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VALIDITY OF ECOLOGY MISCONCEPTION TEST INSTRUMENT USING THREE-TIER TEST METHOD FOR 10TH-GRADE HIGH SCHOOL STUDENTS

Validitas Instrumen Tes Miskonsepsi Ekologi Menggunakan Metode Three-Tier Test untuk Peserta Didik Kelas X SMA

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Abstract

Biology is a science built on various concepts, one of them is the concept of ecology. The difference in conceptual understanding from what has been agreed by experts is described as a misconception that can impact decision making including students' learning outcomes. It is crucial to identify the existing misconception in ecological material to avoid sustainable misconception during studying ecological material, because misconception can impact students' learning outcomes during learning. This study aims to produce a valid ecology misconception test instrument for 10th-grade high school students. This research is development research conducted using 4D research design consisting of 4 stages, namely define, design, develop, and disseminate. This ecology misconception test instrument was developed using three-tier test method on ecology material to map students' conceptual understanding of ecological material. The parameter used is the instrument test validity, including the content, construction, and language aspects determined by calculating the percentage of profit validity for each item according to the aspects tested. The validation process of this misconception test instrument was reviewed by 3 validators consisting of ecologists, assessment experts, and high school biology teachers. Validation is done by assessing each item on the suitability of the aspects being assessed, and the data was carried out in a descriptive quantitatively by calculating the percentage of instrument validity. Based on the results of the study, it is known that the ecology misconception instrument test with a three-tier test method developed was valid in the aspect of the material is 98,40%, construction is 94,58%, and language is 99,50% and the average result after analyzing for each question item is 98,95%.

Keywords: misconception, ecology, instrument, validity.

Abstrak

Biologi merupakan ilmu yang dibangun oleh beragam konsep, salah satunya konsep pada materi ekologi. Perbedaan pemahaman konsep dari yang telah disepakati ahli dideskripsikan sebagai sebuah miskonsepsi yang dapat berdampak dalam pengambilan keputusan termasuk hasil belajar peserta didik. Identifikasi adanya miskonsepsi dalam materi ekologi penting dilakukan guna menghindari kesalahan konsep ekologi yang berkelanjutan ketika mempelajari materi ekologi, karena miskonsepsi dapat berdampak pada hasil belajar peserta didik dalam kegiatan pembelajaran. Penelitian ini bertujuan untuk menghasilkan instrumen tes miskonsepsi ekologi untuk peserta didik kelas X SMA yang valid berdasarkan hasil validitas. Penelitian ini merupakan penelitian pengembangan yang dilaksanakan dengan menggunakan desain penelitian 4D yang terdiri dari 4 tahapan yaitu pendefinisian, perencanaan, pengembangan, dan penyebaran. Instrumen tes miskonsepsi ekologi ini dikembangkan dengan menggunakan metode three-tier test pada materi ekologi untuk memetakan pemahaman konsep peserta didik terhadap materi ekologi. Parameter yang digunakan dalam penelitian ini adalah validitas instrument yang diukur dengan menggunakan lembar validasi mencakup penilaian butir soal dari aspek materi, konstruksi, dan bahasa yang ditentukan dengan menghitung persentase validitas untuk masing-masing butir soal sesuai dengan aspek yang diujikan. Proses validasi instrument tes miskonsepsi ekologi yang dikembangkan ditelaah oleh 3 validator yang terdiri atas ahli ekologi, ahli asesmen, dan guru biologi SMA. Validasi dilakukan dengan menilai setiap butir soal terhadap kesesuaian aspek yang dinilai, data dianalisis secara deskriptif kuantitatif dengan menghitung persentase validitas instrumen. Berdasarkan hasil penelitian, diketahui bahwa instrumen tes miskonsepsi materi ekologi yang dikembangkan dengan metode three-tier test

dinyatakan telah valid dalam aspek materi 98,40%, konstruksi 94,58%, bahasa 99,50%, dan hasil rata-rata setelah analisis setiap butir soal adalah 98,95%.

