



Improving Creative Thinking Skills In Marine Ecology In Developing Bioentrepreneurship

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Abstract: This research aims to determine the improvement of creative thinking skills in marine ecology in developing bioentrepreneurship towards sustainable development in prospective biology teacher students. The material in this research is plankton, especially the cultivation of *Spirulina* sp in the laboratory. The research method used was quasi-experimental with a one-group pretest posttest design. The research sample consisted of 27 students who took a marine ecology course in semester 5 at Central Kalimantan University. The test instruments were multiple choice (PG) reasoned and plankton material description test questions. The research results show that each indicator of creative thinking skills, namely *flexibility, originality, and elaboration*, is significantly different ($p = 0.000$). The research results show that plankton material towards sustainable development can improve creative thinking skills in prospective biology teacher students. The contribution of this research can have implications for *sustainable development goals* point 4, namely quality education, and point 14, namely life underwater

Keywords: Bio entrepreneurship; Cultivation of *Spirulina* sp; Creative Thinking Skills; Marine Ecology; Sustainable Development.

Introduction

One of the 21st-century skills that must be provided to students is higher-order thinking skills (HOTS), one of which is creative thinking skills, this is also one of the goals of education in higher education. Creative thinking skills are critical for students to have, because with creative thinking skills a person can design, develop, discover, or modify old constructs with new ones based on supporting data and information to produce solutions to the problems found (Jumrodah et al., 2021; Diawati et al., 2017). Providing creative thinking skills in science learning can make a positive contribution to personal, social, technological economic, and environmental development in facing challenges in this era of globalization (Diawati et al., 2017; Trnova, 2014) Creative thinking skills are one of the important key factors for overcoming various complex problems in the industrial era 4.0 (Santoso & Wulandari, 2020; Rif 'at et al., 2020; Zainuddin et al., 2020; Santoso and Wulandari, 2020; Rif'at et al., 2020; Zainuddin et al., 2020; Yanti et al., 2020). The goals of

education in the 21st century must refer to sustainable development goals (SDGs), and must also provide the ability to analyze and synthesize social, economic, and environmental issues for now and in the future (Prabawani & Hadi, 2020; Satriawan et al., 2021; UNESCO, 2017).

Based on CPMK, it requires students to think creatively in producing marine ecology towards *sustainable development*, especially plankton material. This material is interesting because several marine and aquatic biological resources have roles and benefits both ecologically and economically, but have not been managed sustainably. Of course, this is of interest to researchers to develop marine ecology learning towards sustainable development by managing biological resources, especially aquatic biota or marine biota which can add economic and ecological value.

Previous researchers have developed ways to improve creative thinking skills in both exact and non-exact materials in universities and schools. to improve creative thinking skills and scientific attitudes on nutrition material, emphasizing practical activities by

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determining local raw materials to process food that is healthy, unique, nutritious, and economically valuable (Susanti, 2013). Other researchers have implemented a simple tool that can detect acidic and basic solutions and from this tool can determine the pH trajectory of the natural indicator that has been made (Candra et al., 2019). Other research carried out characterization by focusing on designing tools used to filter water effectively and efficiently (Ridho et al., 2020). Meanwhile, other researchers improve creative thinking skills through product design activities to solve problems related to environmental pollution (Yamin et al, 2020; Satriawan et al., 2020). Improving creative thinking skills is also carried out in the form of cultivating marine biota, especially cultivating phytoplankton *Chaetoceros recalcitrant* and *Navicula* sp. in the laboratory as *Sea urchin feed*, to increase the economic and ecosystem value of Echinoderms. Students are required to be able to think creatively in designing marine biota cultivation, so that they can produce solutions for preserving and *re-stocking* sea urchins in nature (Jumrodah et al., 2021). Apart from that, Putri et al., 2021 also developed a science e-module based on CPS (Creative Problem Solving) and it was proven to be effective in improving creative thinking skills. Creative thinking skills are characterized by the ability to produce new and unique or unusual and unexpected ideas to produce solutions. The ability to express good thoughts or ideas can influence students' creative thinking abilities (Candra et al., 2019). The research carried out requires students to be able to design and practice cultivating *Spirulina* sp. in the laboratory, then these materials are developed into innovative products in the form of food and beauty. Based on the description above, this research aims to improve the creative thinking skills of prospective

biology teacher students in marine ecology towards sustainable development.

