REID (Research and Evaluation in Education), 8(2), 2022, 152-168
Available online at: http://journal.uny.ac.id/index.php/reid

Developing diagnostic test assessment to measure creative thinking skills of Biology preservice teacher students

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ARTICLE INFO

Article History
Submitted:
17 June 2022
Revised:
20 November 2022
Accepted:
6 December 2022

Keywords
development; creative thinking skills; diagnostic assessments; biology preservice teacher

Scan Me:

ABSTRACT

The research aims to develop a diagnostic test assessment to measure the creative thinking skills of biology preservice teacher students. This research and development used Thiagarajan's 4D (Define, Design, Develop, and Dissemination) model. The diagnostic test assessment was developed in the form of an essay test with five numbers of scoring rubrics. This research was conducted at the Biology Education Study Program, University of Sintuwu Maroso. The results of the expert validation of the assessment instrument are high, and the reliability value is high. The results of the test found that all questions were valid and reliable. The student's creative thinking skills obtained an average value of fluency of 75.01% in the high category, flexibility thinking skills of 64.13% in the medium category, originality thinking skills of 69.56% in the medium category, elaboration skills of 75.01% in the high category and evaluation skills of 75.07% in the high category. All students' creative thinking skills are in the moderate category with a score of 71.74%, and the follow-up to the diagnostic results is that the lecturer can provide remedial on several learning indicators that have not been achieved.

How to cite:
Eliaumra, E., Samaela, D., & Muhdin, N. (2022). Developing diagnostic test assessment to measure creative thinking skills of Biology preservice teacher students. *REID (Research and Evaluation in Education), 8*(2), 152-168. doi:https://doi.org/10.21831/reid.v8i2.50885

INTRODUCTION

Thinking skills are the ability to combine attitudes, knowledge, and skills possessed by a person. An example of this thinking skill is creative thinking. According to Abraham (2015), creative thinking is very important to develop because it is a form of self-expression in a unique way. Furthermore, Zubaidah et al. (2015) reveal that optimizing creative thinking skills is very important, because it is a life skill that needs to be developed. It is necessary to overcome complex problems along with biological development.

Creative thinking is a mental process which involves cognitive processes and is one of the higher order thinking skills that is very important to develop in the 21st century. Creative thinking will produce a creative generation that has the potential to solve complex social as well as environmental problems. Creative thinking is the ability to connect the relationships that have never been made before and produce new and original thinking experiences as a new pattern and it is found that there is a change in creativity strategies related to content, processes, products, and learning environments that will improve student academic achievement (Yusnaeni et al. 2017; Siburian et al. 2019).

ISSN: 2460-6995 (Online)

The three indicators that are used to assess creative thinking skills are fluency, flexibility and novelty. Fluency is students' ability to solve problems of Biology with several alternative answers (various) and correct; flexibility is students' ability to solve problems of Biology in different ways; while novelty is students' ability to solve problems in Biology with several different answers but the value is correct and one answer that is not usually done by students at the developmental stage. Everyone has a tendency to different aspects of creative thinking skills in problem solving, and each aspect of creative thinking skills has a different role in problem solving according to the type of problem given (Purwasih, 2019; Trianggono & Yuanita, 2018).

Creative thinking skills can be improved through learning strategies that involve higher-order thinking as the one of biology. Students in the Biology Education Study Program as preservice teachers in biology subjects are certainly required to have these abilities. The discussion of very complex material in Biology subject makes it difficult for some students to understand the material in depth. As the fact, Students are still very difficult to express their understanding of a material during the learning process, especially in Environmental And Natural Resource Conservation courses and Animal Physiology courses. Students tend to give answers based on what is contained in textbooks without develop their higher-order thinking skills. When the lecturer gives a questions on cognitive levels 4-6 (analysis, evaluation and creation) only some students are able to understand it.

The results of pre-observations on the learning process of two courses found that: (1) the lecturer taught the course material using the lecture, discussion and question and answer method which ended with giving assignments (2) students are unable to answer because students were not fully trained to express ideas that is in their own minds or creative thinking skills. (3) Assessment is still focused on low thinking skills (C1, C2 and C3). (4) The questions given are still less varied, only revolve around mentioning, explaining, specifying, what and when. (5) The questions have not been able to measure students' creative thinking skills.

Based on the results of pre-observations, the steps that need to be solved are (1) the need to reorient test assessments in learning, (2) students' creative thinking skills which need to be considered, (3) competence and learning outcomes in courses which need to be known and measured, so that student competencies can be better, and (4) the need for the use of diagnostic assessments in order to find out the strengths and weaknesses of the students of biology preservice teacher in learning. For this reason, it is necessary to develop an assessment system that aims to determine the level of understanding and difficulties faced by students of preservice teacher, through diagnostic assess-ments on aspects of creative thinking skills, thus an appropriate learning model is obtained in overcoming student difficulties in understanding the subject matter. One way to identify the difficulties of students of biology preservice teacher is a diagnostic assessment.

Diagnostic test assessments on cognitive aspects objectively measure students' learning status, knowledge, and skills (collectively known as latent attributes) and provide appropriate cognitive diagnostic feedback (Tang & Zhan 2021). There are several cognitive diagnostic models or diagnostic classification models and their generalizations that have been proposed to provide theoretical support for the cognitive diagnostic assessment (Ravand & Robitzsch 2015). Cognitive diagnostic assessment is an alternative assessment that can provide a description of student learning processes and cognitive structures to educational stakeholders, thus, learning strategies can be designed according to student needs that are tailored (Chin et al., 2021).

