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OVERCOMING MISCONCEPTION IN ENERGETIC TOPICS THROUGH IMPLEMENTATION OF METACOGNITIVE SKILLS-BASED INSTRUCTIONAL MATERIALS: A CASE STUDY IN STUDENT OF CHEMISTRY DEPARTMENT, UNIVERSITAS NEGERI SURABAYA

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ABSTRACT

Developing metacognitive skills is a prominent objective in the education field. Several institutions use the skills to facilitate students' thinking processes. This study aims to overcome student misconceptions in energetic materials by implementing teaching materials based on metacognitive skills. Several studies have shown that metacognitive skills have played a role in reducing misconceptions through the process of problem-solving in science learning. The subjects of this research are students majoring in chemistry at Universitas Negeri Surabaya, Indonesia. Students' conception status is determined by the result of a conception test equipped with the Certainty of Response Index. With descriptive analysis techniques, results indicated that students who had the potential misconceptions status at the beginning had experienced self-actualization: (1) the number of students who have "the right concept" is more than those who "do not know the concept" and have "misconceptions," and (2) the number of students who have status least misconception. Based on the results of the study, the implementation of metacognitive skills-based teaching materials can overcome student misconceptions in energetic material.

Keywords: chemistry learning process; energetics; metacognitive skills; misconception

INTRODUCTION

The concept of an individual's cognitive structure is the result of experience. The concept or knowledge that students have is the result of the learning process and becomes the foundation in the student thinking structure to solve various problems. Concepts can be considered as ideas, objects, or events that help understand the world (Kuh, 2009). Concept is a mental construction that is used by a student to interpret the results of observation. Therefore, it can be said that understanding the concept becomes one of the absolute and important conditions in achieving learning success.

Chemistry is one of the cornerstones of science, technology, and industry; therefore, it should be taught comprehensively and coherently. One important topic in chemistry is energetics. This material is studied in the subject of basic chemistry and physical chemistry II. The concept of energetics that studies energy and chemical reactions is a basic concept that is closely related to other concepts in chemistry. Obtaining the correct basic concept can strengthen the next material or concept. However, some researches reveal that students have problems with some chemistry topics including energetics. Mondal

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& Chakraborty (2013) identified the topics that lead to misconceptions as chemical equilibrium, acids and bases, electrochemistry, the nature of matter, bonding, physical and chemical changes, solutions, and energetics. On the other hand, some sources also mentioned that in energetic or thermodynamics material, students are still understood misconceptions (Sokrat et al., 2014). Misconceptions often occur with the heat and temperature concept, the concept of endotherms and exotherms and thermochemical concepts, as well as the concept of energy (Schönborn et al., 2014; Saricayir et al., 2016). Misconceptions are a very big obstacle in learning that is more meaningful (Yong, 2017). Therefore, student's misconceptions in the concept of energetics must be corrected or even prevented, to avoid causing an incorrect understanding of all chemical material.

Based on the scope of chemical, energetic material is mostly abstract and very complex. The choice of energetics topics is supported by the results of previous studies, including research results from Nilsson & Niedderer (2014) which aims to reduce the misconceptions on energetic topics using various methods namely enthalpy, enthalpy change, and related concepts; Pratiwi (2016) conducted research in identifying the characteristics of thermodynamic or energetic concepts of students at Malang Kanjuruhan University. The results of his study concluded that students who understood the concept correctly were still classified as low with an average score of 29.68%, while 70.32% of the students experienced misconception.

The interpretation of a concept by a student is called conception. However, students' concept interpretation may vary widely. Conceptual mastery can be achieved once students learn the concepts through a teaching and learning process. Based on the achievement of a student's conceptual understanding suggested by Hasan et al. (1999) in the Certainty of Response Index, there are three groups of conceptions, namely knowing concepts, not knowing concepts, and misconceptions based on. From the three categories, the most difficult concept to overcome is the misconception which as an immortal scourge in the field of education. Misconception occurs when there is a discrepancy between students' conceptual understanding and the scientific theory proposed by relevant experts (Dhinsda & Treagust, 2009). Usually, a different or wrong view is resistant and persistent (Kim & Wood, 2016). Many previous studies have been undertaken, either individually or institutionally by a lecturer or education experts, to find an effective formula for overcoming learning difficulty by applying the conceptual change learning model. However, some researchers found that there are still students who fail to properly construct the basis of chemistry concepts from the beginning of their learning process so they cannot master the advanced concepts built on them (Coil, 2010; Arslan, et al., 2013). Kambouri (2010) adds that some of this knowledge is incorrect and remarkably resistant to change.