Method

This research was carried out at a university in Palangka Raya. The research subjects were students who were programming marine ecology courses in the fifth semester of the class of 2021, a total of 27 students. The method used is a quasi-experiment with a *pretest-posttest design*. This research was carried out in the stages of preparation, implementation, data collection, analysis, discussion, and then conclusion. Several things that must be considered before researching to improve creative thinking skills on plankton material are preparing learning tools consisting of LKM and test instruments as well as laboratory facilities and infrastructure for cultivating *Spirulina* sp. Before cultivation activities are carried out, students are required to design the stages of cultivating *Spirulina* sp. by preparing the composition of media and nutrients and analyzing external factors that influence the lifestyle of *Spirulina* sp.

The data collection technique was carried out using creative thinking skills test questions with aspects measured by *flexibility, originality, and elaboration* (Torrance, 1966). The development of test items on indicators of creative thinking skills in the plankton material implemented can be seen in Table 1. There are two types of test questions used, namely PG reasoning and description, totaling 9 (nine) questions. Data processing was carried out by calculating the pretest and posttest averages, then continued with the statistical normality test (Shapiro-Wilk), after that a mean difference test or hypothesis test was carried out using IBM SPSS version 25 software.

Table 1. Development of Creative Thinking Skills Indicators (KBKr) on the Concept of Marine Biota

KBKr indicator	Developed test items
Flexibility	<ol style="list-style-type: none"> Analyze the impacts and causes of electrification Describe the growth phases of plankton, especially phytoplankton Describe the external and internal factors that influence the lifestyle of phytoplankton, especially <i>Spirulina</i> sp. to plan and design practical work in the laboratory
Originality	<ol style="list-style-type: none"> Describes food and beverage and beauty products made from <i>Spirulina</i> sp. to design products Analyze the stages of plankton cultivation to design practical activities in the laboratory Describe the role and benefits of plankton ecologically and economically
Elaboration	<ol style="list-style-type: none"> Designing stages of plankton cultivation in the laboratory Concluding the appropriate phase for harvesting plankton as raw material for food and beverage products Providing the right solution to prevent eutrophication

Result and Discussion

Activities to improve creative thinking skills were obtained from observation sheet data. The characteristics can be seen in Table 2. There were 6 stages

carried out, namely: orientation. The results of improving creative thinking skills on plankton material, especially *Spirulina* cultivation in the laboratory, were obtained on the average *pretest* and *posttest data*. Pretest and posttest improvement data can be seen in Figure 1.

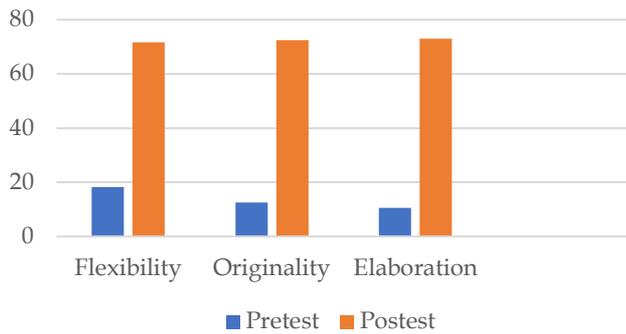


Figure 1. Average *Pretest* and *Posttest* Score Data for Each Indicator in Plankton Material

Pretest and *posttest* learning outcomes from the three indicators, namely *flexibility*, *originality*, and *elaboration*. The lowest *pretest* learning result score was on the *elaboration* indicator, namely with a mean score of 10.56, while the highest *pretest* score was on the *flexibility* indicator with a mean score of 18.18. The lowest *posttest* learning outcome score is in the *flexibility* indicator, namely the average score is 71.66, while the highest *posttest* score is in the *originality* indicator with an average score of 72.45.