Diagnostic tests are designed in order to detect student learning difficulties so in the preparation of diagnostic tests they must be designed according to the format and response of the diagnostic test. A good diagnostic assessment is an assessment that can (1) describe the difference in ability between students in a particular skill, (2) be consistent with the correct data, and (3) the assessment is stated in the shortest possible questions (Dhavala et al., 2020). The diagnostic assessment was developed by Mislevy, Almond, and Luke in an assessment design based on evidence. The framework is an effective structure for designing, producing, and providing assess-

ments. The framework can be used to provide diagnostic assessment information. This model contains three logically connected models: the student model, the evidence model, and the task model. The student model represents students' knowledge, skills, and expertise. These cognitive aspects are usually not observable, but they can be elicited through what students say or performance in their learning process. Assessment constructs can be established after cognitive analysis (Zhang, 2018).

The cognitive aspect was expected to provide information about strengths and weaknesses in the cognitive domain through diagnostic assessment during the learning process. Cognitive diagnostic analysis promotes assessment for learning and the learning process as opposed to assessment of learning outcomes. Through providing detailed diagnostic feedback, it can inform teachers to modify instruction and learning in classrooms, if needed (Ravand & Robitzsch, 2015). Diagnosis is an integral part of instructional decision-making. As the bridge between the identification of students who may be at risk for failure and the delivery of carefully designed supplemental interventions, diagnosis provides valuable information about students' persistent misconceptions in the targeted domain (Ketterlin-Geller & Yovanoff 2009). Assessment has a major impact on students' learning. Assessment influences what students regard as important; it affects students' understanding of learning tasks and impacts the quality of students' involvement in these tasks; and it influences the transfer of these insights to future learning (Schellekens et al., 2021). Based on the aforementioned description, it is necessary to develop a diagnostic test assessment instrument in order to measure the creative thinking skills of students of biology preservice teachers with the following research objectives: (1) to find out the validity and reliability of the diagnostic test assessment instrument in Environmental and Natural Resource Conservation course and Animal Physiology course, and (2) to describe the profile of creative thinking skills of students of biology preservice teacher.

METHOD

The development model of this study is the development of Research and Development which refers to Thiagarajan, Semmel, and Semmel in 1974 (Lawhon, 1976). In the Define stage, material analysis and observations were carried out on the courses of Environmental and Natural Resource Conservation and Animal Physiology to obtain preliminary data. In the Design stage, a diagnostic test assessment was designed in the form of five number essay questions followed by a scoring rubric. In the Develop stage, a diagnostic test assessment was developed in order to measure students' creative thinking skills which are fluent thinking skills, flexible thinking, original thinking, elaborate skills, and evaluating skills. The Dissemination stage was limited to biology education study program students who program the Environmental and Natural Resources Conservation course and Animal Physiology course, totaling 23 people. The types of creative thinking skills developed in this study are presented in Table 1. The blueprint of the think creatively ability in the Environmental and Natural Resources Conservation course are presented in Table 2. In addition, the blueprint test on creative thinking skills in the animal physiology course can be seen in Table 3.

Table 1. Grids of Types and Indicators of Creative Thinking Skills Developed

Number	Types of Thinking Skill	Indicators of Thinking Skill
1	Fluency thinking skills	Having a lot of ideas / ideas about a problem
2	Flexible thinking skill	Applying a concept or principle in different ways
3	Original thinking skill	Thinking about problems or things that have never been thought of by others
4	Elaboration skill	Finding a deeper meaning to answer or problem solving by doing detailed steps
5	Evaluation skill	Giving consideration based on his own point of view

Table 2. Blueprint of Creative Thinking Skills in the Environmental and Natural Resources Conservation Course

Indicators of Creative Thinking Skills	Question Indicator	Question Number
Having a lot of ideas / ideas about a problem	Describing the efforts to conserve natural resources and the environment	1
Applying a concept or principle in different ways	Explaining the conservation of forests, rivers, reservoirs, groundwater, coral reefs, mangroves, and estuaries	2
Thinking about problems or things that have never been thought of by others	Describing effective ways to address natural resource and environmental problems	3
Finding a deeper meaning to answer or problem solving by doing detailed steps	Describing the principles of environmental ethics	4
Giving consideration based on his own point of view	Analyzing Indonesian local wisdom that supports conservation	5

Table 3. Blueprint Test of Creative Thinking Skills in Animal Physiology Courses

Indicators of Creative Thinking Skills	Question Indicator	Question Number
Having a lot of ideas / ideas about a problem	Describing the intracellular and extracellular digestive systems	1
Applying a concept or principle in different ways	Explaining the working mechanism of O2 and CO2 transport	2
Thinking about problems or things that have never been thought of by others	Describing the process of reflex activity	3
Finding a deeper meaning to answer or problem solving by doing detailed steps	Describing the structure and function of the kidney in mammals	4
Giving consideration based on his own point of view	Describing export receptors and proprioceptors	5

Expert Validation

Instrument validation was carried out through three experts' judgments, they are two material experts who were subject lecturers and one learning assessment expert in the Biology Education study program. Data validity is found by recapitulating all aspects assessed and the results of expert assessments then determining the average percentage of expert assessment results for each aspect using the Aiken item validity index formula. To interpret the measurement results, a criterion is needed. The validation criteria if it has a V value is ≥ 0.8 (Aiken, 1980).