Student misconceptions in chemistry can be sourced from students' internal and external factors (Gurel et al., 2015). Internal factors causing students' misconceptions can be sourced from students' daily experiences which are students' initial conceptions, while external factors can be sourced from textbooks, learning processes, learning media, and languages. In this research, students 'misconceptions are focused on students' internal factors, namely initial conceptions, because According to Suparno (2013) students have continued to construct concepts through their life experiences before learning in formal classes. By interacting frequently with the environment in daily life, it is very clear that students have initial concepts about energy, temperature, and heat. Energetic material misconceptions that occur in students must be addressed immediately, so they do not occur on an ongoing basis. According to Suparno (2013), appropriate tips are needed to overcome the occurrence of misconceptions, including 1) by looking for forms of mistakes that students have; 2) find the cause of the error, and 3) determine the right solution to deal with the misconception. In this research, the third step is to determine the right solution to deal with the misconception. One effort to deal with student misconceptions is remediation. According to Sutrisno, Kresnadi, and Kartono (2007) remediation is an activity carried out to improve less successful learning activities.

Learning activity is a process of updating a conception (Kolb & Kolb, 2009). To accelerate the process, the students need to be engaged with a phenomenon focused on a knowing that serves an imbalance thinking process, of which then creating cognition conflict. This conflict further stimulates students to challenge and, then, change their wrong conception of a particular subject matter. In connection with conceptual changes, Piaget states that changing a concept can broaden the understanding and harmonization of thinking patterns to be relevant with the latest information (accommodation) which causes a conceptual reconstruction process (Blake & Pope, 2008). Also, according to the constructivist theory, when students are learning about science, they interpret any new information in the light of their existing ideas and beliefs, which may then become modified or revised. Learning then proceeds as the students' ideas become progressively reconstructed. As an implication, students are aware of the misconception they experience (Gurel et al., 2015).

It is good for students to have the ability to correct a wrong idea or concept in representing submicroscopic phenomena and interlinking it to both macroscopic and symbolic levels (Yau et al., 2017). For students who have mastered the chemistry concepts, the transformation of the understanding of the macroscopic level to the submicroscopic level and vice versa can be easily done because these students have had a representation model in their thinking. This implies that the ability to think is important for qualified and sturdy human resources. In a thinking process, there are various activities such as analyzing, criticizing and retracting conclusions based on accurate consideration. Therefore, the remediation conducted in this study uses thinking skills or cognitive skills.

Generally, thinking is a cognitive process, a mental activity to get knowledge. Cognitive skills involve higher-order thinking skills (HOTS), of which, among others, is metacognition (Kadel, 2015). Metacognitive skills are a set of knowledge and control dealing with the cognitive process performed by students in solving learning difficulties or problems (Downing et al., 2009). This is by the results of Lestari & Wardani's (2018) study which stated that in chemistry education, a student's awareness and thinking control is needed in solving chemistry learning problems. The results of the study are reinforced by the findings of Taasoobshirazi and Farley (2013), that the knowledge of awareness and thought control enables a student to know his strengths and weaknesses when facing learning problems. These weaknesses can be in the form of misconceptions so that they can immediately improve their knowledge.

