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The Effect of Conceptual Change Text on Pre-Service Teachers' Understanding of Heat Conduction

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***Abstract*—The purpose of this research is to investigate the effect of conceptual change text (CCT) on pre-service teachers' (PTS) understanding in heat conduction concept. One group pretest-posttest design was used in this research. The participants of this research were 33 PTS and used the diagnostic test to reveals their understanding about the heat conduction in macroscopic and microscopic level both verbally and visually. The result shows that before the CCT given to PTS the most categories of their conception was Lack of Knowledge (LK) but after CCT was given the most categories was became a Scientific Conception (SC). The level of understanding increased from only knows about the macroscopic level to became understanding at the microscopic level both verbal and visual. This study suggested that CCT can be used to increase the understanding of the PTS not only at the macroscopic level but also at the microscopic level.**

Keywords—heat conduction; conceptual change text; macroscopic; microscopic level

I. INTRODUCTION

Students' conception about the scientific phenomena usually came from their experiences and sometimes they explain science concepts in a novel way [1,2]. Students were constructing their own knowledge in their minds that were related to a certain object, event, phenomenon or concept perceived from the outer world by sense organs or at least by interpreting the truth based on their previous experiences. However, these construction sometimes is not matched with the scientific conceptions, and it is called misconceptions [3,4]. Misconceptions of students indicate that they hold an imperfect or mistaken understanding of the concept [5]. From the constructivist perspective, learning is an individual process that involves linking new ideas and experiences about the learner already knows a fundamental assumption of constructivism is that learners construct understanding through interactions with the physical and/or social environment [6].

Misconceptions in science may happen in students because these are persistent and it is difficult to change them [7]. Science education has a responsibility to help students to understand the natural world, using appropriate skills and scientific process to develop their competencies [8]. So, it is important to use methods and techniques based on conceptual change and constructivist approach which prevents the students from learning the concepts wrongly or incompletely for a meaningful learning [9]. The conceptual change strategy make students understand the concepts and its correlation to the natural events which surround themselves. It might be done by using the tools, including conceptual change texts (CCT) [10]. In this research, the CCT will be used to increase the students' conception of science. CCT might be used to specify students' misconceptions, clarify their reasons, and explain why they are incorrect by using concrete examples [11].

CCT is used to introduce theories that make students believe that they have a misconception about the concept and help them to change their old conception that not according to the scientific conception [12]. CCT is a teaching material based on conceptual change approach. It is preferred in order to achieve conceptual change in the various studies [13], of which CCT teachers will find the students' misconceptions based on their reasoning and explaining in science learning [11]. In CCT, students were given the misconceptions that related to the subject/concepts that they are scientifically explained why those misconceptions are wrong [10,14]. CCT will help students to construct their knowledge became scientific conception because if they keep the misconception it will affect students' further learning in a negative way. Therefore, more importance should be given while teaching to change misconceptions and support meaningful learning [15].

II. RELATED WORKS/LITERATURE REVIEW

Hynd, et al. used CCT to enhance students' conception and they found that the CCT helped students change their intuitive ideas to scientific ones [16]. Mikkilä-Erdmann reveals that students who learned with CCT have a better understanding of the photosynthesis concepts than the students who used the traditional text [17]. Özmen reported that the experimental group received a conceptual change text instruction, the control group received a traditional style of instruction. The results of the study indicated that the students in the experimental group showed significantly greater levels of achievement than the students in the control group [18]. Then Ozkan and Selcuk found that the experimental group's conceptual understanding

was higher than that of the traditional instruction group [12]. It is believed that these texts about "buoyant force," an often misunderstood subject in science education, are very useful class materials that can enable students to learn meaningfully.

Based on the studies about the use of CCT to increase the students' conception we can conclude that CCT is an effective way to remedy the misconception in students. However, several studies do not discuss the microscopic level especially in visualization/drawing in the scientific phenomena. Whereas, drawing is a useful approach to probe understanding in students learning and enables the researcher to reveal the student's and teacher's qualities of understanding that can be hidden through other research procedures [19]. Teaching science should give change for students to represent their understanding not only verbally but also visually [20]. The drawing also involves conceptual knowledge that serves as a way of capturing students' thinking, understanding, and shift [21].

This research will use CCT to describe students' (pre-service teachers) understanding in two level of representation there is macroscopic and microscopic both verbal and visual in heat conduction concept. Because with these two level of representation we can know more about the students' conception and the effect of CCT to increase students' understanding about the heat conduction. So, the main question of this research is "Does the CCT can increase students' understanding of heat conduction concepts at the macroscopic and microscopic?"

