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*Diagnostic Test-Based Assessment Tool Using Moodle to Measure Students' Metacognitive Abilities.*

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# DIAGNOSTIC TEST-BASED ASSESSMENT TOOL USING MOODLE TO MEASURE STUDENTS' METACOGNITIVE ABILITIES

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## Abstract

*As part of mindset, metacognition is one of the key indicators of 21st century skills. In this 21st century learning era, the need for metacognitive assessment tools is very important. This study aims to measure students' metacognitive abilities on science concepts using a Moodle based self-diagnostic assessment and know the correlation between students' metacognitive abilities and their learning outcomes. The research used quantitative methods with a sample consisting of 2 classes of students taking Basic Science Courses Data analysis of students' metacognition level based on evaluation results and correlation analysis of students' metacognition skills and learning outcomes. The result indicated that diagnostic test-based assessment tool using Moodle can be used to measure students' science metacognition abilities. The results also showed a significant correlation between metacognitive abilities and student learning outcomes. Diagnostics test using Moodle can be an alternative metacognitive assessment of the learning process and an opportunity to create a 21st-century skills assessment.*

**Keywords**

Diagnostic Test, Assessment Tool, Moodle, Metacognitive Abilities

## 1. Introduction

Humans are required to be able to keep up with the changes that occur with better knowledge and skills in the era of globalization. The era of globalization is marked by the acceleration of technology in various sectors, with the main demands related to quality and human quality (Sofyan, 2019). The skills needed by humans to face increasingly complex demands and challenges are 21st-century skills (Redhana, 2019). In line with Muhali's research (2019) that 21st-century skills are fundamental to providing in-depth knowledge and demonstrating understanding through performance.

According to Assessing and Teaching 21st Century Skills (ATC21S), 21st century skills are classified into four categories, namely mindsets, workstyles, work tools, and life skills (Griffin et. al., 2012). As part of mindset, metacognition is one of the key indicators of 21st century skills. Metacognition is the ability to think at a higher level, the process of seeing yourself as the object of thought. According to Saavendra & Opfer (2012), metacognition reflects a person's critical awareness of how they think and learn, as well as their self-assessment as a thinker and learner. Metacognition

as a 21st century skill is important for learning to educate independent students, a learning goal declared by the National Research Council of the National Academy of Sciences (2010). Metacognition ability has not been measured because the teacher only focuses on cognitive knowledge (Muhali, 2019)especially on science subjects.

There are many methods for assessing metacognition, such as questionnaires, interviews, analysis thinking-aloud protocols (thinking by saying what is being thought), observation, and awareness raising about assignments, diaries, or autobiographies. All of these instruments have advantages and disadvantages for example, using interviews and think-aloud techniques are not suitable for students with verbalization disabilities, but using questionnaires is easier to manage a large number of students (Rompayom et. al., 2010). Metacognitive abilities in students can be developed with the right learning model and followed by an appropriate assessment.

Appropriate assessments to measure students' metacognitive abilities are those geared towards metacognitive abilities themselves (Asy'ari et. al., 2018). One type of assessment that can be integrated into active learning by measuring metacognition and cognitive skills is the self-diagnostic assessment (Pantiwati, 2017). Valuation in the digital age has led to the use of information and communication technologies (ICTs) by different sectors of society to exchange and receive information, especially in the education sector. The challenges of the 21st century is answered by the innovation of online assessment implementation with the help of existing technology. The application is used to support self-assessment and peer-assessment. One of them is Moodle. Moodle (Modular Object-Oriented Dynamic Learning Environment) is open source software that creates a free, collaborative, student-centered online learning environment with a variety of learning support features available (Bariah & Imania, 2017). In addition, according to Pratama & Salirawati (2018) Moodle can facilitate educators in developing instruments for assessing, collecting, and examining results effectively and efficiently.

