Metacognitive Attitude and Knowledge of Biology Teacher Candidates

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Metacognitive knowledge becomes a target on Indonesian curriculum to improve the accomplishment of Indonesian students’ higher order thinking skill. The study aimed to discover the metacognitive attitudes and knowledge of Biology teacher candidates. The study was conducted with the participation of 90 biology teacher candidates from two state universities in Jakarta. The results revealed that most teacher candidates have moderate metacognitive attitudes and low metacognitive knowledge. Thus, metacognitive strategy in university lectures needs to be developed to improve metacognitive attitudes and knowledge as well as skills of teacher candidates.

Keywords: Metacognitive attitude, metacognitive knowledge, teacher candidates

1. INTRODUCTION

Indonesia’s science literacy in the PISA and TIMSS shows hardly satisfying result. It is mainly because Indonesian students’ achievement on science has always been in the bottom rank. Indonesian students failed in answering higher order thinking questions. It urges the government to develop a new curriculum, namely 2013 curriculum. The curriculum has a new target, which is the accomplishment of metacognitive knowledge. Metacognitive knowledge is really necessary in promoting higher order thinking.

Metacognitive knowledge is a part of metacognition. Metacognition has two components, i.e. knowledge about cognition and processes which include monitoring, controlling and cognitive regulation.

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Several examples of metacognitive skills is learners understand various strategies in reading books, able to monitor and also comprehensively review their comprehension on the reading materials. Learners are able to actively relate their knowledge on their strength as well as weaknesses so that it motivates them to complete their task. They realize their understanding on the topics and why they want to learn about the topics. They will realize that they need to shift their approach to obtain a better result and finally they will activate their situational and conditional knowledge to solve the problem on certain contexts. Metacognition has two components, i.e. knowledge and regulation. Knowledge consists of knowledge about one’s self as a learner and factors affected the performance, knowledge about strategy, about when and how to use the strategy. Metacognitive regulation is the monitoring of one’s cognition and includes planning activities, awareness of comprehension and task performance, and evaluation of the efficacy of monitoring processes and strategies.

Metacognition as one’s ability to evaluate, understand, and monitor on the learning process, it can be seen with the Metacognitive Awareness Inventory or

MAI\textsuperscript{16}. The instrument consists of two aspects, i.e. knowledge about cognition and regulation of cognition. Knowledge about cognition includes three aspects: declarative, procedural and conditional knowledge. Meanwhile, regulation of cognition includes five components: planning, information strategies, comprehension monitoring, debugging strategies, and evaluation.

MAI has been used in discovering metacognitive awareness during learning process.\textsuperscript{20, 22, 17, 15} MAI has 52 true and false statements with five rating scale criteria. A further adaptation is required so that MAI can measure the learners’ attitudes.

Metacognition has been integrated to learning taxonomy; it put metacognitive knowledge into Bloom taxonomy revision, besides the other preceding knowledge and cognitive aspects\textsuperscript{1}. Metacognitive knowledge defines as strategic and reflective knowledge about selves, context and condition that is applied in problem solving and task accomplishment.

Bloom Taxonomy is used as an instrument in planning and assessing learning process. Several questions were addressed to assess and measure the accomplishment of knowledge and cognitive aspects in Bloom Taxonomy. Metacognitive knowledge is a new thing in learning, it need instrument for assessing students’ metacognitive knowledge concerning the knowledge of cognition in the scientific context\textsuperscript{14}. The instrument created to measure metacognitive knowledge, which consists of declarative, procedural and conditional knowledge.

Metacognitive knowledge has been integrated to the current curriculum as competence standard.\textsuperscript{15} Teachers need to acquire metacognitive knowledge so that they are able to help future learners in attaining metacognitive knowledge standard. So the teacher training colleges needs to equip their teacher candidates in acquiring metacognitive attitudes and knowledge.

Science teacher training colleges have significant roles in producing teacher candidates that capable in increasing the students’ scientific literacy.\textsuperscript{24,18}

Living things (biology), physical things (physics), earth and space (geoscience) are content area of science literacy\textsuperscript{10}. The study focused on one science study, i.e. Biology. Biology is more descriptive than either chemistry or physics. It also requires much less mathematical requirements. Biology exposes purely descriptive aspects of a science with no mathematics\textsuperscript{19}. The research aimed to discover metacognitive attitude and knowledge of biology teacher candidates in the following research questions: how is the metacognitive attitude of the biology teacher candidates? How is the metacognitive knowledge of the biology teacher candidates? Is there any correlation between metacognitive attitudes and knowledge? Do the teacher candidates have sufficient metacognitive attitudes and knowledge in order to implement the new curriculum in Indonesia?

2. METHODOLOGY

Methods

The study use survey research design. The study used survey design. The survey was conducted in Indonesian capital city, Jakarta. Jakarta has two public universities that produce biology teachers. The survey was carried out on 90 biology teacher candidates in these two universities. Biology teacher candidates are 8\textsuperscript{th} semester students who have been through teaching practice in the school for 2-4 months. They have taken the whole 140 credits of Biology and education courses and are on the process of conducting research about biology education in senior high schools.

