

Students' metacognition skill: How the implementation in chemistry learning?

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Abstract: This research discusses metacognition skills in learning chemistry. This study aimed to explore how students' metacognition skills in chemistry learning. Metacognition skills have two basic major aspects, they are knowledge about cognition and regulation of cognition. These aspects have eight important sub-aspects for learning achievement, e.g.: declarative knowledge, procedural knowledge, conditional knowledge, planning, information management strategies, comprehension competencies, reduction strategies, and evaluation. The instrument adopted from the MAI according to Schraw & Denise using a Likert scale consisting of five categories of very agree, agree, doubt, disagree, and very disagree. The results of the analysis are further reduced to three categories, they are agree, doubt and disagree. This study is a descriptive with fifty two participants. In this study, the technique analysis of the data was in the form of quantitative descriptive. The results stated that the majority of students use their metacognition skills in learning chemistry. The most sub-aspect used by students was the reduction strategy and the least sub-aspect used by students was declarative knowledge. These metacognition skills can help students in constructing student understanding of chemistry abstractness. However, it needs to be trained again in use with the assistance of teachers in the implementation of appropriate strategies.

Keywords: *metacognition skill, knowledge about cognition, regulation of cognition, chemistry learning.*

1. Introduction

Currently in Indonesia, applied learning must be based on student centers. Students as a center of learning make students have more important role in learning. This is related with the demands of the curriculum-2013, students must be active in probing their own knowledge so that the teacher's role just as a facilitator in developing student learning processes [1]. In fact, student center is still difficult to implement in Indonesia [2]. Beside that, teacher factor still dominates so students tend to be passive and students are full of lack training through learning strategies. This makes students tend to be passive and listening to the teacher's explanation in the classroom or noting what the teacher words merely [3].

Based on the curriculum-2013, chemistry learning refers to a scientific approach with various phases such as observing, asking, trying, setting, and presenting activities. If the scientific approach is used solely because of the demands of the curriculum-2013, it will lose the essence of the scientific approach. In practice that approach, the teacher felt difficult to apply in classroom learning [4]. Therefore, the teacher as a facilitator must be able to approach students to develop their potential. Students can also independently have an increased balance between soft skills and hard skills that are



known based on attitudes, skills and knowledge competencies [5]. One of the skills that can build students' knowledge independently is metacognition skills [6]. In Indonesia, metacognition skills have several obstacles. One of the causes is teacher center based, so the teacher becomes a main source of information and students who are only considered as a space will be filled with knowledge by the teacher [7]. Metacognition skills are higher-order thinking requires students to learn about the meaning of a person's awareness in their thought processes and their ability to control these processes [8] [9] [10]. Some components included metacognition are planning steps to solve problems with appropriate tools (planning), controlling and comparing goals (monitoring), and reflection on given problems, on understanding concepts, and on mismatches between representations and conceptions (reflection) [11] [12].

Having metacognition skills can develop students' thinking abilities to get the success achievement in learning process. The more often students are aware of the thought process as they learn, the more they will be able to control their own goals, personality, and attention and improve their learning achievement [13]. In some cases, there are some materials which still contextual, such as Stoichiometry. Therefore, it is very suitable if this metacognition skill is owned by students because it can solve problems by studying the learning process contained in the content of abstract subject. One of them is chemistry subject. Chemistry is still a difficult subject, it was students' consideration [14]. Some things are complex because they contain a lot of emphasis on concepts, theories and facts that are hard to remember. The fact that is seen in Indonesia in 2019 based on the results of the national exam scores in chemistry subjects is still low or below standard. It can be seen in the figure 1 below.