Metacognitive skills are a person's thinking skills that involve thinking about the sequent processes of learning, planning, monitoring the learning tasks, and evaluating one's outcomes (Mahdavi, 2014). Metacognitive skills act as a key to predict a learning activity in the problem-solving domain for knowing how the execution of tasks is performed (Jacobse & Harskamp, 2012). Moreover, Piaget argues that metacognitive skills play an important role in helping students solve problems or assisting students in comprehending how to express a conscious thought to execute tasks (Keskin, 2013). Metacognitive skills can also help students determine their ways of thinking (Kałdonek-Crnjaković, 2018). Ideally, this process makes students conscious of their typical learning ability. Thus, lecturers should often use the skills to assist students in becoming strategic thinkers that are ready to be confronted with non-routine learning problems. Based on these opinions, learning which empowered the metacognitive skills is focused on how students motivated and participated in designing what they want to learn, monitor the progress of their learning outcomes, and assess what is learned. Metacognitive skills enable students to construct knowledge, apply chemical concepts, and deepen chemical concepts so that they create scientific answers that represent a correct mastery of concepts without misconception. This is consistent with the results of the study which found that there was a strong relationship between metacognitive skills and student learning outcomes with a correlation coefficient of 0.609 (Wijayanti, et.al., 2017). Learning outcomes referred to in the study are the results of mastering the correct concepts without misconceptions. Besides, research conducted by Permata (2012) regarding the application of metacognitive skills in mathematics learning found that students' problem-solving skills were better after applying metacognitive skills because they could develop students' thinking skills in planning skills, monitoring skills, and evaluation skills.

As a medium that helps metacognitive skills to remediate learning, it is necessary to use learning materials based on metacognitive skills. Metacognitive-based instructional materials have been developed by researchers which encompass the lesson plan, student worksheet, metacognitive skills assessment, and conception trace test, to improve the quality of learning, especially in energetics course at the Mathematics and Science Faculty of the Universitas Negeri Surabaya, (Azizah & Nasrudin, 2018).

So, this study was conducted to remediate student misconceptions on energetics material using metacognitive-based instructional materials developed by researchers in the Chemistry Department of the Universitas Negeri Surabaya. This study will demonstrate that the remediation process using metacognitive-based instructional materials is effective in correcting student misconceptions. Also, misconceptions can be overcome or remediated if the numbers of students who understand concepts correctly are greater than those who lack the knowledge and those who have misconceptions, and the least number of students experience misconceptions. The identification of student conception status is determined based on the conception tracking test result using multiple-choice questions supported by the rationales provided in the CRI. The CRI index is used because the low CRI value indicates the existence of guessing while the high CRI value indicates that the respondent has a high level of confidence in the answer. In this situation, if the respondent's answer is correct, it means that a high level of confidence in the truth of the concept has been justified well. However, if the respondent's answer is wrong, it becomes an indicator of misconception.

This research focuses on illustrating conceptual changes in students' thinking in energetics by applying metacognitive-based instructional materials. The changes are demonstrated by the presence of students' correct scientific concepts and the existence of misconception remediation. The purpose of this study was to describe the profile of students' metacognitive skills and the N-Gain categories of students' metacognitive skills in applying the developed instructional materials to enhance conceptual understanding and remediation of misconceptions on energetics topics, and to students' conception profiles before and after applying the instructional materials.

METHODS

This study was conducted in the Chemistry Department, Universitas Negeri Surabaya. This study used a pre-experimental research design with One Group Pretest-Posttest Design (Marsden & Torgerson, 2017). Before the use of metacognitive-based instructional materials, an initial test was performed to review metacognitive skills and students' early conceptions mapping. In the pretest, there were 29 test items tested. Students are said to have misconceptions if they answer incorrectly with a high level of confidence. Next, students used metacognitive-based instructional materials in the teaching and learning process to remediate learning, and they also received a final assessment to reveal the effectiveness of the instructional materials in improving metacognitive skills and remediating student misconceptions. Following the test results, those who experienced a misconception burden were chosen to be involved in this research. Students used metacognitive-based instructional materials in the teaching and learning process in which they also received a final assessment to reveal the instructional materials' effectiveness in improving metacognitive skills and remediating student misconceptions. Through this research design, it is expected that intervention to overcoming misconceptions will be under the learning time of energetic material.

The subjects in this study were students of the Bachelor Degree in Chemistry Education Program at the Mathematics and Natural Sciences Faculty of Universitas Negeri Surabaya. In this research, we used 42 target students (4 male and 38 female). The target students were students who have learned the basic concepts of energetics in the previous semester with the characteristics students are burdened of high misconception on energetic concepts or experiencing misconceptions on more than 50% of the questions tested. This means that out of the 29 questions tested, students who have a high misconception load will misconception respond' at least 15 questions.

