The students' conception track of low-perception-students trough the conceptual change (CCM) module based on mental models on electron configuration concept

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Abstract—Misconception has a close correlation with mental models. The aim of this study is to know the track of student conceptions trough the misconception (MC) remediation using Conceptual Change Module (CCM) based on mental model in electron configuration concept. The research using one group pretest and postest. The research subject were class X MIPA students of SMAN 1 Bojonegoro who had teacher atomic structure material, had a number of misconception (MC) and were at a low level of perception based on CRI diagnostic test and detecting the causes of mental model based chemical misconceptions (P2M3) test. The results were analyzed by qualitative descriptive and inferential statistic. The results show that: (1) The initial conception step was dominated by MC, only 3 students whose in a lack of knowlege (LC), (2) The validation step only 1 student who changed into LC, (3) The cognitive conflict step has changed 21 students to knowledge the correct concept (KCC), 8 LC students, and leaves 1 student who remains MC, (4) giving assistance for equilibration step showed that KCC status was achieved by all students and maintained until the end of the CCM step, (5) CCM was successfully reduce a number of MC to KCC. The decrease of MC was 80%. The MC shifting to KCC, MC becoming LC, and MC still MC in a row by 75%, 14%, and 11%.

Keywords—Remediation of misconception, CCM, mental models, perception.

I. INTRODUCTION

Chemistry as part of science, includes macroscopic, microscopic, and symbolic representations which make the concept of chemistry difficult for students to understand [1]. Therefore, it is often for the concept of chemistry to be understood by students in misconceptions. Misconceptions in chemistry have a big impact because chemical concepts are interrelated with one another. Misconception at the beginning of learning will affect the understanding of subsequent concepts [2]. So, the result is a poor understanding of students and not achieving learning completeness [3]. Therefore, misconceptions should not be ignored.

Research on learning in the classroom found that there was some students who had misconception status in atomic structure material such as Verawahyuni, which in her research stated that there was three dominant concepts in atomic structure that understanding in misconception. There was energy levels concept, orbital concept, and concept of electron configuration [4]. Nurjanah found that the concept of electron configuration as a concept where the highest case of misconception was found, then followed by the concept of quantum numbers at the electron energy level and the concept of orbitals [5]. It is feared that misconceptions will disturb the understanding of other concepts. Remembering the atomic structure is a very important and central concept in both modern chemistry and chemistry in education [6].

The abstract nature of atomic structure material is an implicit description of the microscopic representation of chemical concepts that emphasizes the mental models of students in giving perception to the concept. According to Greca and Moreira, the student's mental model is an imaginary concept in students' though to explain a situation or process that is occur [7]. Mental models are built from student perception, imagination, and reading comprehension aspect [8]. According to Greca and Moreira, the student's mental model is an imaginary concept in students' though to explain a situation or process that is occur [7]. Mental models are built from student perception, imagination, and reading comprehension aspect [8]. According to Wang's research, chemical misconceptions correlate with mental models that students have [9]. Therefore, by forming a high mental models, students' understanding concepts will be good too. Verawahyuni found that students who understanding the concept in atomic structutre by misconceptions, have a low mental model [4].

Based on the three aspects of the mental model, it was identified that the perception aspects had the greatest correlation on misconceptions [4]. Having a same agreement with it, Rehkämper stated that the visual perception aspect is the basic construction of the analogy part of the mental model [11]. Eysenck also stated that visual perception is the main point of the perception aspect [12]. Students with low perceptions will have a greater misconceptions. Perception, according to the Big Dictionary of Indonesian Language has the meaning of a response from a process in which someone knows it through its five senses. According to Eysenck,

perception is a way for someone to interpret information with sense [12]. Based on this, it can be said that perception is a way for someone to interpret information obtained through the senses. Therefore, with an increase in perception is expected to increase students' understanding of a concept.

The existence of misconceptions causes the importance of reducing misconceptions through remediation learning. Hosnan said that remediation learning needs to use various methods that are in accordance with the characteristics of students, for example using conceptual change strategies and using modules [12]. If the two things are combined, the conceptual change strategy that is inserted in a module it is more effective in reducing the students' misconceptions. This was proven by Fakhruddin, Halim, and Meerah which showed that there was a students' conceptual change radically by implementing conceptual change module (CCM) on the atomic concept [13]. After giving the CCM, the students no longer understood the concept of the atom by using the classical concept but had changed using the concept of quantum mechanics. According to Sugiani, Santyasa, & Warpala said that modules containing conceptual change can help students to construct their concepts [14].

The effectiveness of the conceptual change module causes the researcher to assume if we entering the mental model aspects (perception aspect) into a conceptual change module so that it is expected to be more effective in reducing misconceptions. Unfortunately, the conceptual change module based on improving mental models to reduce misconceptions is still in existence. Therefore in this study the researchers aimed to find out the track of students' conceptions in the conceptual change module based on mental models in reducing misconceptions on the concept of electron configuration.