Research on self-assessment, metacognitive assessment and Moodle is being done every year, including Pantiwati & Husamah (2017) who found that self-assessment and peer-assessment have a positive impact on students' active learning. Metacognitive awareness and cognitive abilities. Bariah & Imania (2017) state that it is possible to use Moodle e-learning to achieve excellent qualifications through due diligence, assessments and online assignments based on it. Online assessments and assignments are possible based on Moodle e-learning (Bariah & Imania, 2017). Schweighofer et. al. (2019) research developed the comprehensive quiz application Moodle to create

interactive and randomized quizzes that allow students to self-assess their performance and teachers to automatically assess student learning.

According to several previous studies, Moodle implemented assessments but not for self-diagnostic assessments and metacognitive development. On the other hand, research on self-diagnosis and metacognition has been implemented with Moodle but not yet exploited. Therefore, the researchers wanted to implement a Moodle-based self-diagnostic assessment to measure students' cognitive abilities. Data from the described literature review and observations suggest that efforts to utilize relevant metacognitive assessment skills are needed in the 21st century. This study aims to measure students' metacognitive ability to scientific concepts using a Moodle-based self-diagnostic assessment and to understand the correlation between students' metacognitive abilities and their learning outcomes. This research is expected to be an alternative assessment of the learning process and an opportunity to create a 21st-century skills assessment that can measure students' metacognitive abilities.

## 2. Literature Review

There was previous research related to diagnostic tests, metacognition assessment, and Moodle, one of which is Pantiwati & Husamah (2017) who found that self-assessment and peer-assessment have a positive impact on students' active learning can Increase Metacognitive Awareness and Cognitive Abilities. This study used data collection techniques through the Schraw and Dennison MAI (Metacognition Awareness Instrument), written tests, and document analysis. However, this research has not integrated the use of ICT in the assessment process, so it is considered less practical. Furthermore Bariah & Imania (2017) use Moodle e-learning to achieve excellent qualifications through due diligence, assessments and online assignments based on it. This study only uses Moodle for online assessment of learning outcomes or has not measured metacognition ability.

Schweighofer et. al. (2019) research developed the comprehensive quiz application Moodle to create interactive and randomized quizzes that allow students to self-assess their performance and teachers to automatically assess student learning. This study also only uses Moodle for the purpose of making quizzes as an assessment of learning outcomes. Subsequent research was conducted by Veenman & van Cleef (2018) who compared metacognition measurements using self-assessments and online assessments. The findings show that the on-line instrument is preferable to

the off-line self-assessment instrument for assessing metacognitive skills. This study shows the great potential of using ICT in measuring metacognition abilities.

Based on the results of the literature review above, there has been no research examining the use of a diagnostic test-based assessment using Moodle to measure students' metacognitive abilities. So that researchers are interested in conducting research related to the use of diagnostic test-based assessments using Moodle to measure students' metacognition abilities. The scope of this research is to analyze the profile of students' metacognitive abilities from the measurement results using a Moodle-based diagnostic test and analyze how the correlation between metacognitive abilities and learning outcomes.

## 3. Method

The method used quantitative research. The metacognition assessment tool consisted of 30 questions on the topic of heat and its transfer and 30 questions on the topic of the interaction of living things with their environment. All aspects of the assessment tool received validation scores above 0.87. Therefore, it can be said that the science metacognition e assessment tool based on diagnostic tests is valid in terms of presentation, construction, content, and usage. The results of the reliability test analysis using the Cronbach's Alpha technique obtained a value of r of 0.73. The value of r indicates that the assessment tool also has high reliability. The assessment method was comprised of multiple-choice questions that were reasoned with the scoring guidelines in Table 1.

**Table 1:** *Guidelines for The Score of The Metacognitive Assessment Tool*

| Condition | Score |
|---|---|
| Wrong answer, no reason | 0 |
| Wrong answer, wrong reason | 1 |
| Correct answer, wrong reason | 2 |
| Wrong answer, correct reason | 2 |
| Correct answer, correct reason | 3 |

*(Source: Self)*

The research sample is the students of Universitas Negeri Semarang Science Education Research Program who are taking basic science courses. In this study, 2 classes were selected as a sample, each with 23 students.

Data analysis is based on the results of assessment and analysis of the correlation between metacognitive abilities and student learning outcomes, using students' metacognition levels.

