J. Pijar MIPA, Vol. 18 No. 6, November 2023: 913-917 ISSN 1907-1744 (Print)
DOI: 10.29303/jpm.v18i6.3302 ISSN 2460-1500 (Online)

DEVELOPMENT AND VALIDATION OF A CRITICAL THINKING MEASUREMENT INSTRUMENT BASED ON *Megapodidae reinwardt* BIRD ECOTOURISM

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Received: September 10, 2023. Accepted: November 20, 2023. Published: November 30, 2023

Abstract: Critical thinking skills are important in sharing aspects of life in the current and future era of globalization and information. An important aspect of critical thinking is literacy. Literacy abilities within the scope of Natural Sciences refer to scientific literacy. The critical thinking test results show that students' critical thinking components must still be developed. This paper discusses developing and validating a critical thinking measurement instrument for prospective science-biology teacher students based on Megapodidae bird ecotourism. The aim is to develop and assess the validity, reliability, and characteristics of critical thinking skills instruments so that they can be used to measure critical thinking skills in Science-Biology prospective teacher students. Product development in the form of critical thinking skills test instruments in Biology learning for prospective teacher students at FKIP Unram. Instrument development is carried out in four steps: identifying indicators, developing collection items, making validity checks, and improving item quality. Instrument validation is by a learning expert from FKIP Unram. Essay form questions consist of 21 items with difficulty levels at medium and high levels. The results of expert validation analysis using Aiken's V method for each aspect are classified as valid with a value of 0.79. The instrument developed can be used as a valid and reliable measure of critical thinking ability.

Keywords: *Critical Thinking, Instruments, Development, Validation.*

INTRODUCTION

Critical thinking has become a trend and the main focus of learning. Curriculum authorities in several developed countries include critical thinking skills in their curriculum as learning objectives [1]. The strength of science lies in the ability to formulate hypotheses that spur the development of various thinking skills of students. These abilities can only be developed in science learning with practicum [2]. The existence of natural phenomena regarding habitat characteristics, types of food, behavior, and preferences of each bird species can be used for practical activities in biology. Critical thinking is a high-level thinking skill that needs to be trained for students to have sufficient competence in facing increasingly complex life problems today and in the future [3]. Furthermore, there is a significant correlation between self-confidence and critical thinking skills, as well as critical thinking skills and success in practicum activities [4]. Building critical and creative thinking skills requires learning conditions that provide freedom to develop creativity and expression of thinking [5].

Students can practice analytical thinking by looking for and grouping tendencies in the phenomena above into cause groups and effect groups. Next, students create hypotheses to reveal cause-and-effect relationships. The process of preparing this hypothesis develops students' combinatorial thinking abilities. Students' ability to make the most likely conclusion from cause and effect shows their synthetic thinking ability. As explained above, students' steps, from formulating a hypothesis to making conclusions, will form empirical-inductive thinking skills. Empirical-inductive thinking abilities are developed by synthetic analytical and combinatorial thinking [2]. Therefore, the experience of formulating hypotheses and making conclusions about the natural phenomena above can develop critical thinking skills and build students' creativity.

Critical thinking skills must be distinct from accuracy in measuring students' abilities. Measurement instruments are very important in determining the level of thinking ability. Instruments unsuitable for measuring aspects will cause results that do not follow the actual situation. It will result in errors in determining the criteria for the level of critical thinking ability. The biology learning assessment instruments must be more oriented toward critical thinking skills [6]. Developing a critical thinking instrument must include preparing grids, scoring guidelines, Validation, and item refinement [7]. The instrument's knowledge, language, and construct aspects must also meet the valid category to avoid misconceptions in understanding the questions [8-9].

Results, measurements, and measuring tools are inseparable parts. In addressing the problem of measurement instruments, it is necessary to develop instruments according to certain fields. This research aims to develop an instrument for

measuring the critical thinking abilities of prospective Science-Biology teacher students based on Megapodidae bird ecotourism.

RESEARCH METHODS

The method used in this study is Research and Development (R&D). The steps for R&D research are potential problems, collecting information, product design, design validation, design improvement, product testing, product revision, use trials, product revision, and mass product creation [10]. The development of critical thinking ability instruments is carried out in four steps: identifying indicators, developing a collection of items, checking the validity and reliability of items, and improving item quality.