The reliability of the diagnostic assessment tool uses Interrater Reliability, namely Intraclass Correlation Coefficients (ICC) through the SPSS ver.21 application. The measuring instrument has adequate stability if the ICC between measurements is >0.50, and high stability if the ICC between measurements is ≥ 0.80 (Polgar & Thomas, 2013).

Field Trial

In the field trial, the validity of the items was measured using the product moment formula through the SPSS ver. 21 application. The criteria are used to decide that the developed diagnostic assessment has a good degree of validity if it has a valid Va value or Va 70%, while the reliability of the test in this study uses the Croncbach-Alpha formula using the SPSS ver.21 application. The criteria for testing the reliability of the test are if the Croncbach-Alpha value is > 0.60 (Sugiyono, 2017).

Measurement of the quality of the test is done by calculating the level of difficulty and discrimination power of the questions. It analyzed using the Anates ver.24 application. The criteria for calculating the difficulty index according to Arikunto if difficulty index is > 0.3 with a minimum middle category. Next the discrimination power of test uses the Arikunto criteria discrimination power index is > 0.20 with a minimum satisfactory category (Arikunto, 2013).

The results of the development of the instrument are used to measure creative thinking skills in two courses, namely the Environmental Conservation, Natural Resources, and Animal Physiology course. The creative thinking indicators measured were fluent, flexible, original, detailing, and evaluating skills. Data analysis techniques were carried out statistically descriptively with the formula as presented in Formula (1). Categories and interpretation of creative thinking skills based on the results of adaptation by Gronlund (1996) which provides the criteria for achieving learning outcomes as presented in Table 4. Based on the results of the diagnosis/interpretation of creative thinking skills, a follow-up is made which is described in Table 5.

$$\% \text{ learning achievement} = \frac{\text{Total of Students' Score}}{\text{Total Score}} \times 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Table 4. Categories and Interpretation of Creative Thinking Skills

Interval	Category	Diagnostic/Interpretation
85% ≤ N	Very High	Understand all the material of subject very well
75% ≤ N < 85%	High	Understand some of the material of the subject well
60% ≤ N < 75%%	Medium	Understand some of the material of the subject quite well
40% ≤ N < 60%	Low	Not enough able to understand the material of the subject
< 40%	Very Low	Unable to understand the material of the subject

Table 5. Follow-Up on the Results of the Diagnosis/Interpretation of the Creative Thinking Skills of Students of Preservice Biology Teacher

No.	Category	Follow Up
1	Very High	Students can continue learning on the next material
2	High	Students can continue learning on the next material
3	Medium	Lecturers provide remedial by repeating learning indicators that have not been achieved
4	Low	Lecturers provide remedial by repeating learning indicators that have not been achieved
5	Very Low	Lecturers can use more varied learning methods that can improve students' creative thinking skills

FINDINGS AND DISCUSSION

Findings

Product Development Diagnostic Test Assessment

The results of the development of the creative thinking skills test instrument in the Environmental and Natural Resources Conservation course through a 4D model can be found in Table 6. The results of the development of the creative thinking skills test instrument in the Animal Physiology course are shown in Table 7.

Table 6. Test Instrument for Creative Thinking Skills in the Environmental and Natural Resources Conservation Course

No.	Types of Creative Thinking Skills	Question
1	Fluency thinking skills	What conservation efforts can be done to preserve natural resources and the environment?
2	Flexibility thinking skills	Explain the technology that can be applied in the conservation of forests, rivers, reservoirs, groundwater, coral reefs, mangroves and estuaries! (choose one type of conservation)
3	Originality thinking skills	Explain the effective way to solve natural resource and environmental problems based on the type of natural resources!
4	Elaboration skills	How to apply the principles of environmental ethics in society? Explain with examples!
5	Evaluation skills	Can the local wisdom that has been implemented in Indonesia support the conservation of natural resources and the environment? Explain !

Table 7. Test Instrument for Creative Thinking Skills in the Animal Physiology Course

No.	Types of creative thinking skills	Question
1	Fluency thinking skills	What are the differences between intracellular and extracellular digestive systems in invertebrates and vertebrates?
2	Flexibility thinking skills	Explain the mechanism of action of O2 and CO2 transport in invertebrates and vertebrates !
3	Originality thinking skills	How do reflex movements occur in animals? And what does that have to do with the nervous system?
4	Elaboration skills	Draw the structure of the kidney in mammals and explain some of the functional abnormalities that can occur in the kidneys of mammals!
5	Evaluation skills	What will happen if the sensory organs in animals, namely exporters and proprioceptors, do not work properly?

Validity and Reliability

The validity of the diagnostic test assessment product is determined by the results of content validation by experts which include material, instruction and language criteria presented in Table 8. Based on Table 8, it obtains that the content validity of the diagnostic assessment product developed according to the experts is categorized as high for all questions. The content validity of the diagnostic assessment in the animal physiology course is presented in Table 9.