II. Metodhs

This study uses One Group Pretest-Posttest Design. The research subjects were class X students of SMAN 1 Bojonegoro who had learned an atomic structure material. The research subjects were stated to have a low level of perception based on the P2M3 test, and had a status of misconception with CRI diagnostic test. This research was conducted at SMAN 1 Bojonegoro, in the 2018/2019 school year. First, students are given an initial concept understanding test (pretest). Then remediation is carried out by giving a CCM based on a mental model on perception aspects. Students' answer on CCM showed the students' conception track. At the end of the study students were given a final concept understanding test (posttest) to determine the change in conception status. The results were analyzed quantitatively using Wilcoxon sign ranked test.

Concept understanding test at the pretest and posttest each of which represents the criteria for orbital concepts (name, definition, characteristics, examples, and their application in solving problems). The students' conception status was assessed based on the results of the CRI diagnostic test. CRI describes the level of confidence of students so that students were categorized in KCC status (knowledge the correct concept), lack of knowledge (LC) and misconception (MC) [15]. The three groups are as in Table I.

TABLE I. Provisions of the Combination of Correct or False Answers and High and Low CRI

	Low *CRI* (<2,5)	High *CRI* (>2,5)
Correct Answer	LC (Lack of Knowledge) (lucky guess)	KCC (Knowledge of Correct Concept)
Wrong Answer	LC (Lack of Knowledge)	MC (Misconception)

III. Result of Research

A. Results

The track of student conception status were analyzed based on students' answers to the CCM. The answers to the CCM indicate the status of the students' conceptions at each step of the CCM shown in Figure 1.
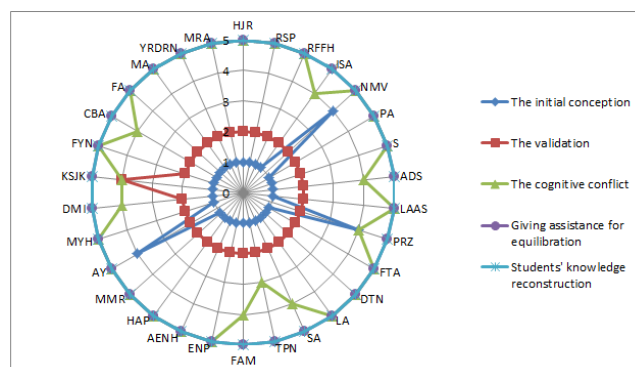

Fig. 1. Graphic Mastery of Concept Results during Pretest

Based on Figure 1 it is known that students have not been successfully changed to KCC at the step of creating cognitive conflict conditions because there are still some students with LC status. Students have been successfully guided into KCC at the step of providing assistance for equilibration and maintained at the reconstruction step of student understanding. The existence of MC1, MC2 and MC3 notation is the step of CCM that students go through, called the first MC, the second MC, and the third MC. There is only 1 student who goes through 3 stages of MC to turn into KCC. 8 students who passed the LC stage before turning into KCC. In addition, the change in conceptual status obtained from MC to KCC in the reconstruction step was 100%. HJR turn into KCC in the second step which is the cognitive conflict conditions, and is maintained in the next stage which is the stage of giving assistance for equilibration, and the stage of reconstruction of students' understanding. The same stage was also experienced by several other students, RSP, PA, S, LAAS, FTA, DTN, LA, ENP, AENH, HAP, MMR, MYH, FYN, FA, MA, YRDRN, and MRA.

To find out the beginning and end of the study, the pretest and posttest results are shown in Figure 2.
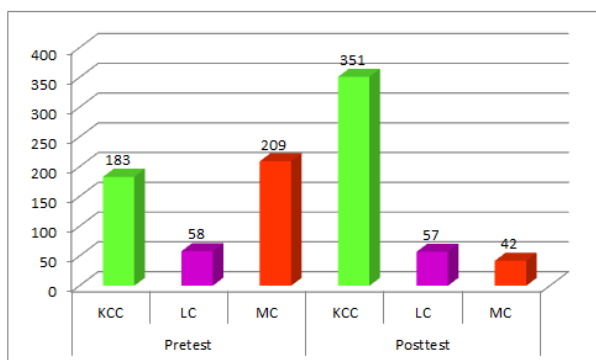
Fig. 2. Comparison of Each Pretest and Posttest Conception Status

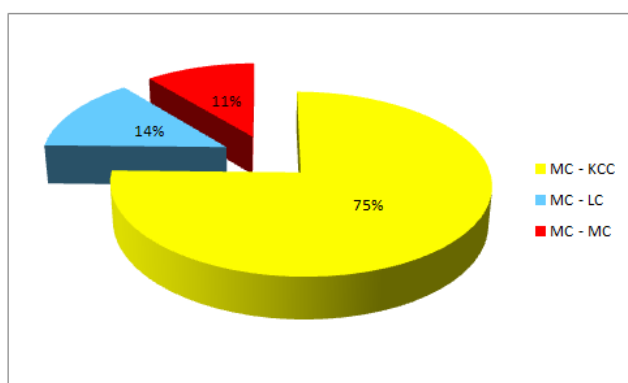Then, MC status was analyzed to determine the change in conceptual status shown in Figure 3.