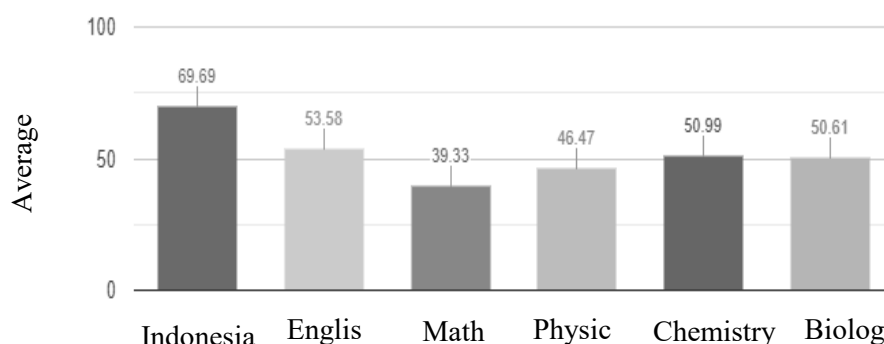


Figure 1. The result of the national exam in indonesia.

This makes it possible that the potential possessed by students is still hampered and also the students' metacognition skills are still unrealize.

Therefore, based on the fact in the field and theories used in this study it is aimed to answer three main questions, those are:

- Do students have good metacognitive skills for learning chemistry?
- What aspects of metacognition are mastered and not mastered in chemistry learning?
- Does the students' metacognition skills come from themselves?

2. Research method

2.1. Participant

Participants in this study are 52 students in XI IPA Yogyakarta / SMA, was carried out randomly XI IPA grade state and superior SMA/MA in Yogyakarta. Participants consisted of 30 students from Yogyakarta Senior High School and 22 students from MAN Yogyakarta.

2.2. Research design

This research was a descriptive study [15]. The design of this research involves collecting and analyzing quantitative data in a study to get more information about students' opinions, attitudes, or beliefs about metacognition skills in learning chemistry.

2.3. Data collection

The process of collecting data in this study is used a research questionnaire. The questionnaire was designed to assess students' metacognition skills in the chemistry learning process. The questionnaire instrument was adopted from MAI Schraw & Denison [16] which was translated into Indonesian with a reliability value of 0.9. There are 52 items related to metacognition skill in chemistry learning and using a Likert scale [17]. This questionnaire has 2 aspects: knowledge of cognition and regulation of cognition. These aspects are broken down again into 8 sub aspects, they are: 1). Declarative knowledge; 2). Procedural knowledge; 3). Conditional knowledge; 4) Planning; 5). Information management strategy; 6). Comprehensive competence; 7). Reduction strategy; and 8). Evaluation.

2.4. Data analysis

The process of analyze the data is used quantitative descriptive. In addition, the questionnaire statement about metacognition skills using a Likert scale with the categories of very agree, agree, doubt, disagree, and very disagree [18]. Moreover, the analysis stage of the results from the questionnaire data was transferred into Microsoft Excel. Then, the data is sorted according to 8 sub-aspects that have been categorized. The percentage of each sub-aspect is broken down based on the Likert scale category to 3, which is agree, neutral or doubtful, and disagree.

3. Results and Discussion

After process the data and analysis the questionnaire and also calculate the percentage of each sub-aspect of metacognition skills, then the data which has been collected are transferred into the following table form:

Table 1. The results of students' metacognition skill.

No	Aspects	Sub-aspects	Percentage		
			Agree	Doubt	Disagree
1.	Knowledge about cognition	Declarative Knowledge	58%	37%	5%
		Procedural Knowledge,	77%	17%	6%
		Conditional Knowledge	70%	25%	5%
2.	Regulation of cognition	Planning	70%	18%	12%
		Information Management Strategies	63%	13%	24%
		Comprehension Competencies	71,4%	5,5%	23,1%
		Reduction Strategies	82%	13%	5%
		Evaluation	71,2%	23,4%	5,4%