Table 8. Recapitulation of Expert Validation Scores in the Environmental and Natural Resources Conservation Course

No.	Rater Deal Index	Validation
1	0.843	High
2	0.987	High
3	0.907	High
4	0.870	High
5	0.880	High

Table 9. Recapitulation of Expert Validation Scores in the Animal Physiology Course

No.	Rater Deal Index	Validation
1	0.826	High
2	0.898	High
3	0.926	High
4	0.870	High
5	0.889	High

Based on Table 9, it obtains that the content validity of the diagnostic assessment product developed according to the experts is categorized as high. The results of calculations on the reliability of diagnostic test assessments from experts in Environmental and Natural Resource Conservation courses and Animal Physiology courses can be seen in Table 10.

Table 10. Reliability of the Diagnostic Test Assessment Tool Sheet

	Assessment Tool Sheet	Reliability	Category
1.	Assessment of creative thinking skills in Environmental and Natural Resource Conservation courses	0.901	High
2.	Assessment of creative thinking skills in Animal Physiology courses	0.892	High

Based on Table 10, it can be seen that the instrument developed has high positive agreements from experts because of its reliability value (R) 0.80. The reliability of the diagnostic test assessment product assessment sheet obtained a high value, namely 0.892-0.901. It is because the scores given by the three experts are almost the same in every aspect assessed. The results of the

field trials on Environmental and Natural Resource Conservation courses and Animal Physiology courses obtained validity values as presented in Figure 1.

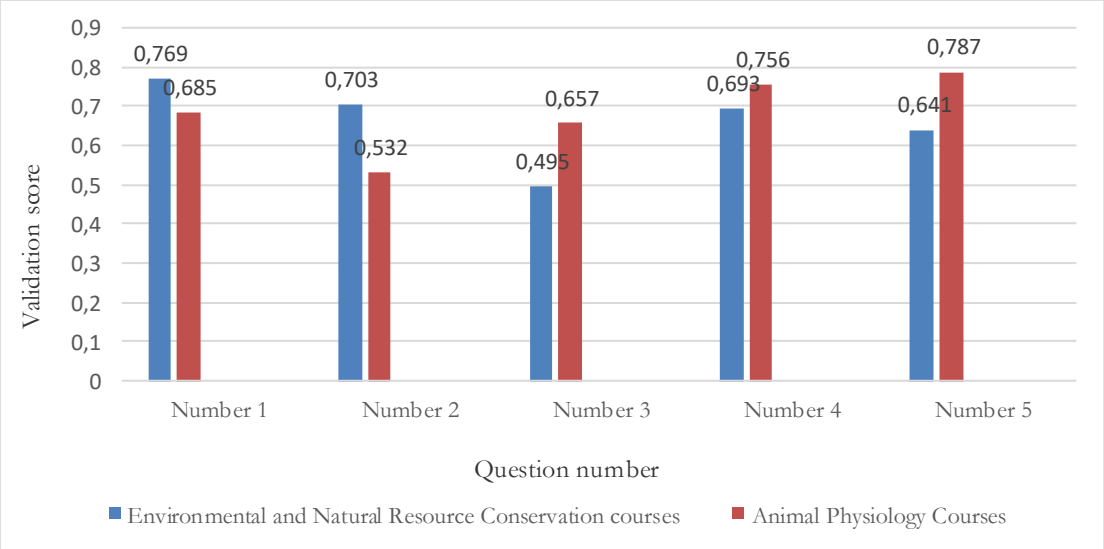

Figure 1. Validity of Creative Thinking Skills Test Questions on Field Trials

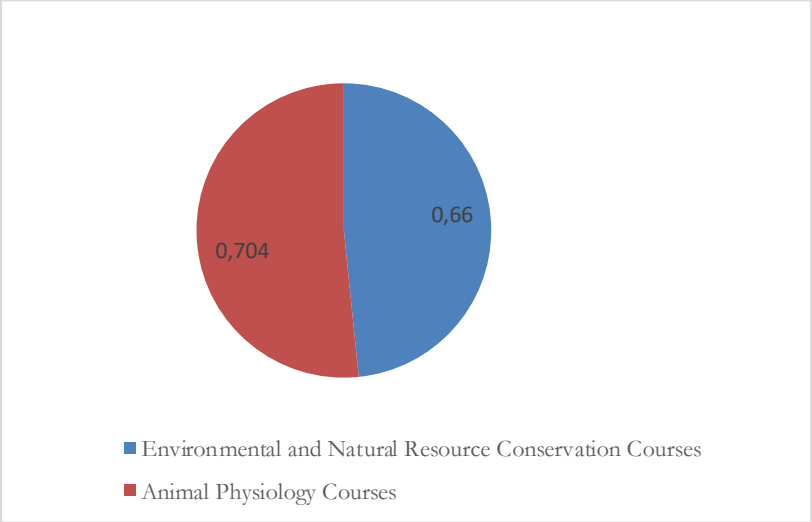

Figure 2. Reliability of Creative Thinking Skills on Field Trials

Based on Figure 1, all questions are declared valid because the value of r count > r table is 0.413. The value of r table with a confidence level of 5% with a sample of 23. The reliability of the questions is presented in Figure 2. Based on Figure 2, the Croncbach-Alpha value is > 0.60 so all questions are declared reliable, thus it can be concluded that the test questions can be used to measure the creative thinking skills of students of biology preservice teachers.