III. Material and Methodology

A. Data

The instrument of this research was written test in two level of representation (macroscopic and microscopic level), using the following stages: 1) main question (macroscopic level); 2) confidence level; 3) reasoning question (the microscopic level at verbal); 4) confidence level, and 5) drawing (the microscopic level at visual). The instrument was given before and after students learn with the CCT to make sure the impact of these treatments to students. The data will be shown in three categories by the students' conception, understanding of the two-level representation, and students' drawing. Three categories will be shown in pre and post-test result. At the two-level understanding will be described students in every stage of the question. In students' conception, we used 6 categories as follows: 1) Scientific Conception (SC); 2) Almost Scientific Conception (ASC); 3) Lack of Confidence (LC); 4) Lack of Knowledge (LK); 5) Misconception (MSC); and 6) Have No Conception (HNC). While at the drawing section, we used 6 categories as follows: 1) Scientific Drawing; 2) Partial Drawing; 3) Misconception Drawing; 4) Undefined Drawing; 5) Non-misconception Drawing, and 6) No drawing.

B. Method

A quasi-experimental design was used in this research using the one group pretest and posttest design. First, the participants were given a pretest and then they read the CCT about the heat conduction. Then we give them a posttest to know how the treatment effect on their understanding about the concepts. The participants of this research are 33 students (pre-service teachers) in the sixth semester.

IV. Results and Discussion

A. Result

The role of the CCT in increasing students' understanding of the heat conduction concepts can be determined from the difference score in every category before and after they were read the CCT. To find out generally which categories the participants in this study before and after the treatment, we can see it in Figure 1.

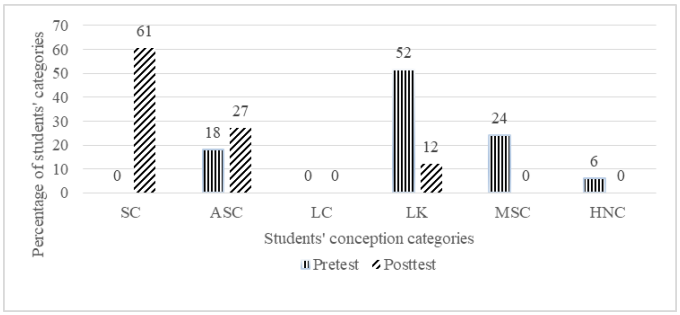

Fig. 1. The analysis of students' conception categories.

Figure 1 shows that students (pre-service teachers) in pretest did not have any scientific conception about the heat conduction concepts. We can see that no one of them can answers all question correctly especially in the drawing section. All students before treatment cannot give a scientific drawing/visualization of the conduction phenomena. Most of them are in lack of knowledge and misconception category. But after treatment by CCT, the SC categories increased and became the most of participant's categories. And to see more detail about students' conception of two-level representation including their confidence level and drawing section, we can see that in Figure 2.

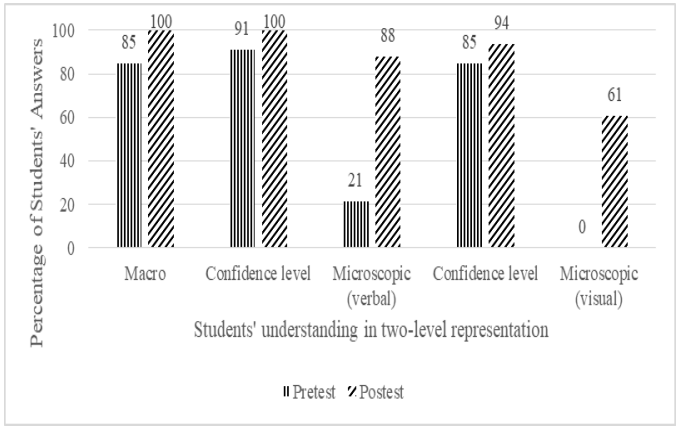

Fig. 2. The analysis of students' understanding in two-level representation.

Based on Figure 2 we can see that before treatment students' only can answers right in the macroscopic level of

understanding with the high confidence level too. But, then it decreases very significantly in microscopic level at verbal but the confidence level very high too. This research can be the proof that the microscopic level (reasoning about the phenomena) is not being a focus of our science learning students only know the macroscopic level and very few of them know what it's really happen based on the scientific conception. Because of that, no one of them can give a scientific drawing about the conduction process. But after giving a CCT understanding of the two-level representation, there is an increase in all level. On the macroscopic level, all participants can give correct answers and all of them very confidence with their answers. At the microscopic level (verbal) we can see that the increase is very significant from 21% became 88% their confidence level is increased too. And at the visualization from no one or 0% of students can't give the scientific drawing to 61% of them can give the scientific drawing. The students' drawing categories at before and after treatment can be seen in Figure 3.