Metacognitive level analysis adopts descriptive analysis, and metacognitive ability is divided into 5 levels, as shown in Table 2.

**Table 2:** *Categorization of Metacognitive Levels Adapted from Mcgregor, Schraw, And Anderson & Krathwohl In Haryani, et. al., (2014)*

| Score range | Metacognition Level | Description |
|---|---|---|
| 0 < score ≤ ~~36~~ 35 | Level 1 | Be aware of thought processes and be able to descril them. |
| 35 < score ≤ 72 | Level 2 | Develop an introduction to thinking strategies |
| 72 < score ≤ 108 | Level 3 | Evaluatively reflect on procedures |
| 108 < score ≤ 144 | Level 4 | Transferring knowledge and procedural experienc to other contexts |
| 144 < score ≤ 180 | Level 5 | Linking conceptual understanding with procedur experience |

*(Source: Author)*

Correlation analysis uses the bivariate coefficient analysis step uses SPSS software. In the bivariate correlation test, if the significance value is less than 0.05, then there is a relationship metacognition ability and learning outcomes.

## 4. Result and Discussion

The findings indicated that it is feasible to employ a Moodle-based assessment tool utilizing diagnostic tests to gauge the science metacognitive abilities of students. The results also showed a significant correlation between metacognitive abilities and student learning outcomes. Further details regarding the research results are available in the following description.

### 4.1. The Profile of The Students' Science Metacognition

Metacognitive skills test questions are used to determine a student's level of metacognitive skills. Ability Test Questions Through these test questions, students' metacognitive abilities were matched to Haryani's, et. al., (2014) indicator of metacognitive level. Each level of metacognition includes indicators from each level (see Table 2). The classification of students' metacognitive ability based on five metacognitive levels is shown in Figure 1.

Figure 1 illustrates the profile of students' metacognitive abilities at each level. The results demonstrated that the majority of metacognitive abilities of students in Class A and Class B reached Level 3, with 17 students in Class A and 13 in Class B. Total number of students with metacognition levels 1, 2, 4, and 5. Slightly, that is, in the range of 4.35% to 13.04%. The questions used in the metacognition test are context-sensitive, which means that the questions posed in this assessment

train students in their ability to integrate conceptual understanding with procedural experience. Learning relevant to student life can improve conceptual understanding (Purnamasari et. al., 2016).

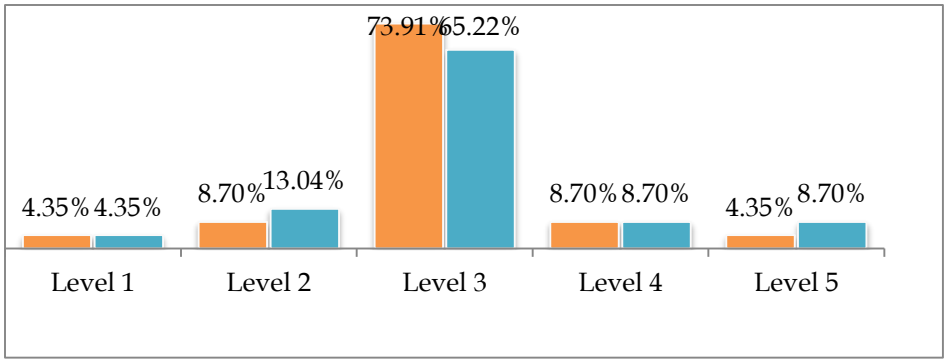


**Figure 1:** *Percentage of Science Metacognition Proficient Based on Metacognition Level Categorization*

*(Source: Author)*

Students who have metacognition level 1 can recognize the process and describe it (Rofii et. al, 2018). This ability can be seen in example of students' answers where when presented with a question regarding the effect of heat on substances, students are able to determine the types of changes that occur in a substance if heat is given. Students with level 2 metacognition skills have been able to develop an introduction to thinking strategies (Dewi, et. al, 2018). Based on the analysis of answers, the example of students at level 2 metacognition ability can analyze materials that can conduct heat from the best to the least good if a question is presented about conductors.