This research used two types of instruments, metacognitive skills assessment in the form of essay questions and conception tracking tests in the form of multiple-choice, along with the reasoning supported by the CRI. First, the metacognitive skills test was developed by researchers previously based on several indicators of metacognitive skills; goal setting (P1), identifying student's known knowledge (P2), determining learning strategy (P3), monitoring the relevance between student's known knowledge and used learning strategy (M1), monitoring the achievement of the goal in the conclusion making (M2), and evaluating thinking process and result (E), of which all indicators are adapted from (Pulmones, 2007). The Adaptation from Pulmones's research results is carried out in the arrange of learning activities in planning skills namely goal setting and determining learning strategy, while for skills of identifying student's known knowledge, monitoring skills and evaluating skills are developed researchers based on the theoretical and empirical studies in previous research (Azizah & Nasrudin, 2018), as well as characteristics of the matter and its learning. After being developed, the metacognitive skills assessment draft was validated by three experts in chemistry; the results of the content and construct validity were shown to be very valid for all questions and had 0.88 reliability revealed in Cronbach's alpha (Azizah & Nasrudin, 2018). The valid metacognitive skills assessment is then used in this study.

The second instrument was the conception tracking test. It was also developed by researchers which accommodated 29 items of the energetics concept arranged in order regarding conceptual attainment indicators. Similar to the metacognitive skills test, this type of tracking test was also valid based on the content and construct validity with 0.86 reliability test scores using product moment Pearson's test (Azizah & Nasrudin, 2019).

The implementation of all metacognitive skills indicators was evident to each learning stage conveyed in the student worksheet. In the planning stage, students applied P1, P2, and P3 indicators to complete the task. In the monitoring stage, students dealt with M1 and M2 indicators to explore relevant concepts using various learning sources and practicum and to monitor knowledge relevance. Lastly, they completed a self-evaluation process toward what thinking process and the result of concepts they got scientifically in the evaluation stage.

The obtained data were then analyzed descriptively to explore the information of certain categorization (using a qualitative approach) and to portray percentages and average scores (using a quantitative approach). Moreover, descriptive analysis using N-Gain (Hake 2002 in Asy'ari & Ikhsan 2019), obtained from the pre- and post-test, was used to reveal the improvement of students' metacognitive skills. The formula of the N-Gain test was drawn as follows:

$$(g) = \frac{\%\,actual\ gain}{\%\,potential\ gain}\ x\ 100$$
$$= \frac{\%\,posttest\ score - \%\,pretestscore}{100 - \%\,pretest\ score}$$

There are three important conditions in classifying students' metacognitive skills level: (1) as "high" if <g>> 0.7, (2) as "medium" if 0.3 < (g) ≤ 0.7, and (3) as "low" if <g> ≤ 0.3 (Hasan et al., 1999). Students' conceptual mastery was indicated by the use of multiple-choice questions with the CRI. Students' confidence levels in answering the conception test are portrayed in Table 1.

Table 1. Confidence Level in Answering the Question

Scale	Rating	Description
0	Totally guessed the answer	Students answered the questions by totally guessing them
1	Almost a guess	Students answered the questions by 75%-99% guessing them
2	Not sure	Students answered the questions by 50%-74% guessing them
3	Sure	Students answered the questions by 25%-49% guessing them
4	Almost certain	Students answered the questions by 1%-24% guessing them
5	Certain	Students answered the questions without guessing them, meaning that they knew exactly how to answer

Source: (Hasan et al., 1999)

Also, there were three levels determining students' conception, namely those who understand the concept correctly, those who have a lack of knowledge, and those who have misconceptions. The criteria for each level can be seen in Table 2. From Table 1 and Table 2, we get the percentage of students who know the concept, do not know the concept and misconceptions. Next, identify the concepts in the material energetics that have misconceptions and look for the factors causing it.

Table 2. Criteria in Determining Students' Conception Levels

Low CRI (< 2,5)	High CRI (>2,5)
Correct answer and low CRI indicate a **Lack of knowledge (lucky guess)**	Correct answer and high CRI indicate the **Knowledge of correct concept**
Wrong answer and low CRIindicate a **Lack of knowledge**	Wrong answer and high CRI indicate a **misconception**

Source: (Hasan et al., 1999)

RESULTS AND DISCUSSION

In coping with overcoming misconceptions found in this study, Figure 1 illustrates a set of profiles of students' metacognitive skills in-energetics class. The attainment of metacognitive skills indicators was determined by the fact that most students had high metacognitive skills and scored very high in all indicators. However, some students still scored in the medium category in all indicators and exhibited low scores in the P1, M1, and M2 indicators.

