According to [5] the consistency of students' conceptions is the accuracy or regularity of students in answering some of the questions that have in common the concept.

3. METHOD

The method used in this study is a mixed method with concurrent embedded design. The study is a mix of research methods that combine qualitative research with quantitative research [6]. Meanwhile, the concurrent design of embedded a research method that combines qualitative and quantitative research methods by combining the two methods are not balanced, in a research activity may be 70% using a quantitative method and 30% using qualitative methods, or vice versa. In this study on the activities of research, quantitative research methods weights greater than qualitative. The following concurrent design scheme of embedded or embedded experimental model described in the scheme:

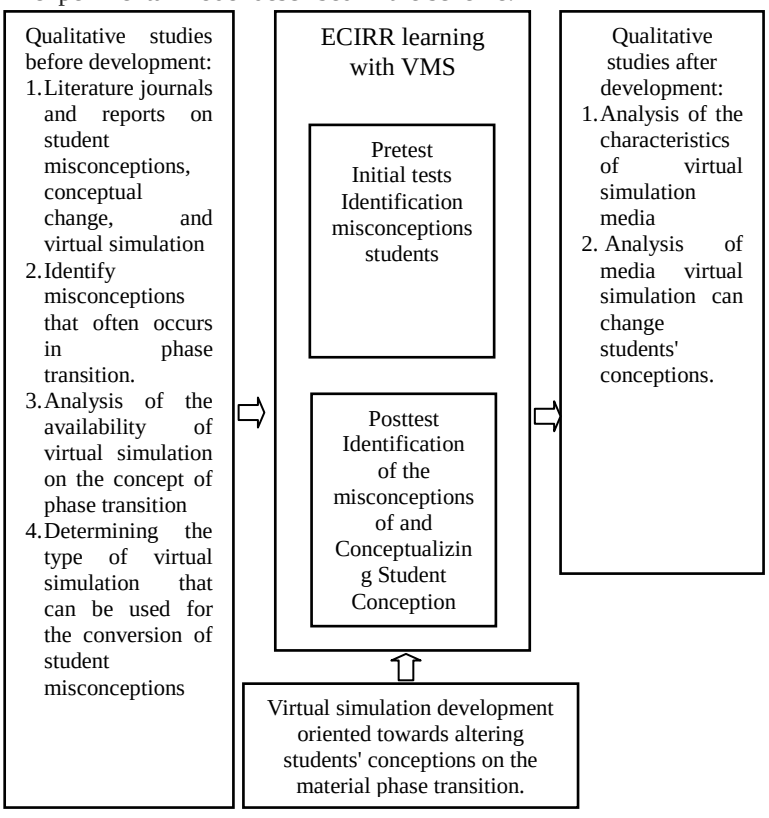

Figure 1. The design of research with embedded concurrent

At this stage of virtual simulation media applications that have been developed (quantitative phase) used pre-experimental research design with a one-group pre-test post-test

design. Following the scheme of one-group pre-test post-test design is illustrated in Figure 2.

Class	Treatment	Post test
Experiments	O	X

Figure 2. Design pre-experimental

Description:
O : The diagnostic test misconceptions
X : The treatments were learning physics model ECIRR with VMS.

Total sample of research of 40 students and 19-21 years old. The sample in this study is the fourth semester students at one high school in Indonesia the academic year 2015/2016. Selection of the samples in this study was selected by purposive sampling. The samples studied were the students who have misconceptions on the material phase transition.

Result development of Virtual Microscopic Simulation (VMS) that will be used in the study can be seen in Figure 3.

Fig 3. A screenshot of the VMS for Phase Transitions

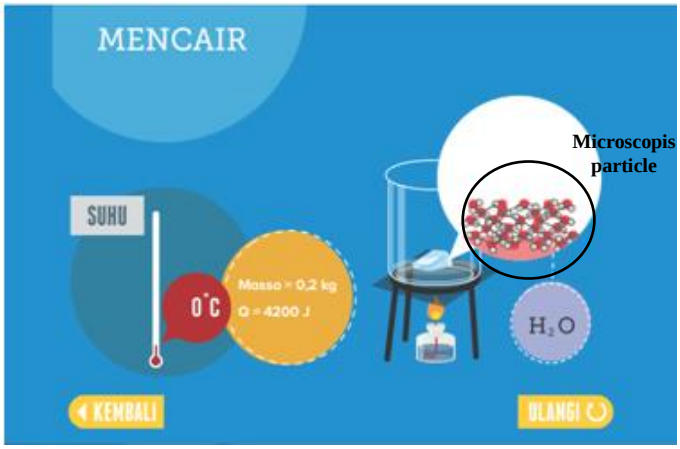

Fig. 4. Development of VMS for three dimension of concept Phase Transitions

4. EXPERIMENTAL RESULT

A. Description Quantity Data Student Misconceptions

Student misconceptions quantity data obtained from the pretest and post-test were measured using a diagnostic test instrument misconceptions phase transition-shaped three-tier test, hereinafter referred Tests Diagnostic Misconception (TDM). Determining the answers experiencing misconceptions following the alternative answers that show each label misconceptions want to be identified.

