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Validity of the Metacognitive Awareness Instrument for Prospective Mathematics Teacher Students

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Abstract. The purpose of this study is to describe the validity of the metacognitive awareness instrument which includes metacognitive knowledge and regulation. The metacognitive awareness instrument is in the form of a questionnaire consisting of 52 statements. This study is a qualitative descriptive study to assess and obtain the quality of a valid metacognitive awareness instrument to characterize students' metacognitive awareness. The student metacognitive awareness instrument was validated by two psychologists and a linguist. The metacognitive awareness instrument was also empirically validated by involving 28 mathematics education students as respondents. The results of the study show: (1) the validator's assessment of the metacognitive awareness instrument from the aspect of content validity is categorized as valid and reliable (Cohen's kappa = 0.29), (2) the metacognitive awareness instrument is empirically valid (Pearson Correlation > r table) and reliable (Cronbach's alpha = 0.754). These results indicate that the metacognitive awareness instrument can be used to characterize the metacognitive awareness of prospective mathematics teacher students.

Keywords: metacognitive awareness instrument, students, validity

INTRODUCTION

Thinking skills are essential skills to be developed at every level of education, as mandated by UNESCO through its four pillars of education (Scott, 2015) . This is because these thinking skills are expected to be a provision to answer the challenges and various problems that arise in the increasingly complex 21st century, especially to become a successful worker and be able to compete with other workers (Zhao et al., 2014) . One of the 21st-century thinking skills in question is metacognitive awareness (Scott, 2015) . Metacognition is not new in the world of education, this term was introduced by Flavel since 1976. Metacognition is related to a person's awareness of their own thought processes when working on or solving a problem (Kaberman & Dori, 2009) . In line with this, metacognition is defined as knowledge about one's knowledge, cognitive processes, and mental states, as well as the ability to monitor and regulate them (Urban et al., 2021) .

Metacognitive awareness is an important aspect for prospective teacher students. Two aspects of metacognitive awareness support student success in learning: metacognitive knowledge (declarative knowledge, procedural knowledge, conditional knowledge) and metacognitive regulation (planning, information management strategies, monitoring, search strategies, and evaluation) (Urban et al., 2021) (Schraw & Dennison, 1994) .

Metacognitive knowledge refers to knowledge about cognition, such as knowledge of good learning skills and strategies and how and when to use them. Metacognitive regulation refers to activities that control one's thinking and learning, such as planning, monitoring comprehension, and evaluating (Danial, 2010) . Metacognitive regulation includes skills in planning, implementing, monitoring, and evaluating the individual's own learning process (Veenman et al., 2014) .

Metacognitive awareness facilitates the improvement of one's critical thinking skills (Cakici, 2018) . Therefore, metacognitive awareness is important for every individual, including teachers and student teachers (Jiang et al., 2016) . Furthermore, students with good metacognitive awareness can only be produced by teachers with good metacognitive awareness (Demirel et al., 2015) .

Assessment of the level of metacognitive awareness is part of the process of developing metacognitive awareness. One instrument that can be used is the metacognition awareness inventory (MAI) (Schraw & Moshman, 1995) (Öz, 2016) . MAI covers all aspects of metacognitive awareness which consists of 2 large parts, namely metacognitive knowledge consisting of declarative knowledge, procedural knowledge, conditional knowledge and metacognitive regulation consisting of planning, information management, monitoring understanding, correction strategies and evaluation (Sperling et al., 2002) (Öz, 2016) . The adaptation of the Metacognitive Awareness Inventory (MAI) into Indonesian has been conducted, but specifically for medical students (Abdullah & Soemantri, 2018) , whereas research examining metacognitive awareness has mostly been conducted in educational contexts (Ismarani & Artayasa, 2023) . This study aims to adapt the Metacognitive Awareness Inventory (MAI) into Indonesian to assess metacognitive awareness in prospective mathematics teacher students. Adapting the instrument according to systematic processes and procedures can increase the availability of valid and reliable instruments that are appropriate to the context. It is hoped that this will have an impact on the quality of the results of measuring metacognitive awareness in students.

METHODS

This study is a qualitative descriptive study to assess and obtain the quality of a valid metacognitive awareness instrument to characterize students' metacognitive awareness. Validation of the 52-item metacognitive awareness instrument was conducted through expert validation involving psychology and language experts, which included a content validity assessment component. Suggestions and input from the validators were used as material for improving the instrument developed to obtain an instrument to characterize metacognitive awareness. valid.

The metacognitive knowledge instrument was also empirically validated by involving 28 students of the mathematics education study program, class of 2023. The sample selection used purposive sampling. The results of the empirical validation of the instrument were then analyzed to determine the validity and validity of the instrument using IBM SPSS Statistics 25 software. The metacognitive awareness instrument can be declared valid if ($r\alpha > r$ Table) and reliable if ($0.6 \leq \alpha \leq 1.0$)

Metacognitive awareness was measured using the MAI (Metacognitive Awareness Inventory). The measured metacognitive awareness indicators included metacognitive knowledge consisting of sub-indicators of declarative knowledge, procedural knowledge, conditional knowledge and metacognitive regulation indicators consisting of sub-indicators of planning, information management, monitoring understanding, action strategies and evaluation (Sperling et al., 2002)