The Level of Difficulty and Discrimination Power Question

The results of the difficulty level analysis of the questions in the environmental and natural resource conservation courses and animal physiology courses can be presented in Table 11. Based on Table 11, the level of difficulty of the questions are in the easy and middle categories so the questions developed are categorized as good. The results of the analysis of the discrimination power of questions in the environmental and natural resource conservation courses and animal physiology courses are presented in Table 12.

Table 11. The Questions Difficulty Level

Subject	Question Number	Difficulty Index	Category
1. Environmental and natural resource conservation courses	1	0.698	Middle
	2	0.583	Middle
	3	0.645	Middle
	4	0.687	Middle
	5	0.667	Middle
2. Animal physiology courses	1	0.754	Easy
	2	0.651	Middle
	3	0.608	Middle
	4	0.698	Middle
	5	0.708	Easy

Table 12. The Discrimination Power of Questions

Subject	Question Number	Discrimination Power Index	Category
1. Environmental and natural resource conservation courses	1	0.433	Good
	2	0.266	Satisfactory
	3	0.225	Satisfactory
	4	0.291	Satisfactory
	5	0.266	Satisfactory
2. Animal physiology courses	1	0.283	Satisfactory
	2	0.283	Satisfactory
	3	0.333	Satisfactory
	4	0.333	Satisfactory
	5	0.291	Satisfactory

Based on the Table 12, it is obtained that the discrimination power index ranges from 0.225 to 0.433 which indicates that the discrimination power of the questions is categorized as good and satisfactory, so that the questions can be declared good because they have been able to distinguish high and low capable students.

Creative Thinking Skills Of Students Of Biology Preservice Teacher

The findings of the research on the creative thinking ability of preservice biology teacher students in two courses namely; Environmental Conservation and Natural Resources obtained data as presented in Figure 3 and Table 13. Creative thinking skills category of preservice biology teacher students in environmental and natural resource conservation courses are presented in Table 13.

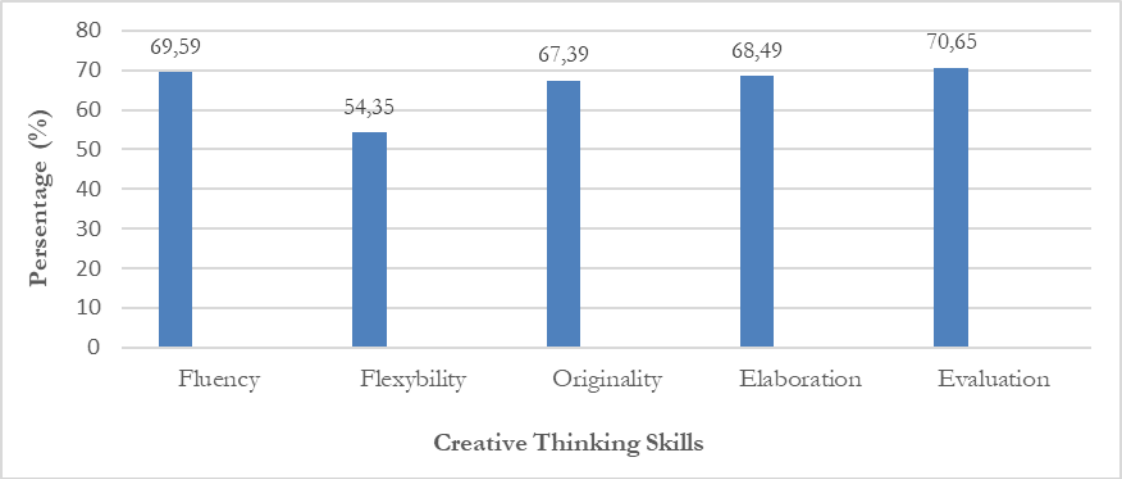

Figure 3. Creative Thinking Skills of Preservice Biology Teacher Students in Environmental and Natural Resource Conservation Courses

Table 13. Creative Thinking Skills Category of Preservice Biology Teacher Students in Environmental and Natural Resource Conservation Courses

No.	Creative Thinking Skills	Category
1	Fluency	Medium
2	Flexibility	Low
3	Originality	Medium
4	Elaboration	Medium
5	Evaluation	Medium

Based on Figure 3 and Table 13, it is found that the creative thinking skills of preservice biology teacher students in Environmental Conservation and Natural Resources course are the highest evaluation skills with a score of 70.65% and the lowest is flexible thinking skills with a value of 54.35%. Based on these results, the follow-up to be given can be seen in Table 14.

Table 14. Follow-Up Learning in Environmental Conservation and Natural Resource Courses Based on The Creative Thinking Skills of Preservice Biology Teacher Students

No.	Creative Thinking Skills	Follow Up
1	Fluency	Lecturers provide remedial by repeating learning indicators, namely an explanation of the efforts that can be made in Environment Conservation and Natural Resources course.
2	Flexibility	Lecturers can provide material reinforcement by providing examples of technologies that can be used in the conservation of forests, rivers, reservoirs, groundwater, coral reefs, mangroves and estuaries in real life in various ways.
3	Originality	Lecturers provide remedial by repeating learning indicators, namely explanations on effective ways to overcome natural resource and environmental problems that have never been applied before.
4	Elaboration	Lecturers provide remedial by repeating learning indicators, namely the application of environmental ethical principles in detail that can help overcome environmental problems that occur in the community.
5	Evaluation	Lecturers provide remedial by repeating learning indicators about Indonesian local wisdom that supports conservation so that students are able to provide considerations based on their own opinions regarding the application of local wisdom.

