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The Use of Conceptual Change Text (CCT) Based Teaching Materials to Improve Multiple Ability of Pharmaceutical Chemical Representation Students

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Abstract. This study analyzes the effect of text-based concept-based teaching (CCT) on changes in the concepts of first-semester pharmacy students in understanding various chemical representations of the concepts of reduction and oxidation (redox). In this study, data were obtained from the results of the pretest and posttest of students' understanding of chemical concepts in multiple representations. This test is given to 50 first-semester pharmacy students. The experimental group consisted of 25 students who received CCT-based teaching materials, and the control group consisted of 25 students who received conventional teaching materials. After the study, data were analyzed using two-way covariance analysis using multiple representations of students' scores as covariates. The results showed that the students in both groups had the same initial knowledge of redox both the control class and the experimental class, while the final knowledge showed that in the experimental class, the understanding of redox concepts with multiple representations increased by 37.78% with an N-Gain value of 0, 4, while the control class only increased by 13.68% with an N-Gain value of 0.1. Based on the results of this study, it can be concluded that the use of CCT-based teaching materials can improve students' understanding of redox concepts in multiple representations.

1. INTRODUCTION

Introductory chemistry is a subject taught in the first semester by pharmacy students. Chemistry is not new to first-year students, as they have studied chemistry concepts before at the high school level. Based on these facts, the understanding of the chemistry concepts of the first-semester pharmacy students will be influenced by the understanding of the concepts they have acquired at the previous level. For this reason, it is important to equate the concepts of chemistry in first-semester students. This concept change is done to avoid misconceptions that will hinder understanding other concepts at a higher level. Because students' initial knowledge will affect how students will understand other concepts more deeply and how these concepts are processed [1]. Moreover, chemistry is an abstract subject, so that in order to convey complete chemical concepts, one must pay attention to macroscopic representations, submicroscopic, and symbolic [2]. If one aspect of the three representations is not conveyed, it will cause misconceptions in students in studying chemistry. One of the chemical concepts that often causes misconceptions

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among students is reduction and oxidation [4]. The misconceptions experienced by students occur due to an incomplete understanding of concepts [5]. To overcome these problems, it is important to implement strategies in the learning carried out. In this study, The strategy developed is to use materials Conceptual Change Text (CCT) based teaching. Conceptual Change Text (CCT) is a text that changes students' conceptions that are chosen to minimize students' misconceptions because students can realize the misconceptions they experience and change them with the correct concept [6]. Conceptual Change Text occurs when students experience dissatisfaction with their understanding of the concept (dissatisfaction); then students find new concepts that are correct and easy to understand (understand); the concepts they understand also make sense; thus generating new knowledge (fruitful) [7]. Based on research that has been done previously, the application of CCT can improve the misconceptions experienced by students [8]-10]. CCT developed in teaching materials is considered practical because every concept displayed can be easily understood [11] In addition, CCT-based teaching materials were also developed by considering several chemical representations both macroscopically, microscopically, and symbolically so that the concept is given in its entirety. To determine the effectiveness of using materials CCT-based teaching on conceptual change for first-semester pharmacy students in understanding multiple chemical representations of the concepts of reduction and oxidation (redox) when compared to traditional text.

RESEARCH METHOD

This research is a quantitative research with a quasi-experimental design. This research was conducted with two classes, namely the experimental class with 25 students and the control class with 25 students [12]. In the study, students of both classes received the same treatment during redox concept learning in two meetings, the only difference being that the teaching materials read by the two classes. For the control class reading traditional texts with the experimental class reading CCT-based teaching materials. At the beginning of the second meeting, the classes were given a pretest in the form of conceptual understanding questions based on multiple chemical representations in the form of 20 multiple choice questions [13], then learning was carried out using traditional teaching materials (control class) and CCT teaching materials (experimental class). Then at the end of the meeting, the posttest stage was carried out. The pretest and posttest data were analyzed using two-way covariance analysis using conceptual understanding based on multiple representations of student scores as covariates. After that, the N-Gain value of the two classes was calculated and the percentage value of the increase in student learning outcomes in the two classes was calculated.