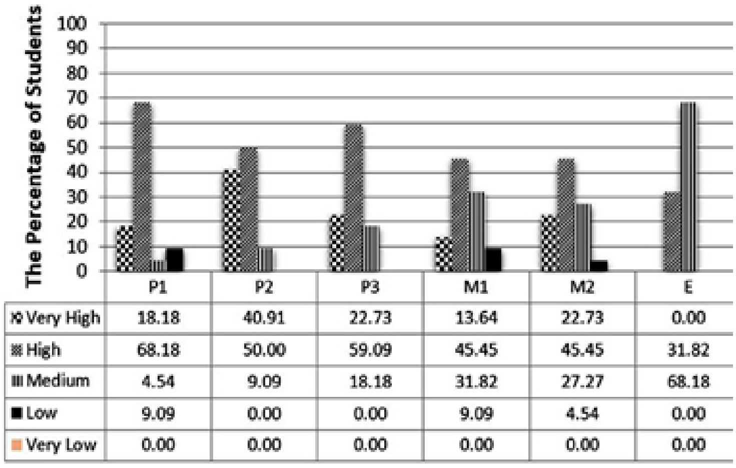

Figure 1. Students' Metacognitive Skills Profiles in Energetics

Also, this study revealed that the N-Gain score indicated a high level of metacognitive skills (see Table 3). This means that teaching and learning activities were able to improve the attainment of metacognitive skills indicators.

Table 3. Average Initial Tests, Final Tests, and N-Gain Each Indicator Metacognitive Skills Tests

Indicators	The Average Initial Tests	The Average Final Tests	N-Gain and Criteria
P1	22,73	78,41	0.72 (high)
P2	25,38	83,71	0,78 (high)
P3	18,94	79,17	0,74 (high)
M1	21,21	73,48	0,66 (medium)
M2	17,42	76,52	0,72 (high)
E	18,18	68,56	0,62 (medium)

Figure 1 and Table 3 indicate that learning activities have empowered metacognitive skills through the students' active role in planning, monitoring, and evaluating the teaching and learning process using various arguments from different learning sources, such as textbooks, worksheets, visual media, and internet.

Along with improving students' metacognitive skills, the teaching and learning process conducted could overcome student misconceptions. Figure 2 illustrates students' conception profiles after the learning process using the percentage of knowledge of Correct Concept (CC), Lack of Knowledge (LK), and Misconceptions (M) for each energetics subtopic, namely subtopic 1 concerning the law of thermodynamics I and sub-topic 2 concerning thermochemistry and the laws of thermodynamics II and III.

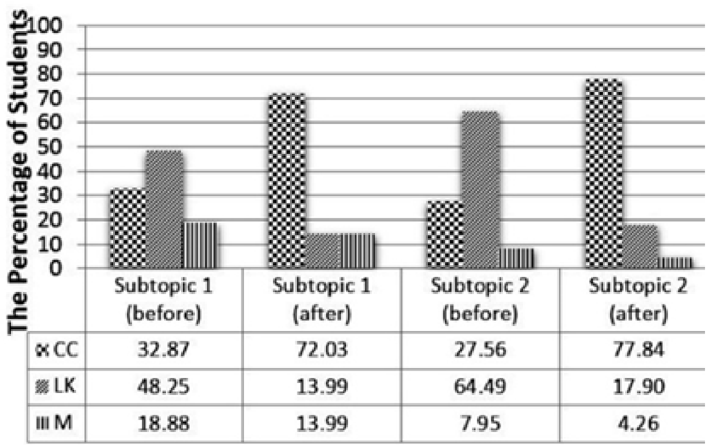

Figure 2. Students' Conception Profiles Before and After the Learning Process

Also, Figure 3 explains students' misconceptions about the whole energetics topic. The attainment of students' conception for each energetics subtopic after the remediation process showed that the number of students categorized in CC class is greater than those in LK and M (see Figure 3).