Table 1. MAI Indicators and Descriptors

Indicator	Descriptor
Metacognitive Knowledge	
Declarative Knowledge	Factual knowledge that students need before processing or using critical thinking related to the topic Knowing what a concept is about Knowledge of one's skills, intellectual resources, and abilities as a learner Students can gain knowledge through presentations, demonstrations, and discussions.
Procedural knowledge	The application of knowledge for the purpose of completing a procedure or process Knowledge of how to apply learning procedures (e.g. strategies) Requires students to know the process and when to apply the process in various situations. Students can gain knowledge through discovery, cooperative learning, and problem solving.
Conditional Knowledge	Determining under what circumstances a particular process or skill should be transferred Knowledge of when and why to use learning procedures The application of declarative and procedural knowledge under certain conditions is presented. Students can gain knowledge through simulations
Metacognitive Regulation	
Planning	Planning

	Goal setting, Allocate resources before learning
Information Management Strategies	The sequence of skills and strategies used to process information more efficiently Arrange To describe Summarize focus and be selective
Comprehension Monitoring	Assessment of one's learning or use of strategies
Action Strategies (Debugging Strategies)	Strategies used to improve understanding and work errors
Evaluation	Analysis of performance and effectiveness of strategies after learning

RESULTS AND DISCUSSION

Content validity is related to the analysis of the measured domain to determine the extent to which the instrument represents the abilities being measured (Retnawati, 2016) . In this study, content validity was analyzed by two expert validators. The researcher provided the instrument outline and items along with the scoring rubric to the validators for input. Based on the expert input, the outline and instrument were then revised. The assessment was conducted using a Likert scale. The validity of the learning device was analyzed using the Aiken's V index.

$v = \frac{\Sigma(s)}{n(c-1)}$ ... (Aiken, 1985)

Where:

V : Expert agreement index regarding item validity

s = r − lo

lo : Lowest validity assessment score

c : Highest validity assessment score

r : Number given by the appraiser

After analysis, the data will be interpreted based on validity criteria. The level of validity is determined based on the following table. (Retnawati, 2016)

Table 2. Validity Level

Criteria	Validity Level
$V < 0.4$	Less Valid
$0.4 \leq V < 0.8$	Valid
$V \geq 0.8$	Very Valid

Table 3. Results of Aiken Index Analysis

Item	Mark	Validity Level
1	0.75	Valid
2	0.875	Valid
3	0.625	Valid
4	0.75	Valid
5	0.5	Valid

From the results of the validity analysis of the metacognitive awareness instrument using the Aiken index, it can be concluded that all items of the metacognitive awareness instrument have high content validity.

Cohen's Kappa test to measure the reliability or consistency between experts in providing assessments, taking into account chance. A high Kappa value indicates strong agreement between experts, so the instrument is considered reliable from an expert assessment perspective. Cohen's Kappa test results The metacognitive awareness instrument has a value of 0.29, providing sufficient agreement. Results of the empirical validity of the awareness instrument A metacognitive questionnaire involving 28 students also showed that the instrument was valid and reliable. There were 52 statements with a Pearson

Correlation value > r table categorized as valid and Cronbach's alpha = 0.754, indicating reliability.

Table 4. Reliability Test Results

Reliability Statistics	
Cronbach's Alpha	**N of Items**
0.754	53

The results of this study are relevant to previous research related to the adaptation of the MAI. The MAI has been adapted into various languages and cultural contexts, consistently demonstrating high validity and reliability, for example in the United States (Harrison & Vallin, 2018) , Turkey (Balcikanli, 2011) , India (Omprakash et al., 2021) , Spain (González-Cabañes et al., 2022) , and Japan (Moxon, 2023) . This adaptation of the MAI also emphasizes the importance of cross-cultural adaptation because differences in cultural and linguistic contexts can affect the understanding of the items in the instrument. The results of this study have implications for the development of psychological instruments in the context of education in Indonesia. This adaptation of the MAI can help researchers, educators, and education practitioners in Indonesia in assessing students' metacognitive awareness accurately, validly, and reliably. The existence of an appropriate measurement tool for assessing students' metacognitive awareness is expected to assist in designing interventions to improve learning outcomes and the achievement of learning objectives. Thus, this instrument is used to encourage students' independent learning skills, especially in the current digital era, especially for prospective mathematics teacher students.

Metacognition is not the same as cognition, for example, the skills used to read a question are different from monitoring understanding of the question. Some things that can be done to develop metacognitive awareness include through the following activity situations: (1) ask questions that focus on what and why; (2) develop various aspects of problem solving that can improve student achievement; (3) in the process of solving a problem, students must actually do it independently or in groups so that they directly feel the twists and turns of the process to get to a solution (An & Cao, 2014) . Metacognitive strategies are provided to guide students in collaborating, allowing them to apply metacognitive strategies independently, and they require external support in the form of scaffolding to do so. Therefore, there is a broad theoretical and empirical consensus that the influence of metacognition on learning outcomes is closely related to scaffolding (Jbeili, 2012) .

CONCLUSION

The results of the study show: (1) the validator's assessment of the metacognitive awareness instrument from the aspect of content validity is categorized as valid and reliable (Cohen's kappa = 0.29), (2) the metacognitive awareness instrument is empirically valid (Pearson Correlation > r table) and reliable (Cronbach's alpha = 0.754). These results indicate that the metacognitive awareness instrument can be used to characterize the metacognitive awareness of prospective mathematics teacher students. The contribution of this study lies in providing an instrument that can be used to evaluate students' metacognitive awareness accurately, so that it can support the development of metacognitive-based learning strategies. The limitation in this study is that construct validation has not been carried out, so that further research is expected to carry out construct validation to ensure the suitability of the measurement model of this instrument.

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