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Testing on A Diagnostic Test-based Science Metacognition Assessment Tool using Moodle

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Abstract

Metacognition is one of the important indicators of 21st century skills as part of ways of thinking. Metacognition ability is used by students to see how cognitive activities such as remembering, learning, and problem solving can be carried out effectively. However, in fact not many assessment tools have been developed to measure metacognitive ability. On the other hand, Moodle has good potential to be used as a platform for creating test instruments. The purpose of this study was to test a diagnostic test-based science metacognition evaluation tool that had been developed with Moodle. The research method used is quantitative by testing the validity, reliability, discriminating power, and level of difficulty on the items of the evaluation tool. The results showed that the science metacognition evaluation tool that had been developed had the characteristics of being valid according to experts, good reliability of 0.73, having a proportional difficulty index; and has good discrimination index. Based on the test results, it was concluded that the science metacognition evaluation tool had good characteristics in all aspects tested so that it was feasible to use it to measure students' science metacognition abilities.

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INTRODUCTION

The National Education Association (NEA) recommends the importance of developing the "Four Cs" for 21st century skills, which include communication, collaboration, critical thinking, and creativity (Sole and Anggraeni, 2018). These competencies are important to be taught to students in the context of core subject areas and 21st century themes. Meanwhile, the Assessment and Teaching of 21st Century Skills (ATC21S) categorizes 21st century skills into 4 categories, namely way of thinking, way of working, tools for working and skills for living in the world (Griffin et al., 2012)

First, ways of thinking include creativity and innovation, critical thinking, problem solving, decision making, and learning about learning (metacognition). Second, ways of working include communication, collaboration, and team work skills. Third, the tools for working include general knowledge and literacy of communication and information technology. Fourth, living in the world includes citizenship, life and career, personal and social responsibilities, as well as competence and cultural awareness (Saavedra & Opfer, 2012). Metacognition is one of the important indicators of 21st century skills as part of ways of thinking.

Metacognition ability is a higher-order thinking skill in which the object of thinking is the thinking process that occurs in oneself. Metacognition reflects individuals' critical awareness of how they think and learn, and their assessment of themselves as thinkers and learners (Saavedra & Opfer, 2012). This is in line with what Sholihah et al. (2018), that a learning activity will be optimal if students are able to become self-regulated learners. Self-regulated learners are responsible for their own learning progress and adapt their learning strategies to meet the demands of the task.

Sagitova (2014) suggests that "The teaching and learning process in the classroom must also allow students to recognize how they learn". In line with Sagitova, Chalkiadaki (2018) states that "Science learning in schools is expected to facilitate students to not only acquire 21st century skills but also encourage them to become independent learners". Metacognitive ability and its implications have become an important issue in the world of education, especially in the learning process (Zohar & Dori, 2012). This is reinforced by the demand that students must master the four dimensions of knowledge, namely factual, conceptual, procedural and metacognitive knowledge.

Metacognition as a 21st century skill is very important to learn to form independent students which is the ultimate goal of learning as proclaimed in the National Research Council of The National Academies. Skills such as adaptability, communication skills, problem-solving skills, self-development, and systems thinking are closely related to students' metacognitive abilities in learning, so they need to be taught to face today's global demands (Asy'ari et al., 2018). Metacognition is used to see how cognitive activities such as remembering, learning, and problem solving are carried out effectively (Asy'ari et al., 2018). Metacognition plays a very important role in the learning process because it must be done before, during, and after teaching (Wen, 2012).

On the other hand, assessment is a very important subsystem in every education system because it is used to measure the achievement of learning objectives and reflects how far the development and progress of learning outcomes (Ariyanti et al., 2018). The need for higher order thinking skills, including metacognition, is very important, this is supported by the fact that students in Indonesia were ranked in the top 10 bottom out of 65 countries in 2011, ranking 69 out of 75 countries in the world in 2015 according to the results of the PISA study (Programme for International Student Assessment) which focuses on reading literacy, mathematics, and science (Asy'ari et al., 2018).

The appropriate assessment to measure students' metacognitive abilities is an assessment oriented to the metacognitive ability itself (Asy'ari et al., 2018). An assessment that can be integrated into active learning by measuring metacognitive and cognitive abilities is a diagnostic test (Pantiwati, 2015).