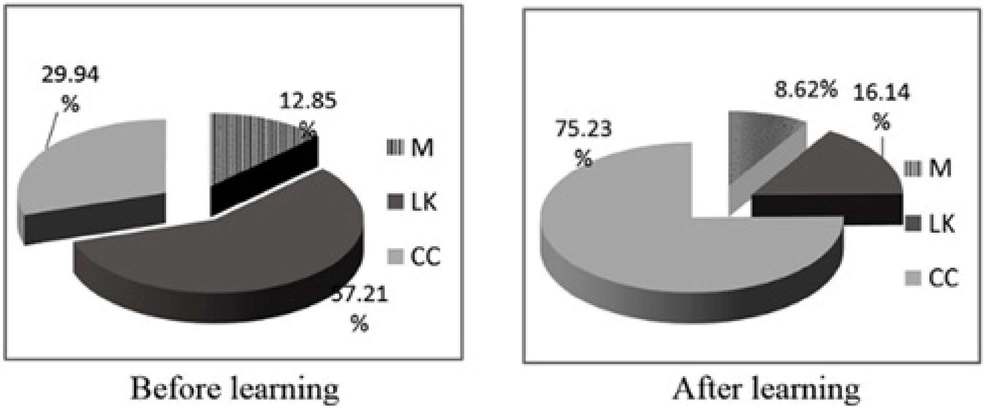

Figure 3. Students' Conception Profiles for Whole Energetics Topic

In other words, CC students dominated the whole concept mastery compared to the other two classes. Before learning, in the first energetics subtopic (the law of thermodynamics I), most students' misconception occurred in a concept that reveals differences between temperatures and heat through submicroscopic representation and defines the first law of thermodynamics. For the second subtopic (thermochemistry and the laws of thermodynamics II and III), most students' misconception occurred in a concept revealing the thermochemical equation and Hess's law. The concept that led to misconception more than any other in energetics was the concept of defines the first law of thermodynamics. After learning, in the first energetics subtopic (the law of thermodynamics I), most students' misconception occurred in a concept that reveals differences between temperatures and heat through submicroscopic representation. For the second subtopic (thermochemistry and the laws of thermodynamics II and III), most students' misconception occurred in a concept revealing the thermochemical equation.The reason isstudents are less able to describe submicroscopic representations of a phenomenon to distinguish the concepts of temperature and heat. Similarly, students are also less able to analyze the phenomenon of the reaction picture between sodium metal and chlorine gas into the thermochemical equation concept.

Nevertheless, there were a small percentage of misconceptions in two administered topics (see Figure 3). This phenomenon was not in line with what was expected at the beginning of this study, which indicates that it was not completely successful in remediating student misconceptions in energetics concepts.

Based on the results of this study, the presence of incisive improvement of the correct concept students' is due to their ability in constructing knowledge autonomously. This situation follows the constructivist theory in which students must discover independently and can transform complex information, crosscheck the latest knowledge with the old rules, and revise the concept if a discrepancy occurs, so that, finally students are aware of wrong concepts or misconceptions (Gurel et al., 2015; Slavin, 2006). Such knowledge can be constructed by linking prerequisite knowledge with energetics materials, and students can deal successfully with the assimilation process that appears in their scheme. According to Blake & Pope (2008), assimilation is the process of using or transforming the environment so that it can be placed in preexisting cognitive structures.

The successful students' scheme in their knowledge construction is exhibited in their answers addressing the conception tracking test's questions using macroscopic, submicroscopic, and symbolic phenomenon representations. The findings in this research are consistent with previous studies of several researchers, including Thomas & Anderson (2014) who also claims that chemical phenomenon representations in each level, and the connection with its notion, are the chemical conceptual description for the sake of enhancing understanding and students' learning process quality. This was also found by Gilbert & Treagust (2009) who argued that the correct understanding in learning chemistry involves multiple representations that cover the macroscopic, submicroscopic, and symbolic.

This current research conveys that students with correct conceptual understanding after the remediation process using metacognitive-based instructional materials demonstrate that metacognitive skills play an important role in overcoming learning obstacles. Several previous studies also confirm that successful improvement in solving problems is influenced by metacognitive activities (Azizah & Nasrudin, 2018). Recently, metacognition, familiarly known as thinking about thinking, became a vital need for students to cope with their 21st-century lives. If students possess thinking skills that are effective in solving problems, their confidence may also develop at the same time. Thus, students need to know their ways of thinking. This also implies that skills of mastering a concept rigorously can be used to overcome misconceptions. Radmehr & Drake (2017) found that misconceptions occur as a result of students' undeveloped metacognitive skills.