In the *elaboration* indicator, the *pretest* learning outcomes were the lowest, this was because students' initial knowledge was very poor in cultivating *Spirulina sp.* in the laboratory, apart from that it was also my first experience. After all, I had never previously cultivated *Spirulina sp.* in the laboratory. The results of these findings reinforce previous findings collected through questionnaires and observations as well as the Torrance framework creative thinking skills test instrument, 1966, that learning so far has provided assignments, but only in the form of papers, then presentations and discussions are carried out without emphasizing concepts that are not yet clear or unclear. It is understood that students' creative thinking skills are still low, besides that so far they have not produced anything useful on a sustainable basis (Jumrodah et al., 2021).

Based on Figure 1, the *flexibility* indicator is the highest post-test learning result. This means that students can provide various arguments for problems. If they are given a problem, they can usually provide various solutions to find a solution. The *flexibility* test item focuses on generating ideas and varied answers or

questions and can also look at a problem from different points of view. This can be seen from the student's ability to provide various answers related to the lifestyle of *Spirulina sp.* which is influenced by external factors and the impact and causes of electrification. This shows that creative thinking skills were better during the *post-test activities*. Students can provide varied ideas for solving problems. This opinion is in line with Wahyudi (2020) that students can flexibly see problems from many alternatives or different directions. Apart from that, creative thinking skills are also formed in students if they are often trained and accustomed to them because thinking skills do not form by themselves. This opinion is in line with Ghanizadeh et al, (2020); and Wahyudi, (2020) state that the development of high-level skills does not just develop, but through proper effort planning and continuous habituation.

Flexibility indicator was developed through expressing thoughts and ideas related to plankton growth and development (see Table 1). This idea was conveyed by students based on the results of observations of the growth phases of *Spirulina sp.* in the laboratory. very effective for developing the ability to think fluently and flexibly, because students are required to actively ask questions and express their ideas (Susanti, 2013; Satriawan et al., 2022). Apart from that, students are also required to produce realistic independence. This opinion is in line with Fitriyah & Ramadani (2021) that students actively solve problems, make decisions, and carry out investigations so that they can produce useful results. Students can analyze various precise information from observations in the laboratory and submit it as an accurate procedure for solving a problem. This finding is to research by Fitriyah & Ramadani (2021); and Rosa & Nursa'adah (2017) that practicum activities and observations in the laboratory can train students to think creatively and critically, carrying out practicums can stimulate students' thinking and creativity. Furthermore, to find out the difference in the increase in creative thinking skills after learning, a statistical test was carried out on the difference between *pre-test* and *post-test means*, which can be seen in Table 2. Analysis of different tests can be carried out using parametric or non-parametric tests. The decision to use parametric or non-parametric tests must be made through normality and homogeneity tests.

Table 2. Descriptive Statistical Analysis (*Pretest* and *Posttest*) for Each Indicator of Creative Thinking Skills (KBKr) in Plankton Material

Indicator	Pre and Post Average	Normality Test	Asymp. Sig. (2-tailed)	Note
Flexibility	18.23	0.030	0.000	Significantly different
	71.61	0.126		
Originality	12.50	0.000	0.000	Significantly different
	72.40	0.035		
Elaboration	10.61	0.002	0.000	Significantly different
	71.97	0.023		

Pretest and posttest mean differences in the flexibility, originality, and elaboration indicators are significantly different, meaning there is a difference in the pretest and posttest of the three indicators. On the flexibility, originality, and elaboration indicators, abnormal data was obtained. The value is said to be normal if the level is significant (Asymp. Sig. (2-tailed) $\alpha > 0.05$). Next, a non-parametric test is carried out, so that a decision is obtained that in the indicators of flexibility, originality, and elaboration there is a significant difference between the pretest and posttest learning outcomes. This shows that project-based learning can improve creative thinking skills. This opinion is in line with research conducted by Desi et al (2013); Lou et al (2012).