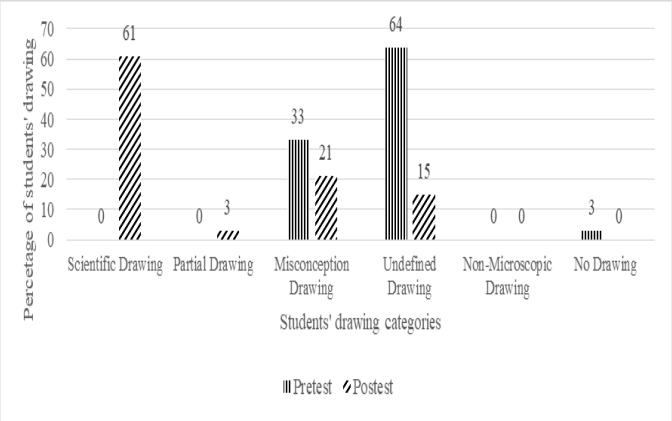

Fig. 3. Analysis of students' drawing categories.

B. Discussion

Based on the results, we can see that all the participant only knows about the macroscopic level, and not at the microscopic level. Although the microscopic level or particle nature of matter is a heart to learn science concepts to the next level of understanding science [22]. Besides the heart of science, microscopic level also helps students to give a comprehensive understanding of the scientific phenomena [20,23,24]. This problem is not only happening in students at the pre-service teacher but also the teachers [25]. Lack of knowledge about this level will make the impact on the teachers in their teaching process [26].

Pre-service teachers are a new generation of a teacher. They must have a better knowledge of the concepts. Since it might be a cause of students' misconceptions [27]. So, to reduce this problem we need CCT to make students' conception in accordance with the scientific conception. Using CCT, the students' understanding increase from the misconception and lack of knowledge became more scientific. Because the purpose of using CCT is to explain misconception or an alternative idea and to activate them by disproving examples of misconception [28]. The conceptual change and constructivist approach might prevent the students from learning the concepts wrongly or incompletely for a meaningful learning [9].

The result also reveals that CCT can make students' conception shifting into a scientific conception and they can make visualization about the concepts. CCT can be used to remediate misconceptions and promote students' understanding of the concepts [1,14]. The students at pre-service teachers must enhance their knowledge about the content of science to optimize the learning process [29]. CCT can be a solution for the pre-service teachers to make their understanding better. Teachers who master only the macroscopic level might to have the same understanding level with their students, and it make them confused and having a low confidence level. Moreover, it will cause the teaching process at the low level [30].

V. CONCLUSION

According to the results of this study, we can conclude that CCT can be a useful and effective way to remediate students' misconception about the concepts not only at the macroscopic level but also in the microscopic level, both verbally and visually. For the future research can be used CCT with another strategy to make it better and comprehension for the students' conception. However, next research must be separated between the students' who read the CCT and students who don't or only read partially to see more detail about the effectiveness the CCT to increased students' conception about the concepts. The research also reveals that CCT can be used as a reading material to strengthen students' understanding of what they have learned. So, with CCT their understanding will be better and more comprehensive.

REFERENCES

[1] İ. Önder, "The Effect of Conceptual Change Texts Supplemented Instruction on Students' Achievement in Electrochemistry," International Online Journal of Educational Sciences, vol. 9, pp. 969-978, 2017.

[2] A. W. Wright and K. Bilica, "Instructional Tools To Probe Biology Students' Prior Understanding," The American Biology Teacher, vol. 69, pp. e1-e5, 2007.

[3] G.J. Posner, K.A. Strike, P.W. Hewson, and W.A. Gertzog, "Accommodation of a scientific conception: Toward a theory of conceptual change," Science Education, vol. 66, pp. 211-227, 1982.

[4] T. Koparan, C. Yildiz, D. Kögce, and B. Güven, "The effect of conceptual change approach on 9th grade students' achievement," Procedia Social and Behavioral Sciences, vol. 2, pp. 3926-3931, 2010.

[5] A.L. Pines and L.H.T. West, "Conceptual understanding and science learning: An interpretation of research within a sources-of-knowledge framework," Science Education, vol. 70, pp. 583-604, 1986.

[6] L.L. Liang and D.L. Gabel, "Effectiveness of a Constructivist Approach to Science Instruction for Prospective Elementary Teachers," International Journal of Science Education, vol. 27, pp. 1143-1162, 2005.

[7] S.B. BouJaoude, "A Study of the Nature of Students' Understandings About the Concept of Burning," Journal of Research in Science Teaching, vol. 28, pp. 689-704, 1991.

[8] E. Ceylan, "Effects of 5E learning cycle model on understanding of state of matter and solubility concepts," Phd, The Graduate School of Natural and Applied Sciences, Middle East Technical University, Ankara, Turkey., 2008.

[9] O. Dağdelen and İ. Kösterelioğlu, "Effect of Conceptual Change Texts for Overcoming Misconceptions in “People and Management” Unit," International Electronic Journal of Elementary Education, vol. 8, pp. 99-112, 2015.

