STUDENTS’ METACOGNITIVE SKILLS FROM THE VIEWPOINT OF ANSWERING BIOLOGICAL QUESTIONS: IS IT ALREADY GOOD?

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ABSTRACT

Recent research in the science learning field emphasizes the importance of science learning that can empower 21st Century skills and implement metacognition-based learning. Metacognition is one of the foremost successful factors of learning achievement, which is the implementation in Indonesian schools is still being questioned. The present quantitative study aimed at gathering information on the profile of students’ metacognitive skills in Malang and figuring out whether the students’ grade influence metacognitive skills or not. This study was in ex post facto research which involves five levels of independent variables (grade level) and metacognitive skills as the dependent variable. The study involved 458 students (99 students in grade VII, 98 students in grade VIII, 98 students in grade IX, 77 students in grade X, and 86 students in grade XI) as the participants selected by homogeneous purposive sampling technique. The data of the metacognitive skills were collected by using Metacognitive Skills Rubric integrated with essay questions as the instrument. The collected data were analyzed through descriptive statistics and one-way ANOVA. The results of this study informed that the students’ metacognitive skills in Malang at each grade were categorized in “very low”. However, the level of grade significantly influenced the students’ metacognitive skills. The Senior High School (SHS) students possessed the highest level of metacognitive skills, and the students of grade VII of Junior High School (JHS) were at the lowest level. Senior High School students have better metacognitive skills than JHS students due to this kind of skills could develop by the increase of students’ grades in the process of education. The findings of this study also reveal the low level of students’ metacognitive skills. Therefore, the learning process is recommended to implement various learning form that can empower students’ metacognitive skills optimally.

INTRODUCTION

The teaching of science in the schools is expected to facilitate students to not only acquire the skills of 21st century but also encourage them to be an independent learner (Chalkiadaki, 2018) and long-life-learning person (Milić, 2013). In order to fulfill the expectations, the implementation of teaching science in the schools has to increase the learning motivation of the students (Baldivino, 2018; Lord et al., 2010). The process of teaching and learning in the class should also enable the students to recognize their ways of learning (Sagitova, 2014). Also, the learning designs must be created to promote student to could regulate their learning process (Gonzalez-DeHass, 2016; Moos & Ringdal, 2012). Along with it all, science learning is expected to produce students who can...
do the planning, monitoring, and evaluating their process of learning. That is why developing stu-
dents’ metacognitive skills are one of the crucial steps to achieve learning goals.

Metacognition is one of the processes of executive function, which is relevant to the pro-
cess of learning (Gottfried, 2015). The students who have adequate metacognitive skills can mon-
itor and control their thinking process (Patter-
son, 2011). The higher the level of the students’ metacognitive, the better their awareness of the
learning process. Further, the students also pos-
sess good self-reflection (Metcalfe & Schwartz,
2018). They will quickly recognize which mate-
rials they have not known yet (Conley, 2014) and
decide to stop, repeat, or continue their learning process (Miller, 2017). In short, the students
will be able to effectively manage their ways of learn-
ning and know the appropriate time to learn.

If metacognition concept is taught effecti-
vely in the schools, the students will significant-
lly improve their achievements. In other words, when the teachers integrate metacognition-based
learning to their teaching, the students’ learning outcomes are optimally enhanced (Perry et al.,
2014). Most of the previous studies also reported that metacognitive skills had significantly
influenced the learning outcomes (Siwasti & Corebima, 2017), critical thin-
ing skills (Diella & Ardiansyah, 2017), and oth-
er academic competences. Also, the metacog-
tsive skills of the students could be seen from their
communicative competences during interaction
with others (Patterson, 2011). These previous
findings that informed the various effects of me-
tacognitive skills led the researchers to conduc-
t studies about the development of metacognitive skills throughout the teaching process.

The implementation of metacognition-
based learning model is the most effective way for
the teachers to enhance the metacognitive skills.
The learning models are, for instance, problem-
based learning (Haryani et al., 2018), simaer-
ca (Darmawan et al., 2018), search–solve–create-sha-
re (Corebima, 2017), project-based learning (Pav-
vukovic et al., 2018), and inquiry-based
learning (Adnan & Bahri, 2018). Furthermore,
some learning techniques such as reflection, self-
feedback (Colbert et al., 2015), and mapping con-
cept (Pedone, 2014) are also strongly recommen-
ded to develop students’ metacognitive skills.