Originality indicator is developed when students study the stages of cultivating *Spirulina* a sp. (see Table 1). Students are required to plan and design the stages of cultivating *Spirulina* a sp in the laboratory by taking into account external factors, including the light intensity required for the growth and development of *Spirulina* sp. This requires students to be able to think about the appropriate way to provide light through a TL lamp with an intensity of 500-10,000 lux in the *Spirulina* a sp cultivation room. Light intensity can be met in other forms even in the laboratory, so that students can successfully cultivate *Spirulina* a sp. in the laboratory by adapting the natural habitat. Originality is related to the ability to generate new ideas (Santoso and Wulandari, 2020; Candra et al., 2019). The ideas and ideas obtained are unique, solving problems in unusual ways and using situations that are different from usual. Creative thinking is related to the ability to create something that already exists into something new (Ridho et al., 2020). Activities provide real situations for students to develop creative thinking skills. Students try to solve problems and provide solutions to the problems they face (Yamin et al, 2020). In the activities, there is always discussion, because discussion can reveal ideas and ideas (see Table 2). Discussion activities are carried out at the beginning of learning and are core activities. Discussion activities are carried out in all activities, starting from asking basic questions, designing plans, preparing schedules, and testing results to reporting results (Kristanti et al., 2016). Apart from that, students are also required to provide the right nutritional composition as a growing medium for *Spirulina* sp. in the laboratory. In this way, students have in-depth and complete knowledge and skills regarding the cultivation of *Spirulina* sp. The success of the learning that has been carried out can certainly increase insight and innovation regarding the cultivation of *Spirulina* sp. in the laboratory. This opinion is in line with Hasanah et al (2023); Hilman & Salman (2021) being collaborative can increase innovation in

producing tasks, as a consequence can be oriented to solving community or environmental problems.

Which is carried out, is also interspersed with discussions, where these discussions can develop and enrich ideas and concepts obtained from other people. This opinion is reinforced by Bakir and Oztekin (2014) regarding *elaboration skills*, in carrying out detailed and in-depth analysis of the experiments carried out. *Elaboration* activities are related to the ability to think in detail and systematically, so they can be done by developing existing ideas and providing ideas for solving problems (Wahyudi, 2020). If *elaboration* skills are carried out correctly, it can be a means for students to communicate their results in detail and depth (Candra et al., 2019). , not only requires students to identify problems and then find solutions but also requires them to combine knowledge and creative thinking skills to solve problems (Ridho et al., 2020; Isabekov & Sadyrova, 2018). The results of cultivating *Spirulina* a Sp. The laboratory also continues to make products in the form of ice cream, cookies, pudding, and masks. Of course, these processed products are very useful and have economic value, so the activities carried out support sustainable development and train bio entrepreneurship for prospective biology teacher students. This is certainly in line with sustainable development (UNESCO, 2017).

Conclusion

The results of this research conclude that in marine ecology plankton material towards sustainable development can improve the creative thinking skills of prospective biology teacher students. Students can improve their creative thinking skills by cultivating *Spirulina* Sp. in the laboratory, then the results of cultivating *Spirulina* Sp. processed in the form of ice cream, cookies, pudding, and masks. Apart from that, it can also train bioentrepreneurship for prospective biology teacher students to solve problems and provide appropriate solutions, by managing natural resources sustainably. Improving creative thinking skills on the three indicators, namely *flexibility*, *originality*, and *elaboration*, can be provided. Further research can be followed up on themes related to the management of natural resources that have not been managed in a sustainable and economically valuable manner and can also add other indicators of creative thinking skills.

Author Contributions

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Conflicts of Interest

The author declares that he has no conflict of interest.

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