3.1. Knowledge about cognition

Based on the table 1, there is a percentage of each sub-aspect. There are three sub aspects of knowledge about cognition. Firstly, declarative knowledge is factual information known by students. This knowledge can be expressed both orally and writing. The percentage obtained from the sub-aspects of declarative knowledge with agree category was 58%, hesitating was 37%, and disagree was 5%. This results state that more than half of the participants mastered declarative knowledge but this result is still relatively low because there are still many hesitant students and did not use declarative knowledge. Secondly, procedural knowledge is knowledge of how person doing somethings, knowledge of how one's performance in carrying out the steps in a process. The percentage obtained from the sub-aspects of procedural knowledge, 77% for agree category, 13% for doubt category, and

6% for disagreed category. These results indicated that metacognition skills in sub-aspects of procedural knowledge have been mastered by students in chemistry learning. However, teachers play an important role in developing their students' metacognition knowledge and skills, due to the importance of metacognition in learning situations and also teachers need to give their students opportunities to develop knowledge and metacognition skills such as discovering when and how to use different learning strategies [19]. Thirdly, conditional knowledge is a knowledge related to whether or not a strategy is used and why a strategy is better than other procedures. For examples of this knowledge include the identification of a case/story problem that requires the calculation of chemical equilibrium as a part of determining the way solution. The percentage obtained from the sub-aspect of conditional knowledge in the category of agree was 70%, doubt was 25%, and disagree was 5%. These results indicated that the aspect of knowledge about cognition is very good, it can be seen from the three sub-aspects. The percentage obtained is more than one-third of participants who use their abilities of knowledge about cognition.

3.2. Cognition regulation

Cognition regulation has four sub aspects, they are planning, information management strategies, competency comprehension, and evaluation. The sub-aspect of planning intended about how students learn to prepare themselves such as thinking what needs to be learned, set goals, manage time and think of several ways to solve problems and choose the best way. The percentage took from the sub-aspect of planning is 70% for agree category, 18% for doubt category, and 12% for disagree category. This number showed that students in their learning have planning, so that chemistry learning can be carried out well [20]. Studied which referred to this study is related with the research conducted by [21]. One of the metacognition strategies students most used is "planning". This remind us to do more works in this regard. The use of students' metacognitive strategies is positively correlated with their understanding of learning chemistry specifically stoichiometry. This can be greatly influenced by the effects of the planning strategy on other strategies. In the sub aspects of information management strategies, such as processing information more efficiently. For example, organizing information, elaborating information, summarizing information so that it can better understand, focus selectively to make information more meaningful.

The percentage obtained from the sub-aspects of information management strategies in the category of agree was 63%, doubt was 13% and 24% for disagree. It is showed that students in the use of information management strategies quite good, it can be prove that more than half of students using that strategy. However, they need to be trained again using these metacognition skills [21]. The sub-aspect of comprehensive monitoring includes in the assessment of one's learning such as asking himself whether found learning objectives, considering all options when solving problems, and pausing learning to check their understanding. Comprehensive monitoring is also an assessment such as analyzing the usefulness of strategies when learnt. The percentage obtained from the sub-aspect of comprehensive monitoring in the agree category was 71.4%, doubtful was 5.5%, and disagreed was 23.1%. The result showed that of all the sub aspects in metacognition, only this sub aspects got the highest percentage of disagreements. In sub-aspects of the reduction strategy that is meant a strategy to correct the understanding and performance errors such as asking for himself to help from others when they don't understand, changing strategies when failed to understand a material, re-evaluating assumptions when confused, re-reading when confused, and returning to search for new information when feeling unclear.

The percentage obtained from the sub-aspects of the reduction strategy in the category agree was 82%, doubt was 13%, and disagree was 5%. These results indicated that students use the reduction strategy well and almost all use it. In the last sub-aspect of the regulation is evaluation. The evaluation in question analyzes the performance and effectiveness of the strategy after the learning such as analyzing how well students do after completing the test, thinking of easier ways to do things after completing assignments, summarizing what has been learned, asking themselves how well in achieving goals after completion learning, and ask yourself if you learn as much as possible after

completing a task. The percentage obtained in the category of agree was 71.2%, doubt was 23.4% and 5.4% for disagree.