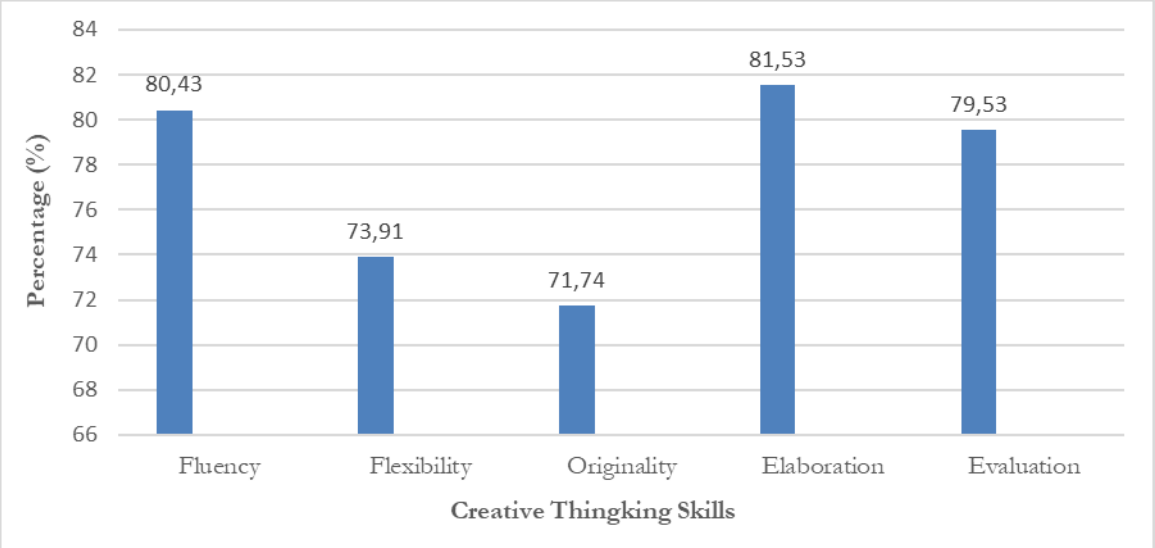

Figure 4. Creative Thinking Skills of Preservice Biology Teacher Students in Animal Physiology Course

Based on Table 14, the follow-up that can be given to preservice biology teacher students Environment Conservation and Natural Resources course is to provide material and remedial reinforcement for several learning indicators that have not been achieved. The creative thinking skills in Animal Physiology course are shown in Figure 4 and Table 15. Creative thinking skills category of preservice biology teacher students in animal physiology course are shown in Table 15.

Table 15. Creative Thinking Skills Category of Preservice Biology Teacher Students in Animal Physiology Course

No.	Creative Thinking Skills	Category
1	Fluency	High
2	Flexibility	Medium
3	Originality	Medium
4	Elaboration	High
5	Evaluation	Medium

Table 16. Follow-Up Learning in Animal Physiology Course Based on the Creative Thinking Skills of Preservice Biology Teacher Students

No.	Creative Thinking Skills	Follow Up
1	Fluency	Students can continue learning in the next material because they already have a good understanding of the intracellular and extracellular digestive systems in invertebrates and vertebrates.
2	Flexibility	Lecturers provide remedial by repeating learning indicators, namely explaining the working mechanism of O2 and CO2 transport in different ways.
3	Originality	Lecturers provide remedial by repeating learning indicators, namely explaining the process of reflex activity and relating it to the nervous system in animals.
4	Elaboration	Students can continue learning in the next material because they have understood the structure and function of the kidney in mammals in detail.
5	Evaluation	Students can continue learning in the next material because they have a good understanding of export-receptors and proprioceptors and how the system works from their own point of view.

Based on Table 15, it is found that the creative thinking skills of preservice biology teacher students in Animal Physiology course are the highest on elaboration skills with a score of 81.53% and the lowest is originality thinking skills with a score of 71.74%. Based on these results, the follow-up to be given is presented in Table 16. Based on Table 16, the follow-up given to preservice biology teacher students in Animal Physiology course is to provide remedial treatment for two materials to improve flexible and original thinking skills.

Discussion

Product Validity Diagnostic Test Assessment

The results of the data analysis of the validator's assessment of the developed assessment product indicate that the average assessment of each aspect assessed is high (>0.8). Thus, it can be said that the diagnostic test assessment product produced is very good because the expert validity value obtained has given precise and accurate results and is able to measure what should be measured in this case students' creative thinking skills. According to Halek et al. (2017), content validity is a drinking requirement that an instrument must have, although it is limited to value, content validity is an important quality indicator of instrument validity and provides an overview of its feasibility and practicality. In addition, several studies, according to Suherman and Vidákovich (2022), stated that in their use of data to assess the validity of a questionnaire's content, perceptions had been reported in the context of a validity index as an acceptable level. In other words, the validity of the content instrument and the validity of the face has also been presented as evidence that the questions were feasible to use.