Kata kunci: miskonsepsi, ekologi, instrumen, validitas

INTRODUCTION

Natural Sciences can be defined as a scientific process. As a scientific product, science includes law, principles, procedures, theories, concepts, facts, and information aspects. Natural sciences are built on various concepts; the concept is the smallest unit of knowledge on which to learn (Ibrahim, 2012). Biology is a branch of natural science with various concepts, one of them is ecology.

Mastery of a concept is essential for everyone. A person without mastering a concept will not be able to do much in his behavior, it can interfere with his survival (Ibrahim, 2012). The difference in conceptual understanding from what has been agreed by the expert is described as a misconception that impacts thinking in making a decision (Queloz *et al*., 2017; Gurel *et al*., 2015; Kirbulut and Geban, 2014; Arslan *et al*., 2012). Misconception that occurs or can be experienced can be found in all biology materials (Auwaliyah and Raharjo, 2017). Understanding the biological concepts in studying biological materials are very important for students because it is the primary or main thing of biology; understanding the concept will facilitate students' understanding of biology. Misconception can impact the students learning outcome and their understanding about new concept or some material.

Currently, the reality that occurs in the community is that there are still many students who have difficulty understanding the biological material concepts, which has an impact on students' biology learning outcomes, which are ultimately low (Abidah, 2018). Misconceptions are misunderstandings or errors in integrating the meaning of information (Ojose, 2015).

According to Vasmin (2020), in line with information obtained from biology teachers that there are difficulties experienced in learning biology, many students are not active in understanding the concept of the material provided. Many concepts on ecological materials must be mastered by the students, such as ecosystems, interaction between ecosystems components, energy flows, and the biogeochemical cycles. In the 2013 curriculum for 10th grade high school, bills related to basic competencies (BC) that students must achieve in ecology material, namely BC 3.10 analyze ecosystem components and the interactions between these components, and 4.10 presents works that show interactions between ecosystem components (food chain, net-food web, ecological pyramid, and biogeochemical cycle) (Ministry of Education and Culture of the Republic of Indonesia, 2016). The data on the national exam report published by the 2019 Indonesian Education Assessment Center, the average national achievement in biology subjects still seems low 50,61 (Puspendik, 2019). Students' low learning outcomes in a material, and this can be caused by misconception (Badruzzaman, 2019; Listiani, 2017; Saputri, 2016) because misconceptions are a barrier to understanding concept.

Zulvita (2017) states that it is crucial to identify misconceptions in senior high school students to avoid continuous misconceptions when studying a material. Mastery of several concepts will allow a person to solve a problem, it is necessary to pay attention to some of the rules, and the rules are based on the concepts someone has. Identification of this misconception can be made using several instruments such as interview method, two-tier diagnostic-test, etc. One of the methods is using three-tier test. The use of a three-level diagnostic test is more valid than in finding conceptions and misconceptions of students (Handayani, 2014).

The Three-Tier Test instrument is a diagnostic test composed of three levels. The first level is a question about the concept, the second level is a question about reasons from the first level, and the third level is the belief in students' answers to the first and second levels. The Three-Tier Test instrument can differentiate misconceptions into positive (false positive) and negative (false negative) misconceptions. Positive misconceptions are about the correct concepts and the wrong scientific concepts, while negative misconceptions are about the wrong concepts and provide correct concepts, three-tier method is known more effective than other method, the test was simply applicable for describing students understanding about several concept (Kirbulut and Geban, 2014)..

Research on misconceptions in the field of understanding biological material is still rarely found. Most education research focuses on implementing learning styles, developing methods and media used in the learning process, and the learning resources. It is still rare and difficult to find an instrument that can be used to identify misconceptions because it has not been developed much. Many teachers, currently, think that if the students' scores have reached the minimum criteria of

mastery learning, then the students understand what the teacher has said and do not experience misconceptions.

Dealing with the background of the problem, it can be conclude that ecology was the branch of biology that consist many concept and have high risk of misconception. The researcher wants to develop a valid misconception test instrument and can be a tool to identify students' misconceptions on ecological material. This study aims to describe the validity of the misconception test instrument developed for students using the three-tier test method on ecology material for 10^{th}-grade high school student.