Identify Indicators

Indicators of critical thinking abilities are interpretation, analysis, inference, explanation, and self-regulation [11]. Indicators are identified as the basis for preparing instrument items. The question items are prepared to cover all aspects of critical thinking skills. The questions are conditioned according to the learning material and educational level.

Question Item Development

The development of critical thinking items refers to achievement indicators by Facione (2011) [11]. The indicators were developed into several sub-indicators to prepare question items. The questions are developed from the lowest level to the highest. It aims to differentiate students' abilities at the level of critical thinking abilities. Variations in questions will be distributed to students into groups according to their level of critical thinking ability—item-level explanation of questions using item-wright maps from the Rasch model. The map will show the level of the questions and students' critical thinking abilities.

Checking the Validity and Reliability of Question Items

1. Content Validity

The validity of critical thinking ability items is using expert validity. Based on the standards set by Aiken [12], Aiken's minimum V standard for this research is 0.75 with a probability of 0.041. Content validity using Aiken's V coefficient is obtained by applying the formula:

$$V = \frac{\sum(r_i - l_0}{[n(c-1)]}$$

Information:
r = number given by the appraiser
lo = lowest validity assessment number
c = highest validity assessment number
n = number of experts & and practitioners who carry out the assessment
i = month number from 1,2,3 to n
n = number of assessors

2. Reliability

Expert reliability is done using the percent agreement of all validators. This method greatly influences the selection of relevant validators to avoid agreements that are purely due to chance. Caution should be used in interpreting Pearson correlations, as they are not subject to systematic bias [13].

Improving the Quality of Question Items

At this stage, it depends on the results of the previous stage of assessment, namely the development and results of the validity of the question items. Question items still classified as causing an understanding bias will be revised according to input from the validator. This stage is the final stage in producing a valid and reliable instrument so that it is suitable for use in research standards to determine students' critical thinking abilities.

Results and Discussion

The critical thinking ability instrument developed is an instrument in the form of a description. The instrument consists of 21 questions. The KBK indicators in the instrument are developed at levels C4 to C6. Students can analyze conditions in the environment to the point of being able to create or make conclusions about the findings. The role of instruments is crucial in measuring students' CBC abilities. The instrument was certainly developed from critical thinking indicators. The results of the instrument development can be seen in Table 1, and the results of construct validation can be seen in Table 2.

Table 1. Critical Thinking Ability Instrument Development Results

Critical Thinking Ability Indicator	Question Items	Levels
Reading text I A group of students wanted to observe the Gosang bird's natural habitat (*Megapodius reinwardt*). Observations were made around the bird's nesting area using a square measuring 50m x 50m. The habitat components observed are biotic and abiotic components. Abiotic components include water, light, air, climate, topography, soil, and space. Biotic components consist of vegetation and micro and macrofauna. From the readings above:		