RESULTS AND DISCUSSION

In the research that has been done, the initial data obtained in the form of pretest results from the two classes showed values that were not much difference between the control class and the experimental class. The pretest value of the control class is 52.64, and the control class is 63.36. Next, after the learning process is carried out in the two classes, the next stage is carried out, namely the posttest of the results of the two classes, to find out the difference in the learning outcomes of classes using traditional teaching materials and classes using CCT-based teaching materials for understanding redox concepts in multiple representations. The posttest results showed a significant difference between the control class and the experimental class, where the control class had an average posttest score of 58.84 in this case, an increase of 13.68%, and the experimental class had an average posttest score of 73.52 with an increase in understanding of the concept of 37.78%. The results of the pretest and posttest can be seen in Table 1.

TABLE 1. Pretest and Postest of Experiment and Control Class

	n	Mean Pretest	SD	Mean Postest	SD	N-Gain
Control Class	25	52,64	5,96	59,84	4,5	0,1
Experiment Class	25	53,36	5,38	73,52	5	0,4

Based on table 1 data, we can find out the increase in learning outcomes in classes that use traditional teaching materials with CCT. The experimental class that uses CCT-based teaching materials can improve understanding of the concept in multiple representations higher than the control class that uses traditional teaching materials. an increase in the understanding of the experimental class by 37.78% while the control class by 13.68%. These changes can be seen in Fig. 1.

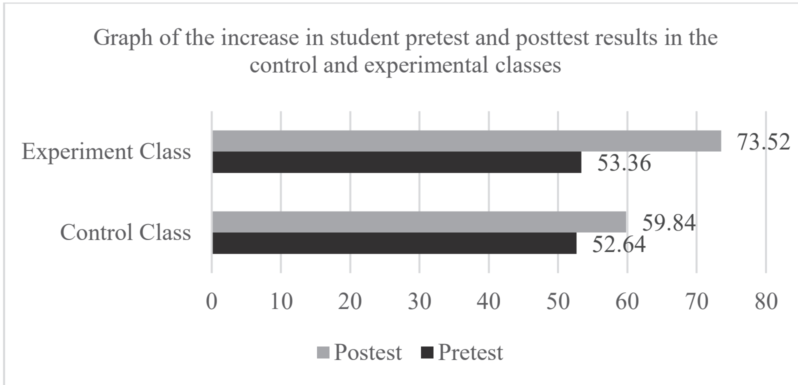

FIGURE 1. The increase in student pretest and posttest results

Based on the resulting data, it is known that the initial understanding of both classes towards understanding the redox concept in multiple representations is the same. The surgery is the teaching material that can be used. in the control class using traditional teaching materials that are not equipped with a discussion of the concept of multiple representations. while in the experimental class, CCT-based teaching materials are used which are written by taking into account multiple representations of the redox concept. CCT-based teaching materials are written covering macroscopic aspects in the form of redox reaction phenomena in everyday life, microscopic and symbolic aspects in conveying concepts. In the control class, explanations from the teacher and reading materials and questions and answers that take place in class become the main factors in learning without paying attention to misconceptions that may occur in students and do not explain redox concepts in multiple representations. While in the experimental class, explanations from lecturers, questions on teaching materials, and discussions of concept changes were experienced by some students so that they could overcome the misconceptions experienced by using CCT-based teaching materials [14] which emphasized some chemical representations so that students were correct. -completely understand the concept of redox. In the experimental class, students who are aware of errors in understanding and are not satisfied with the concept will accept new concepts that are easy to understand and are assisted by lecturers in convincing new concepts presented in CCT-based teaching materials [15], so that students can overcome the misconceptions they experience with new concepts with more confidence. To find out the results of using CCT-based teaching materials on understanding redox concepts in multiple representations, an analysis of the results of the pretest and posttest was carried out in the control and experimental classes.

In table 1 shows is known that the average value of the pretest of the control and experimental classes is not significantly different. The posttest results show that the student's initial understanding in both classes is the same. Significant changes in the experimental class based on the pretest and posttest values showed a better significance value with an N-gain value of 0.4 compared to the control class, which had an N-gain value of 0.1. Based on these results, it shows that learning using CCT-based teaching materials can improve concept understanding [9] and students' multiple representation abilities compared to the control class. The handling of misconceptions carried out in the experimental class turned out to be effective for increasing students' understanding and multiple representation abilities [16]. In the experimental class, the misconceptions experienced by students are analyzed, then students are given the correct concept provided in a complete book with multiple representation explanations, then students are allowed to convince the new concept they understand. Based on the results of the pretest, there are still many students who have difficulty understanding the concept of chemistry as a whole, both macroscopic, microscopic, and symbolic aspects. This happens because there is still a lack of multi-representation chemistry learning, so that many students have difficulty in connecting chemical representations to one another [17]. Many students have difficulty in writing redox reaction equations, especially in the placement of electron positions and balancing the number of electrons involved in the reaction [18]. The students' difficulty in understanding the redox concept shows that the ability of submicroscopic and symbolic representation is still limited.