METHOD

This type of research is development research that refers to the 4D research design namely define, design, develop, and disseminate, but in this study, the dissemination stage was not carried out. The instrument development stage was carried out in November 2020 at the Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, and the instrument validation process was carried out in January 2021 at the Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya.

This research's object includes the analysis of misconception test instrument validity on the developed ecological material in terms of content, construction, and language aspects. The instrument was developed in a three-tier method (three-level questions) after curriculum identification and basic competency analysis. The test instrument's validity was obtained from the validation results of the content, construction, and language aspects by 3 validators consisting of an ecologist, an assessment expert, and a high school biology teacher using a validation sheet.

The research data was processed descriptively quantitatively. The data analysis mechanism was carried out in a descriptive quantitative way by calculating the percentage of instrument validity for each following the aspects tested. Based on the tested aspect, the instrument's validity is determined by calculating the percentage of profit validity for each. There are consist of 20 questions, and each question is created based on the indicators that have been developed. The total score obtained from the validation results is then presented against the maximum score using the following formula (Riduwan, 2016).

$$\text{Validity Percentage Number} = \frac{\text{Total aspects signed}}{\text{Total aspects thoroughly}} \text{ x } 100\%$$

The data obtained were then analyzed and interpreted based on Table 1.

Table 1. Validation Results Category

Validity Percentage	Category
$81{,}50 \leq P \leq 100{,}00$	Highly Valid
$62{,}75 \leq P \leq 81{,}49$	Valid
$44{,}00 \leq P \leq 62{,}74$	Sufficiently Valid
$25{,}00 \leq P \leq 43{,}99$	Less Valid
$0{,}00 \leq P \leq 24{,}99$	Invalid

(Adapted from Riduwan, 2016)

RESULTS AND DISCUSSION

The test instrument is developed based on the basic competency analysis 3.10 analyze the components of the ecosystem and the interactions between these components, and 4.10 presents the work that shows the interactions between the components of the ecosystem (food web and the biogeochemical cycle) into 20 items with indicators analyzed using a sheet validation. The test instrument includes ecological material with sub-topics of ecosystem components, interactions between ecosystem components, energy flows, biogeochemical cycles, niches, and symbiosis. The validation of the test instruments included content, construct, and language aspects validated by 3 validators. The results of the instrument validation are presented in Table 2.

Table 2. The Results of Instrument Validity Based on Each Indicator in The Question Items

Question Item	Indicator	Percentage	Interpretation
1	Identify the community concept in an ecosystem	97%	Highly Valid
2	Identify the concept of the primary energy source that belongs to the abiotic component	97%	Highly Valid
3	Analyze the concept of autotrophic and heterotrophic organisms	100%	Highly Valid
4	Explain the concept of	100%	Highly Valid

	the abiotic component influence on the distribution of an organism		
5	Analyze the concept of the organism energy flow at the trophic level	100%	Highly Valid
6	Analyze the concept of the impact of the food chain breaking	100%	Highly Valid
7	Analyze the concept of the impact of the food chain breaking	100%	Highly Valid
8	Analyze the concept of the impact of the food chain breaking	100%	Highly Valid
9	Specify the concept of energy flow in a food chain	100%	Highly Valid
10	Analyze the examples of the organisms' position at a trophic level in the food web	97%	Highly Valid
11	Identify the concept of one of the materials or chemical compounds included in the biogeoche mical cycle	97%	Highly Valid
12	Define the concept of the decompose rs role in the nitrogen cycle	100%	Highly Valid
13	Define the concept of the plants' role in the carbon cycle	97%	Highly Valid
14	Determine the concept of a biogeoche mical cycle in which its movement does not pass through the atmosphere	100%	Highly Valid
15	Determine the concept of a niche	100%	Highly Valid
16	Determine the concept of a niche in an ecosystem	97%	Highly Valid
17	Determine the concept of the type of symbiosis in the biotic component	100%	Highly Valid
18	Determine the concept of the type of symbiosis in the biotic component	100%	Highly Valid
19	Define the concept of the interactions between species	100%	Highly Valid
20	Analyze the concept of the organizatio n level of living things with the most	97%	Highly Valid

	competition among organisms		
Percentage of Average Result		98,95%	
Interpretation		Highly Valid	

Based on the result, it could be understood that the validity of the misconception test instrument on ecological material using the three-tier test method is considered valid in the material, construction, and language aspects. Based on the material aspect the result are presented in table 3.