Assessment in today's digital era has led to the use of Information and Communication Technology (ICT) as a means of communicating and obtaining information in all fields, especially in the field of education. One form of using ICT in learning can be seen in the existence of alternative learning carried out during the Covid-19 emergency, namely through online learning (Firman & Rahman, 2020)

One of the applications used to support the assessment is Moodle. Moodle (Modular Object-Oriented Dynamic Learning Environment) is an open source software used to create free online learning, collaborative interactions, and student-centered online learning environments with various learning support features (Bariah, 2017). Moodle can make it easier for teachers to develop

instruments in assessments and check the results effectively (Pratama & Salirawati, 2018).

Research on diagnostic tests, metacognition assessments, and Moodle has been carried out from year to year, including the research of Pantiwati & Husamah (2017), which states that there is an effect of diagnostic tests in active learning on students' metacognitive awareness and cognitive abilities. Sholihah et al. (2018), examines the metacognitive skills of SMA Negeri Batu students in biology subjects by using instruments in the form of essay test questions, interview guides for metacognitive skills, and metacognitive skill observation sheets.

The research conducted by Bariah (2017), states that through a feasibility test, evaluation and online assignments based on e-learning with Moodle are feasible to use with very good qualifications so that it can be interpreted that online evaluation and assignments based on e-learning with Moodle are feasible to use. Schweighofer et al. (2019) regarding the development of an integrated quiz application Moodle is able to build interactive and random quizzes, allows students to self-assess their performance, and teachers can automatically assess student learning success.

Based on several previous research studies, assessments using Moodle have been carried out, but have not been carried out in the development of diagnostic and metacognitive tests. On the other hand, research on diagnostic and metacognitive tests has been carried out, but has not been developed using Moodle. Thus, it is necessary to develop a diagnostic test-based metaagonist assessment tool using Moodle. The assessment tool that has been developed also needs to be tested so that it is feasible to use it to measure metacognitive ability.

METHOD

The research method used is a quantitative method by testing items on a science metacognition assessment tool based on a diagnostic test. The assessment tool has been previously developed using Moodle consisting of 60 multiple choice questions. The aspects of the test consist of validity, reliability, level of difficulty, and discriminating index. Research samples are 70 students of the Science Education Study Program.

Validity Test

Testing the validity of the items was carried out by involving assessment experts and media experts. The experts gave a rating of 1 to 4 on each item quality indicator of the product. Product quality was determined by score according to Aiken's V formula (equation 1) and the criteria in Table 1 (Arikunto, 2012)

$$V = \Sigma s/([n(c-1)]) \quad (1)$$

Where V is validation score, s is $r-lo$, r is score form expert, lo is minimum score, n is amount of expert, and c is maximum score.

Table 1. Criteria of validation by expert validation (Arikunto, 2012)

V score	Criteria
< 0.87	Not valid
> 0.87	Valid

The purpose of this analysis is to determine the feasibility of the contents of the assessment instrument (Fadillah, 2017). This is based on the results of the assessment of n experts on an item in terms of the extent to which the item represents the construct being measured (Hendryadi, 2017).

Reability Test

The reliability of the test score is used to determine the level of precision and consistency of the test scores. Test the reliability of the instrument on science metacognitive ability using reliability analysis with the Cronbach Alpha technique in accordance with Equation 2.

$$r=k/(k-1)\{1-[\![\Sigma\sigma b]\!]\hat{}2/[\![\sigma t]\!]\hat{}2\} \quad (2)$$

Where r is instrument reabilty coefficient, k is amount of question item, $\sum\sigma b2$ total variance of items, and $\sigma t2$ is total variance.

Difficulty Index Test

Arikunto (2015) explains that the difficulty index is a number that indicates the difficulty of a question, where the difficulty index is between 0.01-1.00, this difficulty index indicates the level of difficulty of the question. This study uses the calculation of the difficulty index with equation 3 (Arikunto, 2012).

$$P = B/Js \quad (3)$$

Where P is difficulty index, B is the number of students who answered the question correctly, and JS is the total number of students in the test. The criteria for the difficulty index of the questions can be seen in Table 2.

Table 2. The criteria for the difficulty index

Difficulty index	Criteria
P < 0,30	Difficult
0,30 ≤ P ≤ 0,70	Medium
P > 0,70	Easy

Discrimination Index

One of the objectives of the discrimination index analysis is to determine whether an item is able to distinguish between high-skilled trainees and low-skilled trainees (Bagiyono, 2017). Discrimination index is symbolized by the symbol DP. The calculation of the discrimination index of questions uses equation 4 (Arikunto, 2012).

$$D = BA/JA - BB/JB \quad (4)$$

Where, J is the number of participants in the test, J_A is the number of participants in the upper group, J_B is the number of participants in the lower group, B_A is the number of participants in the upper group who answered the question correctly, and B_B is the number of participants in the lower group who answered the question correctly.