The results obtained from each sub-aspect of metacognition showed that the lowest sub-aspect of declarative knowledge were 58% because, declarative knowledge of factual information is known by students. This sub aspect is not trained by the students themselves. In fact, chemistry is included in difficult subject and many formulas must be known in the process [14]. The highest percentage of metacognition was 82% in strategy reduce, it was a strategy to improve understanding and performance errors. Metacognition skills mostly arise from students themselves. However, it needs to be practiced again not only from their own initiative, the role of the teacher is also very important to improve the metacognition skills from the selection of learning strategies and approaches that can bring up this potential in chemistry learning.

4. Conclusion

Most students get agreed responses above 50% to statements about metacognition skills. These results indicate that metacognition skills are implemented in the chemistry learning process. This is very useful for students in improving understanding of abstract concepts that tend to be difficult to understand, because aspects of metacognition can help construct their understanding deeper. This finding shows the sub-aspect of a reduction strategy that is widely used by students in chemistry learning and the sub-aspect that is the least used by students in learning is declarative knowledge. Metacognition skills mostly arise from students themselves. However, it needs to be practised again not only from their own initiative, the role of the teacher is also very important to improve the metacognition skills from the selection of learning strategies and approaches that can bring up this potential in chemistry learning.

References

- [1]. Katuuk A D 2014 *J. Cakra. Pend.* **1** 12-26
- [2]. Mislinawati N 2018 *J. Pes. Das.* **6** 22-32
- [3]. Dewanto and Abidin 2018 *J. Pend. Tek. Mes.* **6** 34-40.
- [4]. Budiyanto M A *et al* 2016 *Proc. Biology Education Conf. (Malang)* vol 13 (Malang: Universitas Muhammadiyah Malang) p 46-51
- [5]. Schneider W and Waters H S 2010 *Metacognition and Memory Development in Childhood and Adolenscence* (New York: The Guilford Press) pp 54-81
- [6]. Sрни M H 2014 *Erudio.* **2** 13-20
- [7]. Schoenfeld 1992 *Learning to Think Mathematically Problem Solving Metacognition and Sense Making in Mathematics* (New York: Macmilian) pp 334-70
- [8]. Ozsoy G and Ataman A 2009 *Int. Elec. J. Elem. Educ.* **1** 67-82
- [9]. Iwai Y 2011 *The. Read. Matrix.* **11** 150-159
- [10]. Fresenborg E C, Kramer S and Pundsack F 2010 *ZDM. Math. Educ.* **42** 231- 44
<https://doi.org/10.1007/s11858-010-0237-x>
- [11]. Nett U E, Goetz T, Hall N C and Frenzel 2012 A C *Educ. Res. Int.* **2012** 1-16
<https://doi.org/10.1155/2012/958319>
- [12]. Pierce W 2003 *Metacognition: Study Strategies Monitoring and Motivation* (Maryland: Prince George's Community College) pp 1-5
- [13]. Sirhan G 2007 *J. Turk. Sci. Educ.* **4** 2-20
- [14]. Creswell J W 2009 *Research Design Qualitative Quantitative and Mixed Methods Approaches 3rd Ed* (Newbury Park: Sage Publications) pp 173-202
- [15]. Scraw G and Denison R S 1994 *Contemp. Educ. Psych.* **19** 460-75
<https://doi.org/10.1006/ceps.1994.1033>
- [16]. Creswell J W 2002 *Research Design Qualitative Quantitative and Mixed Methods Approaches 2nd Ed* Thousand Oaks (Massachusetts: Sage Publications) pp 174-204
- [17]. Russel J and Cohn R 2012 *Likert Scale* (Maryland: Bookvika Publishing) pp 153-57

- [18]. Kuvac M and Koc I 2018 *Educ. Stud.* **45** 646 - 66
- [19]. Mathabathe C K and Potgieter M 2017 *Int. J. Sci. Educ.* **39** 1465 - 84
- [20]. Haidar A H and Al Naqabi A K 2008 *Res. Sci. Techn. Educ.* **25** 215 - 37