Level 3 metacognition is the ability to reflect on the assessment process. Students who are able to reach metacognition level 3, that is, those students who are able to overcome errors when solving problems and are able to identify the source of errors from experiments. The study by Gholami et. al. (2016) showed that a component that can complement the development of metacognitive skills is the ability to reflect or monitor thinking. Level 4 metacognition is the capacity to transfer knowledge and practical experience to other situations (Schuster et. al., 2020). Students at metacognitive level 4 have the capacity to transfer knowledge and practical experiences to other situations. The final metacognitive skill at level 5 is then the capacity to combine conceptual understanding with practical experience. Level 5 is the most advanced level of metacognition. A student who reaches the fifth level of metacognitive ability, this means that the student is capable of explaining their answers through the reasons for writing good answers (Fauzi & Saa, 2019). Mastery

of Level 5 metacognition is influenced by the student's background and experience prior to engaging in the learning activity.

Since the metacognitive assessment tool used uses Moodle, it is easy to analyze the students' metacognitive ability profiles according to level classification. Moodle facilitates additional features in the form of quizzes that are multiple-choice questions that require reasoning (Abdula et. al., 2022). Reasoning multiple-choice questions makes it easier for educators to measure students' metacognition against diagnostic tests because scores are determined not only based on correct and incorrect answers, but also on why students answer questions. This negligence determines the degree of realization of students' metacognition level.

### 4.2. Correlation Between Metacognitive Ability with Learning Outcomes

The results of the bivariate correlation test between metacognitive abilities and learning outcomes using SPSS are shown in Table 3.

**Table 3:** *Bivariate Correlation Test Results*

| Class | Average metacognitive score | Average learning outcomes score | Sig. |
|---|---|---|---|
| A | 98.47 | 36.52 | 0.02 |
| B | 97.61 | 38.02 | 0.03 |

*(Source: Author)*

According to Table 3, the significance is less than 0.05, which indicates a connection between metacognitive abilities and student success. The relationship between learning outcomes and metacognitive abilities is extremely close, and the two are inseparable. Efforts to improve cognitive skills must be supported by improving metacognitive skills, and vice versa (Putri et. al., 2022). When applied to learning activities or problem solving, cognitive and metacognitive processes can occur simultaneously or in series, supporting each other (Kamdemir & Karadeniz, 2021). As mentioned earlier, metacognitive skills are basically awareness of thinking about the known and the unknown. A person's learning success is influenced by their metacognitive abilities (Suendarti and Liberna, 2018). Optimal results are easily achieved if every learning activity is associated with a learned-to-learn metric.

If students can maintain conscious control over their cognitive processes and influence the improvement of metacognitive skills, the quality of student learning outcomes can be said to be high. Research by cognitive psychologists on the differences between students with lower and higher IQs

has shown that metacognitive skills are important (Biwer et. al., 2022). Students' metacognitive skills can be strengthened through school learning strategies. Monitoring metacognitive abilities of students' own learning outcomes using specific strategies to facilitate the development of learning and memory (Setiawan et al., 2020).

## 5. Conclusion

A diagnostic tool that's based on tests and assessments can be employed to measure students' metacognitive abilities in science. In Moodle, there is a quiz-like feature that is multiple-choice derivations that can diagnose a student's metacognitive abilities. Results of measuring metacognitive skills using assessment tools showed that students' metacognitive skills ranged from level 1 to level 5, with level 3 having the highest percentage, reflecting the procedure in an evaluative manner. The results also demonstrated a significant correlation between metacognitive abilities and student achievement. The use of Moodle's diagnostic assessment tool can serve as a substitute for a more traditional assessment of learning and offers the opportunity to create 21st century assessments that can be used to measure students' metacognitive abilities. This research has limitations where the assessment tool developed was only in the form of a test even though the assessment of metacognition ability can be integrated with a questionnaire as well. This research can be developed in the future for metacognition abilities in other materials, not only science. In addition, it also needs to be developed further by integrating it with the assessment method using a questionnaire.

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