The question used is a question that has a discrimination index value of 0.20. The criteria for discrimination index of questions can be seen in Table 3.

Table 3. Criteria of discrimination index

Discrimination index	Criteria
0,40 up	Very good
0,30-0,39	Good
0,20-0,29	Standard
0,19 down	Bad

RESULT AND DISCUSSION

Validity Test

The results of expert validation on the science metacognition assessment tool are shown in Figure 1. These results show that all validated aspects obtained a V score of more than 0.87. So, it can be said that the diagnostic test-based science metacognition evaluation tool is valid in the aspects of presentation, construction, content, and use (Arikunto, 2012). The validation scores for each indicator are detailed in Table 4.

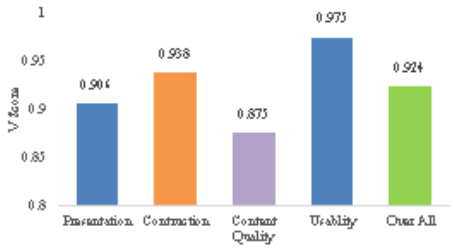

Figure 1. Result of validity test

From the results of the analysis of the validity of each item, there are questions that get a V score of 1.00 for all aspects (the questions are shown in Figure 2).

Figure 2. Question with V score = 1,00 for all aspect

Reability Test

Reliability shows how much the test instrument can be trusted. A test is said to have high reliability if it gives a constant result. The results of the reliability test analysis using reliability analysis with the Alpha Cronbach technique obtained an r value of 0.73. The results of the r value indicate that the assessment tool has high reliability (Livingston, et al., 2018).

Difficulty Index Test

The results of the difficulty index test for each item are presented in Figure 3.

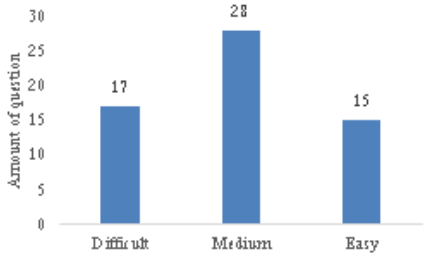

Figure 3. Distribution of the level of difficulty of the questions.

It can be seen in Figure 3 that the difficulty index of the questions obtained is proportional where the distribution of the questions with the medium level is the most, while the difficult and easy questions have relatively the same amount. The proportional difficulty index shows that the assessment tool developed is feasible to use (Sorayа, et.al., 2021).

Discrimination Index

Questions can be said to be good if the questions are able to distinguish students with high and low abilities. Based on the value of discrimition index, questions that have discrimition index on bad criteria indicate that the questions cannot be used to distinguish students in the up-

Table 4. Validation score for each indicator

Aspects	Indicators	*V Score*
Presentation	Presentation of complete questions in accordance with basics competency	0.911
	Each question must have one correct answer, with homogeneous and logical answer choices in terms of material	0.904
	The subject matter does not provide clues to the correct answer	0.899
	Does not contain statements that are double negative	0.908
Construction	The questions in the assessment are contextual and formulated in a clear, concise, and firm manner	0.944
	The suitability of the questions with the level of students' knowledge and indicators of metacognition	0.932
Content Quality	Able to encourage students to use metacognitive knowledge and strategies	0.859
	Able to measure students' metacognitive ability	0.891
Usability	Objective	0.978
	Ekonomic and Flexible	0.972

per and lower classes (El-gohary, et. al, 2018). Questions on these criteria also cannot be used to test students' metacognitive abilities. The results of the discrimination index of questions that have been analyzed and presented in Table 5. These results show 53 of 60 questions can be used because they do not have bad discriminating index.

Table 5. Distribution of discrimination index

Criteria	Amount of question	Decision
Very good	21	Used
Good	17	Used
Standard	15	Used
Bad	7	Not used

CONCLUSION

Testing of the diagnostic test-based science metacognition assessment tool obtained the expected results. The assessment tool is declared valid by the expert, has good reliability, and has a proportional level of difficulty. 53 questions have standard to good distinguishing power so that they are suitable for use. Based on the test results, 53 of the 60 science metacognition assessment questions are suitable to be used to measure scientific metacognition ability. Furthermore, it is necessary to conduct research to measure the ability of science metacognition using the evaluation tool that has been developed.

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