Unfortunately, most of the Indonesian
teachers are rarely implement teaching designs
which develop students’ metacognitive skills. The
statement is supported by the fact that reports
of Indonesian students’ metacognitive
skills (Diella & Ardiansyah, 2017; Nurajizah et
al., 2018), and mapping concept (Pedone, 2014),
and self-reflection (Siwasti & Corebima,
2017a) but also on critical thinking skills (Mag-
no, 2010). Besides, metacognition also positively
correlates with reasoning ability (Haryani et al.,
2018) and implementing the knowledge effective-
ly (Scharff et al., 2017).

One effective way to empower metacog-
nition is when the teacher teaches various biologi-
cal concepts to their students. Various studies also
reported, by applying the appropriate learning design, biology learning was able to effectively
empower student metacognition (Heilanti et al.,
2017; Listiana et al., 2016). The good develop-
ment of student metacognition will be seen from
their ability to respond to the biological problems
presented by the teacher. The statement is based
on the references that inform a person’s ability to
communicate the results of their analysis or eva-
luation of a problem is one of the leading indi-
cators in metacognitive skills (Corebima, 2009;
Pattison, 2011).

The majority results of the studies about metacognition showed that the metacognitive skills
were different from metacognitive knowledge
(Perry et al., 2019). That was why, several pre-
vious metacognitive studies were focusing on the
domain of metacognitive skills (Amin & Sukes-
tiyarno, 2015; Colbert et al., 2015; Darmawan et
al., 2018; Palennari et al., 2018). Unfortunately, the
results of the practicums are not designed based on in-
quiry activities. The practicum handbook is de-
signed like a “cookbook” where students only imple-
ment the work presented in the practical. From
determining the title of practicum, observa-
tion activities, data collection, to the format of
tables in the reporting of practicum results.

Related to the observation results, the low
awareness of teachers on developing meta-
cognitive skills and their inadequate knowledge
of metacognition has also been reported in the
previous study (Dewi et al., 2017). The learning
assessment which does not base on higher-level
thinking (Winarti et al., 2015) and unsupported
media and learning resources (Dewi et al., 2017)
are also contributing to the problem. Interest-
ingly, although the majority of studies informed the
lack of metacognitive skills of the students, some
other studies were on the contrary (Amin & Su-
kentiyarno, 2015; Palennari et al., 2018). Their
research was conducted to examine the future
of students’ metacognitive skills with
different designs, perspectives, and instruments
by recommending assessment (Colbert et al.,
2015) to provide an in-depth analysis of metacognitive
skills. Specifically, studies which aim at investigating
metacognition of Junior and Senior High School
students in Indonesia are still few in numbers.

Metacognition research has been carried
out in Indonesia over the past few years. The
most current research was studying the effect of
applying learning models or strategies on the em-
powerment of students’ metacognition, such as
inquiry-based learning (Nunaki et al., 2019), pro-
ject-based learning (Husamah, 2015), and prob-
lem-based learning (Haryani et al.,
2018). Some other studies limit their research to the develop-
ment of metacognition measurement instru-
ments (Corebima, 2009; Zulfiani et al., 2018),
while other studies aimed at developing metacog-
nition-based learning source (Dewi et al., 2018)
or media (Siagian et al., 2019). Other studies have
indeed examined the metacognition profile of
students, but only involved class XII high school
students (Yanti et al., 2017) or involved first year
students in Malang. It does differ from similar previous studies. Furthermore, the
teachers in Indonesia are also contributing to the problem. Interest-
ingly, although the majority of studies informed the
lack of metacognitive skills of the students, some
other studies were on the contrary (Amin & Su-
kentiyarno, 2015; Palennari et al., 2018).

This study employs different characteristics than
other metacognitive studies. Firstly, the data on
metacognitive skills are collected by using differ-
ent instruments with previous studies. Secondly,
the study involves greater participants than in oth-
er previous studies. Thirdly, this study also exa-
mines if the students’ grades correlate to the level
of students’ metacognitive skills.

METHODS

The present quantitative study includes ex
post facto research design which aimed at presen-
ting the profile of students’ metacognitive skills
in Malang. The study was limited in the metacog-
nitive profile of the Junior High School (grades
VII – IX) and Senior High School/SHS students
(grade X and XI) in Malang. The steps of the study
were developing the instruments, piloting and try-
ing out the question items, selecting the partici-
pants, analyzing the data, and interpreting the find-
ings. The collection of the data was carried out by con-
ducting test using the developed instrument in
the targeted schools that were randomly selected.
The administration of the test involved the stu-
dents of Department of Biology Education,
the University of Muhammadiyah Malang who were
joining the teaching apprentice program in their
schools.