Based on the pattern of student answers in the answer diagnostic tests misconceptions phase transition in a hierarchy three tier test, in this study the students can be grouped into five categories, namely scientific knowledge (SC), lack of knowledge (LK), error (E), the misconception (MS) and guessing (GS). Here is presented a recapitulation of the percentage of the quantity of student misconceptions on the test pretest and posttest in Table 1.

Table 1. Percentage of students at each label quantity misconceptions

Label Misconception (M)	Pretest (%)	Posttest (%)
MI	19	0
MII	10	2
MIII	27	0
MIV	39	5

Based on Table 1. The overall percentage of students who have misconceptions quantity before and after the learning has decreased. MI label and label MIII as the highest, while the MII label as the lowest.

The average quantity of students who have misconceptions on the pretest did not reach 50% in each label misconceptions, while the rest are scattered in other categories, such as 12% Scientific knowledge, 26% Lack of knowledge, 9% Error, and 30% Guessing. This indicates that many students guess the answers and do not understand the concept at first. After learning, the student who has a scientific knowledge 65%, experienced an average increase of 60% in the moderate category. Students who do not understand the concept of 26% experienced an average decrease of 67%. Recapitulations of the percentage of students in each category are presented in detail in Table 2.

Table 2. Percentage of students in each category quantity for each item about TDM

Item	Quantity category of each student (%)				
	SK	LK	ER	MS	GS
	<g>	<g>	<g>	<g>	<g>
Q1	83	-86	0	-100	-71
Q2	95	0	3	0	-97
Q3	56	-55	3	-100	-25
Q4	53	-75	-40	-100	-43
Q5	26	-50	-50	-100	-53
Q6	23	-50	-33	-50	-48
Q7	89	-100	0	-100	-60
Q8	49	-92	-50	-100	-38
Q9	55	-81	-25	-100	-14
Q10	47	-33	-62	-100	-46
Q11	74	-82	-100	-75	-57
Q12	77	-100	-50	-83	0
Rata-rata	60	-67	-34	-84	-46

Based on Table 2, the average percentage in each category have increased and decreased, but the decrease is only 67% in the highest category reduce Lack of knowledge while the lowest are in the category of Error at 34%. Increased knowledge Scientific highest in Q2 TDM items by 95% and the lowest in the TDM item Q6 only by 23%. This shows that students still experience difficulties at some of the items after learning about. In-depth analysis of this matter will be presented in more detail in the discussion.

B. Effectiveness of Using Media in Learning Physics

Effectiveness of the media virtual simulation developed in physics learning-oriented students' conceptions changing the phase transition material, the quantity is determined by the percentage of students who have misconception remediation.

Table 3 Percentage of student's quantity misconception remediation.

Label Misconce-ption	Pretest (%)	Posttest (%)	Students misconcep-tions remediation (%)	Category
MI	19	0	100%	High
MII	10	2	82%	High
MIII	27	0	100%	High
MIV	39	5	87%	High

From Table 3 above it can be seen that in general the percentage of students who misconception remediation quantity in the category High. This shows that the use of virtual simulation media effectively used in learning physics oriented towards altering students' conceptions on the material phase transition.

Misconceptions identified on the label MIV are "The density of ice (solid) is greater than the density of water (liquid)". In TDM phase transition, MIV label consists of three items about which Q10, Q11 and Q12. The quantity of students who have the highest misconceptions contained in item Q12 that is as much as 76%, while the lowest was found in only 11% Q11 and Q10 as much as 62%. After learning, the item is already remediation Q10 overall with the percentage of students who misconception remediation quantity of 100%, while 3% of students in the item Q11 still have misconceptions. The percentage of students who are still misconceptions quantities contained in item Q12 reached 13% and is the highest percentage among all the items about. MIV label is a label with the quantity of students with the highest misconceptions on the pretest that is equal to 39%. The results of students' conceptions of identification conducted by researchers at the stage of identification showed that 100% of students found the density of ice is greater than the density of water. Student opinion is accompanied by the reason that the density of solids is always greater than the liquid. Even after learning there are still 5% of students who are still misconceptions, the quantity of students who misconception remediation on the label MIV stands at 87% including High category. This shows that misconceptions students may be remediated. Possible causes are still some students who misconceptions on the label MIV item Q12 because the phenomena presented in a matter of much different to the example given when learning and require an analysis of changes in volume when it turns to ice water.

C. Description Data Consistency Conception Students

Consistency conception visits to ensure that the student misconception is completely remediated. Consistency seen students' conceptions of student answers conformity with the scientific conception and the consistency of the students apply the concept in different contexts. Data consistency is obtained from the scientific student pretest and posttest results were measured using TDM, as well as misconceptions. Determining the answers to the consistency of students 'conceptions seen only the students' answers are included in the category of Scientific knowledge, and each item in the TDM is set label consistency conception as presented in Table 3.9 in the previous chapter. Range of students' conceptions consistency scores were at 0-2. Answer students are divided into three categories, namely In-Consistent (IC), Self-Consistent (SC) and Consistent (C). Recapitulation average score consistency of students' conceptions can be seen in Table 4.