Table 3. Validity Result Based on Material Aspect

Aspect	Percentage	Interpretation
The questions item suitable according to the indicator	100%	Highly Valid
The questions item suitable according to the correct concept	100%	Highly Valid
Key answer (Tier 1)	100%	Highly Valid
Key answer (Tier 2)	96,66%	Highly Valid
Each question only has one correct answer	96,66%	Highly Valid
Average result	98,40%	Highly Valid

Based on the construction aspect the result are presented in table 4.

Table 4. Validity Result Based on Construction Aspect

Aspect	Percentage	Interpretation
Test items are appropriate in writing the question instructions on how to do the questions	100%	Highly Valid
The subject matter has been formulated in a concise, clear, and concise manner	98,33%	Highly Valid
The subject matter does not provide clues to the answers of other items	100%	Highly Valid
Items were assessed not using a negative form	100%	Highly Valid
Answer choices are homogeneous, logical, and relatively uniform in length	100%	Highly Valid
Graphs/pictures/tables/diagrams that are used are clear and can help students understand the questions	91,66%	Highly Valid
Answer choices in the form of numbers are arranged in order of small to large or vice versa	66,66%	Valid
The answer choices do not use the statement "all true/false answers"	100%	Highly Valid
Average result	94,58%	Highly Valid

Based on the language aspect the result are presented in table 5.

Table 5. Validity Result Based on Language Aspect

Aspect	Percentage	Interpretation
The language are suitable with the rule	100%	Highly Valid
Does not give multiple interpretation	100%	Highly Valid
The language are easy to understand	100%	Highly Valid
There are no repetitions of words in the main sentence in the alternatives	98,33%	Highly Valid
Average result	99,50%	Highly Valid

Based on the table, the content aspects assessed include the test items' suitability against the indicators and the concepts' correctness. The construction aspects that were assessed included the suitability of the instructions for handling the questions, the formulation of the main questions, the preparation of answer choices, and pictures or diagrams. The language aspect assessed includes the suitability of using acceptable language that is easy to understand and does not cause multiple interpretations. Boshuizen (2020) states the quality of students' understanding of concept and knowledge is determined by the quality of the knowledge structure which is the basis for thinking. Misconceptions occur because the

students' mastery of concepts is still incomplete, too simple, and different due to limited information so that they have different initial concepts or are not in accordance with the correct concept agreed upon by experts (Ibrahim, 2012). So that there is a conceptual conflict when students combine the concepts they have just learned with the concepts they already have. Measuring the validity of an instrument is an important thing to do because it is the primary first step (Gurel, 2015) so that when it is used, accurate data can be obtained so that the test instrument developed must be valid (Mardapi, 2017).

The validation results above also indicate that the items developed from the indicators have covered several subtopics of ecological material and are considered valid to measure understanding of the concept of ecological material. Ecology lesson in grade 10 high school is a lesson that has a broad scope. The ecology lesson covers several topics and the concepts in ecology material are often sees as very difficult for most students to understand (Yazid *et al.*, 2016).

Based on the results of instrument validation, it was found that all the items were considered very valid to test the students' understanding of the concepts of ecology. The development of the misconception test instrument begins with analyzing the curriculum and the basic competencies that are the subject of the assessment. The basic competencies used include understanding related to ecology topic, namely basic competencies 3.10 analyze ecosystem components and their interactions between these components and 4.10 to present works that show interactions between ecosystem components (food webs, and biogeochemical cycles). The results of the analysis will be the basis for compiling the item indicators used to measure concepts related to ecology topic.