Instrument

The study use Metacognitive Awareness Inventory (MAI) and Metacognitive Knowledge Inventory (MKI). MAI is used to measure metacognitive attitudes. Meanwhile, MKI is used to measure metacognitive knowledge.

MAI is adapted from Schraw & Dennison\textsuperscript{16} which then adapted to Indonesian context. It is translated into Indonesian language. MAI is modified from measuring awareness (with disagree-agree rating scale) into measuring attitude (with execution frequency standard rating scale). Psychology experts then validate MAI’s content. Then the content’s instrument reading and context validation is tested to 47 students with the age between 19-21 years old. The validation result of the content and context shows that there are 40 valid questions, which have alpha Cronbach score around 0,769. There are 12 MAI questions in Schraw & Dennison\textsuperscript{16} which are not included in the study, i.e. number 4, 5, 6, 9, 17, 24, 39, 40, 41, 42, 43, 49, and 52. Metacognitive knowledge inventory is adapted from Rampayom et al.\textsuperscript{14} There are three aspects explored in metacognitive knowledge, they are declarative, procedural and conditional knowledge. Declarative knowledge is explored by a question, such as: “What is the relevant information required to be able to answer question number x correctly? Explain your answer!” Procedural knowledge is explored by the following question: “Explain your thoughts step by step so that your answer conclusion is related to your explanation for question number x!” Conditional knowledge is explored by a question as: “In which condition do you think you assume number x correctly? Explain your answer!”

Data Analysis

The data is analyzed descriptively to find its data dispersion and mean. Rho Spearman Correlation Test is used to analyze the relations between metacognitive attitude and knowledge of teacher candidates.
3. RESULTS AND DISCUSSION

Metacognitive Attitude

Metacognitive attitude in each aspect can be shown in figure 1. The score of metacognitive attitudes on 40 statements lays around 80 to 85. The score shows that there are only 22.5% to 40% statements that often performed by prospective teachers. The teacher candidates are qualified to possess a good metacognitive attitude if the score gained is more than 93.75. The score above 93.75 shows that there are 75% statements the prospective teachers usually performed.

According to the gender, there is no difference on metacognitive attitude (Mann Whitney U Test, Sig 0.923).

Table 1. Metacognitive Attitudes that Teacher Candidates rarely do

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Never</th>
<th>Rarely</th>
<th>Frequently</th>
<th>Usually</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>27. I have found myself an automatically most advantageous strategy application.</td>
<td>0 (0%)</td>
<td>22 (24%)</td>
<td>54 (60%)</td>
<td>14 (16%)</td>
<td>90 (100%)</td>
</tr>
<tr>
<td>2</td>
<td>28. I have found myself a time off to regularly check my ability</td>
<td>0 (0%)</td>
<td>25 (28%)</td>
<td>53 (59%)</td>
<td>12 (13%)</td>
<td>90 (100%)</td>
</tr>
</tbody>
</table>

There are two out of forty statements that the teacher candidates usually do. The statements, which are shown in Table 2 are related to declarative and conditional knowledge.

Table 2. Metacognitive Attitudes that Teacher Candidates Frequently Do

<table>
<thead>
<tr>
<th>No.</th>
<th>Statement</th>
<th>Never</th>
<th>Rarely</th>
<th>Frequently</th>
<th>Usually</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11. I learnt better when I have known the topic.</td>
<td>0 (0%)</td>
<td>1 (1%)</td>
<td>15 (17%)</td>
<td>74 (82%)</td>
<td>90 (100%)</td>
</tr>
<tr>
<td>2</td>
<td>36. I learnt deeper when I am interested in the topic.</td>
<td>0 (0%)</td>
<td>2 (2%)</td>
<td>19 (21%)</td>
<td>69 (77%)</td>
<td>90 (100%)</td>
</tr>
</tbody>
</table>

Figure 1. Metacognitive Attitudes Score of the Biology Teachers Candidates

There are two out of forty items, which rarely conducted by prospective teacher. Table 1 shows two statements which most of the teacher candidates rarely do. The attitude lies in procedural knowledge and monitoring aspects.

Metacognitive Knowledge

The average score on metacognitive knowledge of the teacher candidates is 7.11 (Std. Deviation 2.94) of the ideal score, 21. It means the average score on the metacognitive knowledge of the teacher candidates in 100 scales is 33.84 (Std. Dev. 14). There are only 11% teacher candidates who get metacognitive knowledge’ score more than 50. Figure 2 shows the distribution score of metacognitive knowledge.

Metacognitive knowledge is explored high order-thinking questions. Some questions were adopted from PISA. Here, the example of a question:

(Q.2): From the two graphics, Zaim concluded that the increase of the average temperature in atmosphere is caused by the increase of carbon dioxide emission. Do you think Zaim opinion is correct? If you support him, which part supports Zaim’s conclusion? If you refute his conclusion, which part refutes Zaim’s opinion? If you you’re your own conclusion, explain it!