The learning of redox concepts that have been accepted by students in general only concerns the macroscopic and symbolic levels, while the submicroscopic level is not considered. Understanding the redox concept will be difficult to understand well if only using the macroscopic and symbolic levels. This fact is consistent with the finding that errors in understanding chemical concepts are caused by a weak submicroscopic ability to visualize structures and processes [19]. The concept of a redox reaction will not be well understood if the explanation simply moves from one representation to another without connecting them. One form of representation is an explanation of other representations. The findings of this study can be used as a basis for designing appropriate learning strategies in teaching the concept of redox reactions in universities by involving three levels of representation [20]. So that the application of CCT-based learning that pays attention to multiple aspects of chemical representation is very useful in learning chemistry in general. In addition, the application of CCT-based teaching materials is very important to be developed in other subjects so that students' understanding of the concept of chemistry can be understood well and for good from the macroscopic, microscopic, and symbolic aspects.

CONCLUSION

Basic chemistry learning on the redox concept developed with CCT-based teaching materials whose contents pay attention to multiple aspects of chemical representation is more effective in improving students' conceptual understanding when compared to learning using traditional teaching materials. This can be seen from the results of the experimental class pretest and posttest, which was able to increase students' understanding of concepts by 37.78% with an N-Gain of 0.4, while the control class was only able to increase students' understanding of 13.68% with an N-Gain of 0.1.

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REFERENCES

1. R.R. Bransford, J. D., Brown, A. L. & Cocking, *How People Learn—Brain, Mind, Experience, and School.* (2000).
2. V. Talanquer, Int. J. Sci. Educ. **33**, 179 (2011).
3. A. Kolomuc, H. Ozmen, M. Metin, and S. Acisli, Procedia - Soc. Behav. Sci. **46**, 1761 (2012).
4. Y.S. Makiyah, S. Utari, and A. Samsudin, J. Phys. Conf. Ser. **1157**, 0 (2019).
5. W. Sukmawati, J. Inov. Pendidik. IPA **5**, 195 (2019).
6. G. Ozkan and G.S. Selcuk, Univers. J. Educ. Res. **3**, 981 (2015).
7. G.J. Posner, K.A. Strike, P.W. Hewson, and W.A. Gertzog, Sci. Educ. **66**, 211 (1982).
8. A. Banawi, W. Sopandi, A. Kadarohman, and M. Solehuddin, Int. J. Instr. **12**, 359 (2019).
9. H. Özmen and A. Naseriazar, J. Serbian Chem. Soc. **83**, 121 (2018).
10. M. Akpinar and M. Tan, J. Educ. Sci. 139 (2012).
11. W. Sukmawati, J. Inov. Pendidik. IPA **6**, 247 (2020).
12. R. Amir and P. Tamir, J. Biol. Educ. **29**, 111 (1995).
13. S. Yamtinah, N.Y. Indriyanti, S. Saputro, S. Mulyani, M. Ulfa, L. Mahardiani, T. Satriana, and A.S. Shidiq, J. Phys. Conf. Ser. **1157**, (2019).
14. G. Poutot and B. Blandin, Am. J. Educ. Res. **3**, 116 (2015).
15. R.S. Anam, A. Widodo, and W. Sopandi, J. Pendidik. Fis. Indones. **16**, 63 (2020).
16. Garba Shehu, IOSR J. Res. Method Educ. **5**, 15 (2015).
17. Beerenwinkel, I. Parchmann, and C. Gräsel, Int. J. Sci. Math. Educ. **9**, 1235 (2011).
18. N. Yürük and P. Eroğlu, J. Balt. Sci. Educ. **15**, 693 (2016).
19. K. Paige, B. Bentley, and S. Dobson, Aust. J. Teach. Educ. **41**, 1 (2016).
20. A. Pabuçcu and Ö. Geban, Int. Online J. Educ. Sci. **4**, 563 (2012).