The study population was all high school students in Malang, with 981 students selected through homogeneous purposive
sampling. The homogeneous sample creates based on school academic level. The selected schools

Research that examines students’ metacog-
nition improvement from one class level to the class level needs to be considered. This study will inform how the role of the learning process in schools in empowering students’ metacog-
nition. Such information will also be the basis for evaluating and reflecting the learning process in
schools regarding metacognitive-based learning.

Also, the research should use metacognition instru-
ments that more suited to the characteris-
tics of Indonesian students. The purpose of this
study was to examine the metacognition
profiles of Junior High School/JHS (grades
VII – IX) and Senior High School/SHS students
(grade X and XI) using essay-based metacogniti-
ve skill instruments.

The current study presents the profile of
students’ metacognitive skills in Malang. It does
not only investigate the profile of metacognitive
skills of students in a particular grade but also
students in some grades. It makes the study diffe-
rent from similar previous studies. Furthermore,
the research employs different characteristics than
other metacognitive studies. Firstly, the data on
metacognitive skills are collected by using differ-
ent instruments with previous studies. Secondly,
the study involves greater participants than in oth-
er previous studies. Thirdly, this study also exa-
mines if the students’ grades correlate to the level
of students’ metacognitive skills.
The scores of students’ responses were analyzed by using descriptive and analytical statistical analysis. Firstly, the students’ average scores in every grade were calculated. The level of students’ metacognitive skills was based on categories presented in Table 2. Afterward, the data of students’ competencies were analyzed by employing one-way analysis of variance (ANOVA) to reveal if there was a different level of competencies in the different grades. The Least Significant Difference (LSD) was chosen as the additional analysis after ANOVA. The result of LSD analysis was presented in the chart.

Table 2. The Categories of Metacognition Level

<table>
<thead>
<tr>
<th>Scores</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>86-100</td>
<td>Very good</td>
</tr>
<tr>
<td>76-85</td>
<td>Good</td>
</tr>
<tr>
<td>60-75</td>
<td>Enough</td>
</tr>
<tr>
<td>55-59</td>
<td>Low</td>
</tr>
<tr>
<td>0-54</td>
<td>Very low</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Metacognitive skills play a crucial role in supporting students’ learning achievement. The present study analyzed the metacognitive skills score of grade VII to XI in Malang. The data of metacognitive skills were presented in Table 3. Based on Table 3, it was shown that the average skills of critical thinking of the students in all grades were categorized as “very bad”. The findings implied that the development of students’ metacognitive skills in Malang was not maximum.

Table 3. Metacognitive Skills Mean Scores of Junior and Senior High Students in Malang

<table>
<thead>
<tr>
<th>Grades</th>
<th>Mean ± SD</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII</td>
<td>10.61 ± 5.866</td>
<td>Very low</td>
</tr>
<tr>
<td>VIII</td>
<td>13.09 ± 7.341</td>
<td>Very low</td>
</tr>
<tr>
<td>IX</td>
<td>15.53 ± 6.483</td>
<td>Very low</td>
</tr>
<tr>
<td>X</td>
<td>19.42 ± 7.288</td>
<td>Very low</td>
</tr>
<tr>
<td>XI</td>
<td>17.58 ± 6.768</td>
<td>Very low</td>
</tr>
</tbody>
</table>

The low level of metacognitive skills of the students in Malang revealed in this study. It was consistent with the information about metacognitive level of the students in other regions as described by the previous studies such as in Sukabumi (Nurajizah et al., 2018), Tasikmalaya (Diella & Ardiansyah, 2017), and Bandar Lampung (Yanti et al., 2017), Papua (Tjalla & Putriyani, 2018), Medan (Diella & Ardiansyah, 2017), and Semarang (Susilo et al., 2019). The information was based on the actual studies and the profile of students’ competence in which the researchers, according to the ethics of research, were one of the external factors. In other words, the information obtained from the present study or other previous studies were the real condition of the students in the schools.

The students’ unfamiliarity with the model of question items as the instrument in this study might have interfered the findings. It was due to the measurement of students’ metacognitive skills used in this study was based on their abilities in expressing the idea after analyzing and evaluating the information presented in the test. The students who have high level of metacognitive skills would give grammatically appropriate responses and well-structured sentences (Corebima, 2009). Then, the problem was if the students were barely trained to evaluate and analyze their problems, they would encounter the difficulty in giving the proper responses in the test. Some results of previous studies supported this information in which Indonesian junior high school students were rarely, even, exposed with high order thinking questions (Kusaeri et al., 2019). Therefore, they had some problems in providing responses to the questions (Hadi et al., 2018).