Table 4. The average score of the consistency of students' conceptions

Label Consistent (K)	Pretest	Category	Posttest	Category
KI	0,1	IC	1,4	SC
KII	0,1	IC	0,5	IC
KIII	0	IC	1,0	IC
KIV	0,1	IC	1,2	SC

From Table 4. Can see that the overall consistency of the conception of the students before the learning is in the category Inconsistent. All labels consistency increased, but the average score of students' conceptions consistency highest KI only 1.4 on the label is in the category Self Consistent while the lowest at KII label with an average score of 0.5 in the category Inconsistent. This shows that students are still less consistent in applying some conception phase transition in a different context. Complete data consistency processing students' conceptions result in Appendix C.3. Consistency is highest conception of the conception of KI with an average percentage score the consistency of conception by 72% and the lowest at 25% KII. This indicates that the KI and KIV, misconceptions students have completely remediated. A discussion of the consistency of students' conceptions is described in detail in the discussion. While teaching a student's using simulations, students gain a better understanding for the computer simulation can show the microscopic significantly [9].

Data consistency is obtained from the scientific student pretest and posttest results were measured using TDM, as well as misconceptions. Before the study, the entire label consistency conception in the category Inconsistent. But after learning, the average score of students' conceptions consistency highest KI only 1.4 on the label is in the category Self Consistent while the lowest at KII label with an average score of only 0.5 in the category Inconsistent. KIII in the category Not Consistent with an average score of 1.0 and the consistency of the conception of KIV in the category Enough Consistent with an average score of 1.2 higher consistency than KIII but still less than KI. In Annex C.1 Table 3 shows that the item about the quantity of students who are included in the category of Scientific Knowledge highest in Q2 item with a percentage of 95%, while the lowest is only 29% contained in the item Q6. This indicates that the student has not been consistent in

applying the conception phase transition into the different applications on the KII and KIII.

Consistency conception visits to ensure that the student misconception is completely remediated. If the student misconception is completely remediated, the students' answers are consistent if conception is remediated applied to the different phenomena. From the research data it can be concluded that misconceptions on the Label MI and MIV is completely remediation. It can be seen from the students' conceptions of consistency that has included the category Fairly Consistent with the KI and KIV which is about the same items. Although at KIII in the category Inconsistent, MIII remediation can be said for the percentage of students who misconception remediation quantity on both label these misconceptions that are in the category of High and average consistency score of 1.2 was nearing conception Simply Consistent. Label MII can be said is not really remediation because the average score of the consistency of the conception of only 0.5 in the category Inconsistent although the percentage of students who misconception remediation quantity in the High category. Researchers cannot compare these results with the results of previous research for this study is the first study on the consistency of the material conception phase transition.

From the research data we can see that the MI with items about Q1, Q2 and Q3 are already remediation with the percentage of students who misconception quantity already remediation of 100% including High category. Item same questions used as KI and are in the category of Self-Consistent. MII with items about Q4, Q5 and Q6 already remediation with the percentage of students who misconception quantity already remediation of 82% including High category. However KII is the category Not Consistent with an average score of consistency only 0.5, so it can be said MII has not been completely remediated. MIII with items about Q7, Q8 and Q9 already remediation with the percentage of students who misconception quantity already remediation of 100% of students who have misconceptions on the label MII already remediation including High category. Although KIII are on average 1.0 to category Inconsistent, MIII be said to have remediation with the percentage of students who misconception quantity already remediation of 100% including High category. MIV with items about Q10, Q11 and Q12 are already remediation with the percentage of students who misconception quantity already remediation of 87% included in the category of High. KIV with reference to the same questions that are in the category of Self-Consistent, with an average score of 1.2 consistencies. Although MII has not been completely remediated, MI, MIII and MIV already be remediated with the percentage of students who misconception remediation quantity included in the category of High, with a level of consistency Self-Consistent. It can be concluded that student misconceptions in the material phase transition is completely remediation.

5. CONCLUSIONS

Simulation can help students in understanding the meaning of the scientific knowledge, concepts and facts for students'. Virtual simulation contributes to student teachers in professional development, and provides an understanding of science in science teaching and teacher training programs [10]. Indicate that the use of virtual media can change the conception of learners who have misconceptions through in-depth restructuring concept, Besides virtual media can also give way scientific reasoning in studying the concept of thermal expansion and heat transfer [11].Based on the analysis, findings and discussion that has been presented, it can be concluded as follows:

1. Media developed virtual simulation effectively remediate misconceptions students on the material phase transition. It can be seen from the percentage of students who misconception remediation quantity in the fourth misconception label > 75% in the High category.
2. Consistency students' conceptions as the effects of the implementation of virtual simulation media in the learning phase transition materials that are in the category of Self-Consistent. Consistency highest conception is at KI label with an average score of 1.4 in the category consistency Simply Consistent while the lowest are in the KII label with an average score of 0.5 consistency category Inconsistent.

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