The assessment is not conducted based on right and wrong since the questions are related to procedural question. Therefore, the assessment is carried out based on the argumentation attributes. The argumentation attributes are claim, warrant and reservation. 57% of participants provide one of three argumentation attributes,
while 9% of them provide two attributes. No participant can present all of the three attributes, and even 34% of them are unable to present the argumentation attributes correctly.

Based on the graph, the expected answer of the question is as the following:

*Zaim’s answer is correct. The increase of the average temperature in atmosphere is caused by the increase of carbon dioxide emission (Claim); because the graphic of carbon dioxide emission and atmosphere temperature shows an increase trend (Warrant); Even though in 1910, 1950, 1970 carbon dioxide has been increased, the temperature in atmosphere has been decreased (Reservation).*

Here is the example of participant’s answer.

*I agree that carbon dioxide is the cause of the increase in temperature. It is because there are less trees which absorbs CO₂ and there also a lot of glass buildings.*

The answer succeeded in making claim, but unable to find warrant as well as reservation in the context of the question. The warrant comes from the information in the participant’s thought and does not come from the result of analyzing the context in the question.

Metacognitive knowledge is explored in three questions for declarative, procedural, and conditional knowledge aspects. Here is the question to explore declarative knowledge aspect (Q.n.1): Which knowledge do you need to answer question number 1 correctly? Explain your answer! The question to explore procedural knowledge aspect is (Q.n.2): Explain the steps that you use to get the answer for question number (1)! The question to explore conditional knowledge aspect is (Q.n.3): When and why did you use such steps to answer question number 1?

Figure 4 shows the result of metacognitive knowledge for the three aspects. The picture shows that the participants’ score acquisition for all metacognitive knowledge is low. The difference of the average score obtained and the ideal score should be high enough.

**Correlation between Metacognitive Attitudes and Knowledge**

The result of Spearman correlation shows there is no significant relation between metacognitive attitude and metacognitive knowledge ($r_s=0.095, \text{Sig.} 0.374$). There is also no significant correlation on metacognitive attitudes component and score of metacognitive knowledge. The result of correlation between each component of metacognitive attitude and knowledge can be seen in Table 3. The significant correlation occurs in attitude and skills of declarative knowledge aspect ($r_s 0.327, \text{Sig.} 0.002$).

<table>
<thead>
<tr>
<th>No</th>
<th>Metacognitive Components</th>
<th>Attitude</th>
<th>$R$ spearman</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Declarative knowledge</td>
<td>0.192</td>
<td>0.070</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Procedural knowledge</td>
<td>0.047</td>
<td>0.657</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Conditional knowledge</td>
<td>0.182</td>
<td>0.087</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Planning</td>
<td>0.101</td>
<td>0.342</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Monitoring</td>
<td>0.010</td>
<td>0.927</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Evaluation</td>
<td>0.320</td>
<td>0.766</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Information Management strategy</td>
<td>0.066</td>
<td>0.535</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Debugging strategies</td>
<td>0.030</td>
<td>0.779</td>
<td></td>
</tr>
</tbody>
</table>

**Discussion**

The new high school curriculum in Indonesia has placed the accomplishment of metacognitive knowledge. High school students are targeted to achieve metacognitive knowledge. If most of the teacher candidates have low metacognitive attitude and knowledge, it is feared that the future curriculum in Indonesia will not be achieved properly.

Biology teacher training college used some methods in its teaching and learning. They are lecturing, classroom discussion, laboratory practice, and field study. These methods were considered insufficient to improve the
metacognitive attitude and knowledge of the teacher candidates.

Biology teacher training colleges need to re-think their teaching and learning methods for teacher candidates. Some research showed several learning strategies in improving metacognitive attitude and knowledge. The teacher candidate-producing universities should consider metacognitive strategies in their lecturing classes. Metacognitive strategy were the most effective one in enhancing academic achievement and be integrated in the classroom so as to help students learn material more efficiently, retain information longer and generalize skills. Implementation of metacognitive strategies contributed to the increase of learning and curricula. According to previous studies at the intermediate level, problem-based learning (PBL) shows effective results in increasing metacognitive knowledge. PBL is also effective in developing awareness and metacognitive attitudes. The other studies show the effectiveness of Problem Based Learning in developing student metacognition (undergraduate students). The strategy of writing daily journals or diary is also very effective in improving metacognition.

5. CONCLUSIONS

Metacognitive attitudes and knowledge of Biology teacher candidates are not good enough. The metacognitive attitude and knowledge of teacher candidates have not been proportionated yet for Indonesia to implement the new curriculum. Universities need to evaluate their lecturing strategies that can develop metacognitive attitudes and knowledge of teacher candidates.

REFERENCES


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