Another internal factor that contributed to the lack of students’ metacognitive skills was their communicative competences. As explained in the beginning, the ability to respond to the questions by using well-structured and understandable language was one of the indicators of one’s metacognitive skills. This statement was supported by Patterson’s (2011) explanation stating that a person who had adequate metacognitive skills would be able to communicate with others in the real context of communication and ensured their utterances were clearly understood. Excellent communication ability was monitoring the utterances a person said and wrote and evaluating the understanding of interlocutors about what being communicated. However, this study revealed that the communicative competences of Indonesian students, both spoken and written, was categorized as “low” (Wangsa et al., 2017), even some of them did not convey a clear and understandable meaning when communicating (Musliah et al., 2015). As a result, it was not surprising when this study showed the low level of students’ metacognitive skills. The concern and insufficient knowledge of teachers about metacognition also became an obstacle in developing students’ metacognitive skills (Rahman et al., 2010). One of the indicators was the implementation of teaching and learning activities that was only teacher-centred – the learning activities were dominated by students while the teachers as to be the facilitator (Kurniati & Surya, 2017; Zulfikar, 2013) The application of conventional model of teaching inhibited the development of students’ metacognitive skills during the learning process (Alzahraini, 2017). Moreover, the condition was worsened with the limited availability of learning resources and assessment that had not designed based on higher critical thinking skills (Dewi et al., 2017; Ramdiah et al., 2019).

The observation results that conducted before, during, and after the process of taking quantitative data in this study also reveal the reason why students’ metacognitive skills level in Malang still in the low category that have been conducted in several schools were generally showed that a small number of schools have implemented metacognition-based learning. Most of the remaining schools had not yet implemented such learning.

Some schools that have implemented metacognition-based learning are more concentrated in the Malang City area. These schools are dominated by public schools where PBL is the most common learning model implemented by teachers in these schools. A worksheet from one of the state schools was able to show the PBL learning syntax that students must follow clearly. On the other hand, other public schools and most private schools in the Malang City area have not yet implemented such learning. Discussion activities do appear in some learning, but the learning flow is less able to reflect one of the learning models that could empower metacognition.

In line with several schools in Malang City, many schools in Malang Regency also still implement learning that was less able to empower students’ metacognition. Some teachers more often instruct students to answer questions on student worksheets then class discussions take place. Practicum activities were also carried out using practical manuals that guide each step.
The activities of the internship teachers distributed in many schools in the Malang City and Batur City also informed the same thing. Yet almost all internship teachers do not understand what metacognition is and how to empower it. The accompanying teacher was also not able to guide the internship teachers to design and implement various learning models that could improve students’ metacognition.

Furthermore, based on the Kolmogorov-Smirnov test, the data of this study were normally distributed (p-value grades VII, VIII, IX, and X I were .052, .091; 200; .052; and 200). The result of Levene’s test also informed that the variance among groups were homogeneity (p-value = .056). Therefore, the data of the present study fulfilled the requirements to be analyzed by using one-way ANOVA. The summary of the ANOVA test was presented in Table 4. The result of ANOVA analysis described that the students’ grade had significantly influenced the students’ metacognitive ability (p < .005). That was why LSD was utilized to carry out further analysis. The result of LSD analysis was consistent with the previous studies reported that the level of education was an important factor consistent with the previous studies reported that the level of education was an important factor (Davis, 2015; Darmawan et al., 2018). Also, some other references suggest a more active model of teaching such as inquiry learning (Adnan & Surya, 2018; Thomas, 2012), self-reflection activities (Colberi et al., 2015), and mind-mapping (Pedone, 2014).

The improvement of students’ metacognitive skills from a lower grade to the higher grade described that this kind of skills could develop by the increase of students’ grades in the process of education. The result of this study was in consistent with the recent meta-analyses studies on metacognition are suggested to be conducted in Indonesia. This kind of studies is needed to gain trend and description of the current results (Cavas, 2015; Egímr et al., 2017; Fauzi & Pradipta, 2018). Through the activities, hopefully, the teaching models that have positive impacts on the students’ metacognition could be identified and collected. Furthermore, information obtained from meta-analyses studies can be used as a guideline for the future researchers to conduct other studies.

In the 21st-century education, students are required to access their understanding and to be an excellent facilitator for the students so that they can implement their learning strategies and develop critical thinking. Metacognition is closely related to other factors which are used to predict the students’ achievement. Metacognition is also significant correlated with students motivation (Oğuz & Ataseven, 2016) which is not only general motivation but also self-efficacy and students achievement goals (Muna et al., 2017). Students who have good metacognitive skills will be more confident in the process of learning (Kiscak & Budak, 2014). It will improve their learning achievements. Thus, it is undeniable that metacognition is very important and can be developed by teachers who do not acquire the concept and are not familiar with metacognition. Consequently, professional development programs and teacher training are highly needed in order to create well-trained teachers so that they are ready to develop the metacognitive abilities of their students.