Although a learning process based on metacognitive thinking skills has been successfully built students' skills in interconnecting levels of chemical phenomena, there are still some students with a lack of knowledge or misconceptions who face difficulties in interpreting and transforming submicroscopic phenomenon representations. Those difficulties, however, cannot be hindered since students are still in a learning process of using representations of submicroscopic phenomena (Cheng & Gilbert, 2017).

This study also finds that there are several students with a lack of knowledge because, besides physical knowledge construction, they also have to deal with rigorous mathematical-logical construction in energetics concepts. Mathematical-logical construction in energetics concepts is found in the concepts of standard enthalpy changes and physical enthalpy changes, Hess laws and the concept of enthalpy changes. Piaget (Schunk, 2012) states that the mathematical-logical structure is not permanent to students, but rather gradually formed through developmental phases. Student misconceptions are still found in energetics concepts because most students attend the class by only using their conceptions. Schunk (2012) states that the preconception has been constructed as a result of their daily life experience long before they enrolled in university. Misconceptions still exist in students' cognition since preconception is substantially different from scientific perspectives (Treagust et al., 2014).

There is unsuccessful learning for eliminating student misconceptions in energetics materials since it needs longer times to transfer misconceptions or lack of knowledge conception into correct concept ones. For instance, Demircioğlu et al. (2005) conveyed that 18% their students experience misconceptions in the salt concept, and Duit & Treagust (2012) explained that building student conception can fail even when good teaching and learning processes have been used due to the shallow conception of newly constructed concepts. Lastly, Hughes et al. (2013) claimed that misconceptions are difficult to improve.

Nevertheless, based on the results of the study implementation of metacognitive skills-based instructional materials, several findings have been obtained, namely: (1) students have been able to manage their learning using indicators of metacognitive skills applied in this study through worksheets. In working on a worksheet, each student must go through several stages so that a conclusion is reached. The stages in question are as follows: (a) In the first stage, students are given a problem/phenomenon that is often encountered by students in their daily lives. The problem in question is presented at the beginning of the worksheet. At this stage, students solve the problem accordingly to his initial knowledge, followed by setting goals and determining learning strategies to solve problems; (b) In the second stage, students solve problems using learning strategies and known knowledge through practicum activities or using other learning resources. At this stage, students discover for themselves the truth of a concept according to the problem given, and (c) In the third stage, students discuss what things they find while learning and to equate perceptions about the learning concepts that have been concluded. In this activity, students construct new knowledge and revise previous misconceptions so that students' understanding will be more optimal. In the fourth stage, students evaluate his thinking process and result; (2) By applying indicators of metacognitive skills, students can improve understanding of concepts and minimize the number of misconceptions for each energetics concept. An increase in understanding scientific concepts better will have an impact on the minimum misconceptions experienced by these students so that it can be believed that the implementation of metacognitive skills-based instructional materials can reduce student misconceptions better.

CONCLUSION

In this research, we have studied overcoming student's misconceptions through the development of metacognitive skills-based instructional materials. Before learning, most students' misconception on four concepts, namely the difference in temperature and heat, the law of thermodynamics I, thermochemical equations, and Hess's law. After learning by using metacognitive skills-based instructional materials, there are still some students' misconceptions about two concepts, namely the difference in temperature and heat and thermochemical equations. Based on the results of this study, it was concluded that the implementation of metacognitive skills-based teaching materials could overcome student misconceptions in energetic material as indicated by the following: 1) the number of students who had "the right concept" was greater than those who "did not know the concept" or had a "misconception," and 2) the number of students who had the least status of misconception. As an implicative suggestion, it is important to examine further the topic of overcoming student misconceptions in learning chemistry. In this case, lecturers should have an understanding of conceptual changes using metacognitive skills that can be an alternative teaching and learning process, instead of applying the traditional teaching model. By looking at the whole discussion, this study suggests that the researcher and curriculum developer should put more focus on preconception and misconception issues because most students fail to master all materials effectively.

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