Critical Thinking Ability Indicator	Question Items	Levels
Diagnosing Problems	1. Write down the problem statement;	C4
	2. Identify and explain what the habitat problem is for *Megapodius reinwardt*;	C4
Describes the existence of a logical relationship between problems	3. Describe the profile/image of the biotic components (flora and fauna) in the natural habitat *Megapodius reinwardt;*	C4
	4. Describe the abiotic components (topography, temperature, light, pH, etc.) in natural habitats*Megapodius reinwardt;*	C4
	5. Describe the relationship between the biotic and abiotic components of natural habitats *Megapodius reinwardt;*	C4
Collect and organize the necessary information.	6. Determine aspects of the biotic components of the bird's natural habitat*Megapodius reinwardt;*	C6
	7. Compare the biotic aspects of the habitat*Megapodius reinwardt* between observation locations/stations;	C5
		C5
Assess facts and evaluate statements.	8. Examine the condition of each component of the natural habitat of *Megapodius reinwardt* (H, E, D, INP) or	C5
	9. Calculate the Species Diversity Index (H), Abundance (E), and Dominance of flora and fauna between observation locations in the natural habitat of *Megapodius reinwardt*;	C5
Make the necessary conclusions and similarities	10. Measure aspects of each component of the *Megapodius reinwardt* habitat at the observation location;	C5
	11. Calculate the Diversity Index, Density, Distribution, Abundance, and Dominance of flora and fauna types in the natural habitat of *Megapodius reinwardt* (Analyzing);	C5
	12. Interpret the results of the analysis of the biotic and abiotic components that make up *Megapodius reinwardt* habitat;	C6
	13. How (Conclude) do *Megapodius*' preferences align with the components and aspects of its habitat (Chi)2?	C6
A group of students wanted to observe the characteristics of *Megapodius reinwardt* nests. Observations were made on many former nests and active nests. The nest aspects observed include nest vegetation and fauna around the nest as well as abiotic factors, which include nest position, light, temperature, pH, diameter and height of the nest mound, soil type, mass, number of holes, and diameter of nest holes, height (from sea level), distance to water sources and number of residents, etc. Apart from that, food sources, population disturbances, and predators will also be studied. From these activities:		
Diagnosing Problems	14. Determine the aspects of nest vegetation that need to be observed/measured in the *Megapodius reinwardt* nest area;	C4
	15. Determine the aspects of the nest's abiotic components that need to be observed/measured;	C4
Describes the existence of a logical relationship between problems	16. Sort the results of measuring the biotic and abiotic components of the *Megapodius reinwardt* nest that you obtained;	C4
	17. Describe the relationship between nest vegetation and the nest *Megapodius reinwardt*(Type, size, profile, and density)	C5
	18. Describe the relationship between abiotic components and the nest of *Megapodius reinwardt* (nest position, light, temperature, pH, diameter and height of the nest mound, soil type, mass, etc.);	C5
Collect and organize the necessary information.	19. Describe the vegetation profile of *Megapodius reinwardt* nest (type, size, density, and canopy);	C6
	20. Compare the biotic components between each *Megapodius reinwardt* nest (IS analysis, etc. distribution);	C5

Critical Thinking Ability Indicator	Question Items	Levels
Assess facts and evaluate statements	21. Compare the abiotic components between each Megapodius reinwardt nest (IS analysis, etc. distribution);	C5
		C5
Make the necessary conclusions and similarities	22. What are (Conclude) the characteristics of the nest *Megapodius reinwardt*?	C5
	23. Design an in-situ conservation model of Megapodius reinwardt.	C6

Table 2. Construct validation results

Aspect	Aiken's V value	Criteria
Material	0.81	Valid
Construction	0.76	Valid
Language	0.80	Valid
Average	0.79	Valid

The field practice instrument for measuring students' critical thinking abilities showed valid results with an Aiken V value of 0.79. Three aspects of instrument validation, namely material aspects, constructive aspects, and language aspects, all meet valid criteria. The instrument can be applied to measure students' critical thinking abilities regarding the results of observations in the field [14-16].

Instruments with levels C4 to C6 are very compatible for measuring student abilities [17-19]. In the field, students often encounter problems with gossard birds. Starting from the population, habitat, and conditions that disturb the gossard bird population. All problems can be tabulated based on answers to questions on the instruments that have been developed. Field practicum activities guided by assessment instruments certainly focus more on the objectives to be achieved in the observation. The results of evaluations determine students' critical thinking abilities through instruments. Ability to analyze, evaluate field data, and draw conclusions based on data. This instrument can develop students' level of thinking. Activities that continue to encourage thinking skills can create a higher level of thinking. Hands-on practicum can improve students' critical thinking skills [20-22].

The uniqueness of this critical thinking ability instrument is that it provides a little insight into student activities in the field. This description is very helpful in making observations. Activities become more independent, and the results follow the practicum objectives. From this hands-on practical activity, students can analyze the bird's environment, evaluate and reduce observation data, and draw conclusions based on the data. If this ability can be carried out well, then students are classified as having fairly high critical thinking skills.

CONCLUSION

Field practicum is a very important activity in supporting critical thinking skills. Thinking achievements are evaluated through the development of assessment instruments. Based on the results of the validation analysis, the critical thinking ability instrument is classified as valid with an average Aiken V value of 0.79. Adequate material, good instrument construction, and easy-to-understand language can help students understand field conditions during practical activities. The instrument can be applied to other activities with modifications according to the objectives of the field practicum.

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