The items developed from the indicators were tested for their validity on the material, construction, and language aspects by the validator. Based on table 2 regarding the average results of the instruments developed in the study, it can be seen that the indicators in items 1, 2, 10, 11, 13, 16, and 20 have a validity value of 97% which is considered very valid. These items have a realm of thought which includes the ability to define concepts and analyze concepts covering the subtopic domains of ecological material for ecosystem components, energy flows, biogeochemical cycles, niches, and interactions between components in the ecosystem. Referring to the results of validation with validators consisting of ecologists, assessment experts, and high school biology teachers, it was found that there was a need for improvement in these questions because there were deficiencies in the material aspects, namely the reason the answers were not following the correctness of the concept, there were still more correct answers than 1 in the questions, as well as the subject matter which is written has not been formulated in a concise and clear.

The items developed from the indicators in numbers 3, 4, 5, 6, 7, 8, 9, 12, 14, 15, 17, 18, and 19 have a validity value of 100% which is considered very valid. The value of 100% is the maximum validity value that each item has so it is classified as very valid. These items have a thinking domain which includes the ability to define concepts and analyze concepts covering the subtopic domains of ecosystem component ecology, interactions between components in the ecosystem, energy flow, biogeochemical cycles, niches, and symbiosis. The items are stated following the assessment aspects. Assessment aspects under these items include assessments of material aspects, construction, and language. The material aspects of these questions include that the whole test items are following the indicators, the test items are following with the correctness of the concept, the answer keys in tier 1 are in accordance with the correctness of the concept, the answer keys in tier 2 are following the correctness of the concept, only questions there is 1 correct answer. The construction aspects of the questions include that the whole test items are appropriate in writing the question instructions on how to do the questions; the subject matter has been formulated in a concise, and clear; the subject matter does not provide clues to the answers to other items; items were assessed not using a negative form; answer choices are homogeneous, logical, and relatively uniform in length; graphs/pictures/tables/diagrams and the like that are used are clear and can help students understand the questions; answer choices in the form of numbers are arranged in order of small to large or vice versa; the answer choices do not use the statement "all true/false answers" and the like. The language aspect of these questions is appropriate in the use of language in accordance with language rules, the language in the questions does not cause multiple interpretations, the questions have used language that is easy to understand, and in the questions, there are no repetitions of words in the main sentence in the alternatives.

The preparation of this ecology misconception test instrument received several improvement suggestions provided by the assessors. These improvements include replacing some of the vocabularies in the test instrument that is not appropriate to use, reformulating the answer options provided, improving the writing of several terms in ecology, reformulating the answer key reasons available to make them more relevant to the answer choices chosen by students. Test improvements were made after the first validation process and then revised the question instruments so that the questions that could be tested on students had very good quality.

The misconception test instrument developed into 20 items has been adjusted by applying the misconception test model with the three-tier test method. A three-tier test

is said could be effective if the instrument is used as a tool for teachers to identify student misconceptions. In other words, the effectiveness can be known through the validity of the test instrument.

A valid misconception test instrument can measure the extent to which students understand the concept of material. The trial results using a valid misconception test instrument can later be used to evaluate information from learning resources used by teachers and students' learning resources during learning activities, which may be a factor in errors in understanding concepts when learning (Handoko and Sipatuhar, 2016).

After a valid instrument is used to measure misconceptions, the teacher can remediate the misconceptions. According to Ibrahim (2012), several ways or learning strategies to minimize the occurrence of misconceptions or remediate misconceptions among others are through conceptual changes, cognitive conflicts, constructivist strategies, and concept maps.

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CLOSING

Conclusion

Based on the results of research that has been carried out, the test instrument developed to detect misconceptions in 10th-grade high school students on ecology topic using three-tier method consist of 20 question items is declared valid. The test instrument to detect the misconceptions of 10th- grade Senior High School students on ecology material using the three-tier test method containing 20 items was declared valid in the aspects of the material, construction, and language. The validity result for aspects of the material is 98,40%, construction is 94,58%, and language is 99,50% and the average result after analyzing for each question item is 98,95% which are categorized as highly valid instrument.

Suggestion

This misconception test instrument should be tested in limited scale of students to measure understanding of the concept on ecological material to get empiric validity score for improving the quality of instruments that have been developed.

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