Several suggestions and corrections from the validator team were taken into consideration for revising the developed assessment. The results of the field trials have also shown very good results so that in terms of implementation in the field the resulting assessment is declared valid, because it produces data that is appropriate and relevant to the objectives of the assessment and measurement. Thompson (2013) suggests that validity is an evaluative assessment integrated with empirical evidence and theoretical reasons to support the adequacy and suitability of conclusions and actions based on test scores or other forms of measurement. Lia et al. (2020) also state that the assessment instrument in measuring the question attributes as students' evaluation material must be valid and reliable.

The results of the analysis of the reliability of the diagnostic test assessment product that was developed obtained good results, namely in the high category as well as in the field trials obtained a value with a reliable category. Thus this assessment has been able to have accuracy in measuring something, in this case creative thinking skills because reliability found the extent to which a test obtains a stable value and is free from measurement errors. A reliable test will provide a good estimate in measuring the ability or trait to be measured. This is in accordance with what Darmadi (2011) stated that a test is high reliability if the test has consistent results in measuring what is to be measured. Furthermore, Thompson (2013) also explains that reliability refers to the accuracy or repetition of the same score. Based on the reliability value, the assessment product developed has been declared valid and feasible to use. de Vries et al. (2022) suggests that the reliability of the test is very important because it will be used for the purpose of giving marks to students as an assessment to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited.

Profile of Creative Thinking Skills of Students of Biology Preservice Teacher

Based on the findings of research on the creative thinking ability of preservice biology teacher students using a diagnostic assessment, it was obtained that there were differences in the ability of each indicator of thinking skills in two courses, namely Conservation Environmental and Natural Resource course and Animal Physiology course as presented in Figure 4 and 5. Each indicator of creative thinking skills can be described as follows.

Fluent Thinking Skills (Fluency)

Fluency thinking skills through diagnostic assessments in Environmental Conservation and Natural Resource course obtained a score of 69.59% in the medium category, this means that preservice biology teacher students are quite good at generating many ideas based on the questions given because they have understood some of the material quite well. However, there are some student answers that are still focused on the theory learned according to the material provided by the lecturer, without relating the experience gained from observing the surrounding environment. According to Munandar (2014), creative thinking skills are influenced by internal factors, namely the existence of self-motivation to activate all their capacities when individuals form new relationships with their environment, for example is openness to experience to receive all sources of information without pressure and stiffness. Creativity is a highly sought-after capacity in many learning discourses. It is often positioned as vital to education futures, given the complex problems and settings that students face. However, an often-ignored aspect of educational creativity is its connection to risk-taking (Harris & de Bruin, 2018). Risk-taking, enacted through a willingness to try new ideas and possibilities, and engage with the potential for failure, is key to the iterative nature of creativity and learning (Henriksen et al., 2021).

Fluency was obtained with a score of 80.43% in the high category in Animal Physiology course. The high percentage of scores obtained based on these results is due to the fact that students already have openness to the concept as a whole and are able to implement it in the form

of self-confidence and a good perception of the questions given. The fluent thinking skills possessed by students are found by providing several alternative answers well, although there are still students who are lacking in providing alternative answers. It is in line with Susanto (2013) that fluency in thinking is being able to spark many ideas, solve problems, many answers and suggestions for doing various things. Integrating creativity into science education promises to make the provision and management of knowledge more sustainable (Henriksen et al., 2021). Creativity refers to process-related to the skills required for reading which can engage in activities that encourage creativity such as thinking, remembering, reasoning, questioning, exploring, and expressing oneself reading and listening exercises (Sur & Ateş, 2022). Creativity is understood to support the acquisition, transfer, and application of knowledge at schools (Roth et al., 2022).

Fluency thinking skills in general obtained the average score in both courses was 75.01% in the high category so that the follow-up given was that students were able to continue learning on the next material because they already had a good understanding of the subject matter.

Flexible Thinking Skill (Flexibility)

Flexible thinking skills through diagnostic assessments in Environmental Conservation and Natural Resource course obtained a score of 54.35% in the low category, while in Animal Physiology course the medium category with a score of 73.91%, so that the average score of 64.13% in medium category. It is found that almost most students are less able to provide answers or ideas that are more varied so that students do not provide different alternative answers. The low score obtained is due to the lack of sensitivity of students in answering questions, students have not been able to assess the situation based on their personal standards, and because students do not understand the subject matter well.

Creative thinking is synonymous with saying something new or solving a case in education that is different from the others. Creative thinking is also a habit of sharp thinking with intuition, moving the imagination, telling (to reveal) new possibilities, uncovering extraordinary ideas and inspiring ideas that are not expected (Armandita et al., 2017; Prasetiyo & Mubarokah 2014). In almost any life pursuit, people need to think (1) creatively to generate new and valuable ideas, (2) analytically to judge whether their ideas and the ideas of others are worthwhile; and (3) practically to implement their ideas and convince others of the value of those ideas. People also need (4) wisdom to help to ensure that their skills are utilized to achieve a common good that balances their own (intrapersonal) interests with other people's (interpersonal) and institutional (extrapersonal) interests over the long term, not just the short term (Sternberg, 2015). Creative thinking involves certain attitudes and dispositions that involve being flexible and motivated (Álvarez-Huerta et al., 2022). The creative thinking ability is a person's skill for new ideas that can be applied to deal with problems. Thus, students could see a concept from various points of view, this activity could improve their flexible thinking skills (Saregar et al., 2021).