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Figure 1. The Summary of LSD Test Results. Differences Notation Represents the Mean Difference at the Significance Level 0.05

<table>
<thead>
<tr>
<th>Sources</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast</td>
<td>4</td>
<td>23.98</td>
<td>&lt;.005</td>
<td>.175</td>
</tr>
<tr>
<td>Error</td>
<td>453</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It could be seen in figure 1, the students in grade VII significantly possessed the lowest metacognitive skills than the other grades. The students in grade VIII acquired higher level of metacognitive ability than students in grade VII. Furthermore, the average of metacognitive skills of the students in Senior High Schools was also better than the students of Junior High Schools. Furthermore, the finding of this study indicated that the higher the grades of the students, the better their levels of metacognitive skills.

Table 4. The Summary of ANOVA Test Results on the Effect of Grade Level on Metacognitive Skills

The improvement of students’ metacognitive skills from a lower grade to the higher grade described that this kind of skills could develop by the increase of students’ grades in the process of education. The result of this study was in consistent with the previous studies reported that the level of education was an important factor consistent with the previous studies reported that the level of education was an important factor (Davis, 2015; Darmawan et al., 2018). Also, some other references suggest a more active model of teaching such as inquiry learning (Adnan & Surya, 2018; Thomas, 2012), self-reflection activities (Colberi et al., 2015), and mind-mapping (Pedone, 2014).

Besides the enormous numbers of the recommended teaching models, strategies, and techniques, some principles that should be considered by the teachers in order to optimize the students’ metacognitive skills. Firstly, the teachers must be able to encourage students to be aware of the importance of materials that were being discussed. Besides, the teachers should be an expert of designing a set of assessment that is not only measuring the lower-order thinking skills but also developing students metacognition skills such as portfolio (Gencel, 2017) and self-assessment (Siegsmund, 2017). In this context, giving a lot of exposures to the students to evaluate their learning should be conducted in order to build the students’ awareness and self-efficacy (Miller, 2017). As a result, the students are motivated to decide what have they do to understand the materials that were being discussed. Finally, the teachers must have to make their students regularly involve in the continuing metacognition-based learning.

Designing good quality of metacognitive learning is not a piece of cake, particularly in Indonesia. The researches in other countries. They reported that the development of students’ metacogniti-
on the findings of this study about metacognitive skills should be taken into account to improve the quality of education in Indonesia.

However, this study has several limitations that need to be addressed in future studies. The choice of schools from moderate levels is one of the limitations of the study. The selection of high- and low-level academic schools seems to need to be done to see students' metacognitive skills generally. In addition, the involvement of different school levels can be used to study the effect of academic levels on metacognitive skills. The collecting data process using only one type of instrument is also another limitation of this study. Therefore, the assessment of student metacognition profiles using various other instruments is highly recommended. Some other instruments, e.g., the Metacognitive Awareness Inventory (Schraw & Dennison, 1994) or Metacognitive Strategy Knowledge Test (Karlen, 2017) were recommended for use. The use of Teacher Metacognition Inventory (Yang et al., 2016), Teachers' Metacognition Scale (Wilson & Bai, 2010), or Awareness of Independent Learning Inventory (Meijer et al., 2013) also needs to be done to see the information about metacognition profile of teachers and Pre-service teachers, considering that teaching factors probably cause one of the causes of the low level of students’ metacognition.

**CONCLUSION**

To sum up, the present study contributed to the profile of students' metacognitive skills in Malang. The findings showed that the metacognitive skills of the students in all grades (VII - XI) were categorized as “very low”. Furthermore, the JHS students in grade VII performed the lowest level of metacognitive skills than other grades, while the students in grades X and XI possessed the highest level of metacognitive skills. The results of this study have revealed an unfortunate learning condition. The education process in secondary schools is less able to empower students' metacognitive skills. Information from this research can also be used as a basis for related education service policies and as a primary reference for teachers and education researchers, especially in the Malang region.

Since the findings revealed that the students were lack of metacognitive skills, the development of students' metacognitive skill should be a crucial issue in the education field and research in Indonesia. The potential solution to solve this problem is that teachers are encouraged to improve their knowledge and understanding of metacognition and trained to design well-structured metacognition-based learning. By this, it is expected that they can be a good and professional facilitator to their students in order to develop metacognitive skills. Then, the availability of learning resources and metacognition-based assessments should be also taken into account. In addition, content analysis of metacognition studies in Indonesia has been conducted in order to see the progress of metacognitive development and to find the best solution to solve the problem.

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