Fig. 3. MC Shiftment

B. Discussion

Figure 1 showed that at the initial conception step was dominated by MC, only 3 students whose in LC. Only 1 student who changed into LC, at the validation step. At the cognitive conflict step has changed 21 students to KCC, 8 LC students, and leaves 1 student who remains MC. The next step was giving assistance for equilibration step showed thath KCC status was achieved by all students and maintained until the end of the CCM step. The difference in the process of changing the status of conception in each student because indeed every student has a different speed in understanding the concept [16].

The first step of CCM, (the initial conception step) there was 2 students who started with LC status while 28 others started with MC status. The LC status occurs because students have begun to equip themselves with previous learning, students have taught themselves at home before being given a CCM because they know many question of the pretest answers were wrong. Unfortunately the LC status did not last long, because in the second step of CCM (the validation step) they turn into MC again.

The second step of CCM (the validation step) shows that there is only one student with LC status, 29 of whom are MC. This step provides questions related to electron configurations and aufbau rules. KSJK, as the only student with LC status, answered doubtfully about the questions submitted. KSJK was doubt of his answer related the electron configuration of Vanadium elements with the aufbau order as presented in the CCM. Students tend to be

agree with the electron configuration presented by CCM, which is based on aufbau rules.

Cognitive conflict step as the fourth step of CCM, commonly referred to as cognitive dissonance is a condition when new information is obtained by students does not match with students' cognitive scheme, so that disequilibrium (imbalance) occurs in the cognitive structure. Cognitive conflict is used to change the understanding cognitive by giving new conditions as external factors that conflict with the students' cognitive structure. Implementation in CCM, cognitive conflict is given by giving a some example in accordance with scientific principles, which is contrary to the previous student's understanding. Based on the results of the CCM answer, seen the variations of students' conception status. This step still leaves 1 student with MC status. 8 students who have successfully shifted their conceptions to LC. One MC student is still persistent with his concept related to the electron configuration that must be related with the aufbau rules while 8 LC students indicate that the students have started to conflict in their logical structure. Students have begun to realize that there is an error in the electron configuration but they still have doubts.

The giving assistance for equilibrium step shows that all students have successfully changed their status to KCC. Cause the CCM step that were passed and the structured information at this fifth step, students can find the correct concepts.

The next step is the reconstruction of student understanding step. This step is a continuation of the previous step. KCC status has been successfully maintained until this stage and the final stage of CCM. This reconstruction step, students are guided to reconstruct their conceptions. The MC students is then shaken at the cognitive conflict step. Cognitive conflicts that occur then are given enlightenment at the giving an assistance for equilibrium step until successfully changed to KCC. Then, the correct concept is reconstructed to get the right arrangement on the students' cognitive scheme, and its relation to other concepts.

Based on the CCM step that have been passed, there are several MC that often occur, which are shown in Table II.

TABLE II. THE MOST COMMON MISCONCEPTION

Common Misconception	The Correct Concept
Electron configuration is the location of electrons in the atomic shells based on aufbau rules	Electron configuration is a way of describing the spread of electrons based on an increase in the energy level of atomic orbitals
The aufbau rule is the same as the electron configuration	The aufbau rule only show the sequence of electrons distribution
Orbital energy ns < (n-1)d	Orbital energy in elements with atomic numbers < 20, ns < (n-1)d. Orbital energy in elements with atomic numbers > 20, (n-1)d < ns.
Electron configurations must comply with aufbau rules, without exception	Electron configuration in elements with atomic number > 20, (n-1)d written first from ns orbitals
$_{23}V$ electron configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^3$	$_{23}V$ electron configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$

Figure 2 shows that there is a dominance changing in the pretest and posttest. Prestest which is dominated by MC status changes to KCC in posttest. Also seen a decrease in MC that occurred after the CCM was given at 80%, although it has not been able to completely erase MK. It is shows that CCM based on mental models has succeeded in reducing MC.

Then inferential statistical calculations are carried out using Wilcoxon sign rank test to determine whether there is an influence of CCM mental models for MC reduction on the electron configuration concept. The result shows that sig 2-tailed value was> 0.05 which means that CCM has a significant influence to reduce MC.

Figure 3 shows the data shifting of the MC status in the pretest with the posttest. The shift of MC was dominated by a change to be KCC by 75%, and followed by changes to LC and MC. The MC status caused by the students turn back into their previous conception even though it has been successfully changed with CCM and declared successful in constructing the concept of electron configuration correctly. in posttest the student returns to the wrong conception so that it remains MC. Such conditions are explained by Ibrahim that MC is resistant or difficult to change even though it has been introduced to the correct concept [17]. So it is not impossible for students who have been successfully guided to become KCC, then return to their initial wrong concept.

IV. CONCLUSION

The result of the study show: at the initial conception step was dominated by MC, only 3 students whose in a lack of knowlege (LC). At the validation step only 1 student who changed into LC. The cognitive conflict step has changed 21 students to KCC, 8 LC students, and leaves 1 student who remains MC. Giving assistance for equilibration step showed that KCC status was achieved by all students and maintained until the end of the CCM step. CCM was successfully reduce a number of MC to KCC. The decrease of MC was 80%. The MC shifting to KCC, MC becoming LC, and MC still MC in a row by 75%, 14%, and 11%.

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