Based on the results of the diagnosis obtained, the follow-up given is the lecturer providing remedial by repeating the learning indicators and providing explanations and reinforcement of the material accompanied by real examples according to the subject matter.

Original Thinking Skill (Originality)

Creativity is described as "the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others" (Li et al., 2022), and original thinking is the ability to express ideas in ways that other people don't think of. Broad knowledge is the basis for creativity. The wider knowledge comes up with new ideas that it can affect one's original thinking ability (Haerunisa et al., 2021). The results of the analysis of original thinking skills through diagnostic assessments in both subjects were in the medium category with 67.39% and 71.74% respectively. It is found that 69.56% of students are quite good at expressing new things and have given answers that come from their own thoughts after reading or hearing information and ideas, although there are still

textbook answers. Akhan et al. (2022) explain that students have high success in solving world problems. They do this based on their personal interests, life circumstances, and education and development trajectories in different areas of achievement and profession. The education of these special students, who can change their age, finds solutions to many problems created by human beings, and produces solutions to many threats. For example, students have different perspectives on social and environmental problems. These features enable them to think more creatively than their peers in analyzing the change in their environment and producing solutions to problems. Thanks to their high-level awareness and sensitivity toward environmental problems, they are expected to produce creative solutions in this regard. For this reason, encouraging gifted students to think about the problems of the current age during their education will also be beneficial in terms of improving their high-level thinking skills. This is also in line with what was stated by Syafrial et al. (2022) that creative thinking involves looking for gaps, paradoxes, opportunities, challenges, or concerns, and then finding new meaningful connections by solving different types of problems and possibilities (from a different angle or point of view), unusual or original possibilities and details to further develop or enrich existing possibilities.

Based on these results, it was also found that there are still more than 30% of students who have not been able to provide original answers so the follow-up given is that the lecturer provides remedial by repeating the learning indicators by providing in-depth explanations of several indicators that have not been achieved.

Elaboration Thinking Skill

Elaboration thinking skills through diagnostic assessments in the environmental Conservation and natural resource course obtained a score of 68.49% in the medium category while in the animal physiology course the high category with a percentage of 81.53% so the average value obtained was 75.01% is categorized as high. Thus, it can be said that students have been able to describe simple things into broader concepts as indicated by the ability to detail the answers to the questions given accompanied by pictures and real examples that occur in the community. A good understanding of the concept is also one of the factors to improve elaboration thinking skills so that the follow-up given is that students can continue learning on the next material.

According to Susanto (2013), elaboration skills have the characteristics of being able to develop an idea or ideas, and elaborate in detail an object into something interesting. This skill is demonstrated by looking for a deep meaning to a problem or answer with detailed steps, examining in detail the direction to be taken to display something interesting and dissatisfied with a simple display. In accordance with the findings by Gulliksen (2018) that creativity is defined as referring to something which is both innovative and functional, a trait that can be recognized in or carried by a product or a process and that is held, developed, experienced, and expressed by a person or persons in a socially and culturally specific context. Ernawati et al. (2019) also explained that elaboration is to explain, develop, enrich, or describe in more detail an answer or ideas given. With this capability, students can answer tasks. Students with this ability also get good grades because they help their friends enrich their ideas belonging to others.

Evaluation Thinking Skill

Evaluation skills are the ability to judge whether or not an idea is good or bad. The results of the analysis obtain that the skills of evaluating biology teacher candidates are in the medium to high category (70.65% - 79.35%) and the average score is 75.07% in the high category. It can be found in the ability of students to evaluate the problems given. The ability of these students can be influenced by a good understanding of the subject matter, sharpness of thought, and patterns of thinking that are focused on solving a problem so they are able to provide solutions and their own views on the problems given based on their experience.

The findings of this study are in line with Munandar (2014) that evaluating skills is the ability to determine the truth of a statement or problem solving, able to give considerations based on

their own point of view and spark their own views on a matter. The follow-up given based on the results of this diagnosis is that students can continue learning. In almost any life pursuit, people need to think (1) creatively to generate new and valuable ideas, (2) analytically to judge whether their ideas and the ideas of others are worthwhile; and (3) practically to implement their ideas and to convince others of the value of those ideas. People also need (4) wisdom to help to ensure that their skills are utilized to achieve a common good that balances their own (intrapersonal) interests with other people's (interpersonal) and institutional (extrapersonal) interests over the long term, not just the short term (Sternberg, 2015). Creativity is also supported when having individual freedom to make some decisions about one's own work regarding the creative process. There should be sufficient resources, which include time and space in addition to physical resources, like materials, although monetary awards usually do little to enhance creativity. Adding organizational support will certainly foster creativity (Morney, 2022). Creative thinking has been known as a divergent pattern of realistic thinking skills. Creative thinking allows one to connect problems from different perspectives and find unique solutions (Habibi et al., 2020).

CONCLUSION

Based on the findings of the study, it can be concluded that the diagnostic assessment product developed is valid and reliable, the creative thinking skills of preservice biology teacher students through diagnostic assessments are in the medium category with a score of 71.74%, and the follow-up to the diagnostic results is the lecturer can provide remedial on several learning indicators that have not been achieved.

ACKNOWLEDGMENT

We would like to thank the Chancellor who has provided funding for this research, lecturers in environmental and natural resource conservation courses, lecturers in animal physiology courses who have helped during the research process and students majoring in Biology Education, University of Sintuwu Maroso Poso.

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