[10] G. Aydin, "Pre-service Science Teachers’ Views on Conceptual Change Strategies and Practices Carried out," International Journal of Psychology and Educational Studies, vol. 2, pp. 21-34, 2015.

[11] B.J. Guzzetti, W.O. Williams, S.A. Skeels, and S.M. Wu, "Influence of text structure on learning counterintuitive physics concepts," Journal of Research in Science Teaching, vol. 34, pp. 701-719, 1997.

[12] G. Ozkan and G.S. Selcuk, "Effect of Technology Enhanced Conceptual Change Texts on Students' Understanding of Buoyant Force," Universal Journal of Educational Research, vol. 3, pp. 981-988, 2015.

[13] H. Özmen and A. Ayas, "Students Difficulties in Understanding of the Conservation of Matter in Open and Closed-System Chemical Reactions," Chem. Educ. Res. Pract., vol. 4, pp. 279-290, 2003.

[14] C. Tekkaya, "Remediating High School Students' Misconceptions Concerning Diffusion and Osmosis through Concept Mapping and Conceptual Change Text," Research in Science & Technological Educational vol. 21, 2003.

[15] B. Atasoy, H. Akkus, and H. Kadayifci, "The effect of a conceptual change approach on understanding of students’ chemical equilibrium concepts," Research in Science & Technological Education, vol. 27, pp. 267-282, 2009.

[16] C.R. Hynd, J.Y.McWhorter, V.L. Phares, and C.W. Suttles, "The role of instructional variables in conceptual change in high school physics topics," Journal of Research in Science Teaching, vol. 31, pp. 933-946, 1994.

[17] M. Mikkilä-Erdmann, "Improving conceptual change concerning photosynthesis through text design," Learning and Instruction, vol. 11, pp. 241-257, 2001.

[18] H. Özmen, "The Effectiveness of Conceptual Change Texts in Remediating High School Students’ Alternative Conceptions Concerning Chemical Equilibrium," Asia Pacific Education Review, vol. 8, pp. 413-425, 2007.

[19] M. Bahar, M. Ozel, P. Prokop, and M. Usak, "Science student teachers' ideas of the heart," Journal of Baltic Science Education, vol. 7, pp. 78 - 85, 2008.

[20] W. Sopandi, A. Kadarohman, M. Rosbiono, A. Latip, and R. R. Sukardi, "The Courseware of Discontinuous Nature of Matter in Teaching the States of Matter and Their Changes," International Journal of Instruction, vol. 11, pp. 61-76, 2018.

[21] J. Einarsdottir, S. Dockett, and B. Perry, "Making meaning: children’s perspectives expressed through drawings," Early Child Development and Care, vol. 179, pp. 217-232, 2009.

[22] J. Snir, C.L. Smith, and G. Raz, "Linking phenomena with competing underlying models: A software tool for introducing students to the particulate model of matter," Science Education, vol. 87, pp. 794-830, 2003.

[23] D. Treagust, G. Chittleborough, and T. Mamiala, "The role of submicroscopic and symbolic representations in chemical explanations," International Journal of Science Education, vol. 25, pp. 1353-1368, 2003.

[24] H.K. Wu, J.S. Krajcik, and E. Soloway, "Promoting Understanding of Chemical Representations Students’ Use of a Visualization Tool in the Classroom," Journal of Research in Science Teaching, vol. 38, pp. 821-842, 2001.

[25] A. Banda, F. Mumba, V. Chabalengula, and S. Mbewe, "Teachers’ understanding of the particulate nature of matter: The case of Zambian pre-service science teachers," Asia-Pacific Forum on Science Learning and Teaching, vol. 12, pp. 1-16, 2011.

[26] N. Valanides, "Primary Student Teachers’ Understanding Of The Process And Effects Of Distillation," Chemistry Education: Research and Practice in Europe, vol. 1, pp. 355-364, 2000.

[27] W. Sopandi, A. Latip, and A. Sujana, "Prospective Primary School Teachers’ Understanding on States Of Matter and Their Changes," Journal of Physics: Conference Series, vol. 812, p. 012075, 2017.

[28] Ö.S. Çakir, Ö. Geban, and N. Yürük, "Effectiveness of conceptual change text-oriented instruction on students' understanding of cellular respiration concepts," Biochemistry and Molecular Biology Education, vol. 30, pp. 239-243, 2002.

[29] A. Widodo, D. Rochintaniawati, and Riandi, "Primary school teachers’ understanding of essential science concepts," Cakrawala Pendidikan, vol. 3, pp. 522-528, 2017.

[30] C. Tekkaya, J. Cakiroglu, and O. Ozkan, "Turkish pre-service science teachers' understanding of science and their confidence in teaching it," Journal of Education for Teaching, vol. 30, pp. 57-68, 2004.