Preserves creative thinking skills on biotechneur programs

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Abstract. The aim of this research is to know how the biotechneur program influences towards creative thinking skills of biology preservices teacher. The lessons were held for 14 lectures, divided into four phases. Each phase contains learning strategies that support the formation of students' creative thinking skills. The subjects in this study is 34 biology preservices teacher who take biotechnology courses at the University of Wiralodra. The instrument used in this research is 5 essay test items of creative thinking skill in biotechnology. The answers are then given a score using assessment guidelines rubric to obtain data in the form of a score at the time before and after learning. The data is then analyzed quantitatively with the result n-gain value in the medium category and in a significant decision. Based on the results of data analysis it can be concluded that the biotechneur program influences towards creative thinking skills of biology preservices teacher, with all the creative thinking aspects has been developed very well. This research has also revealed that biotechnology programs can be combined with entrepreneurship, and not just an enhanced creative thinking skill but also produce biotechnology products that made from local resources and have high economic value.

1. Introduction
Indonesia has abundant local biological resources, but according to BPS data [1], the number of unemployed in August 2015 was 7.56 million from the total labor force of 122.40 million people. The facts show that about 83 percent of college graduates work as employer [1]. Department of biology education as part of the higher education that prepares professional teachers should prepare so that its graduates to have additional competencies such as entrepreneurship that utilize local resources.

Entrepreneurship can be successful if accompanied by a skill that called creative thinking [2]. Because through creative thinking skill can be produced a new invention in the field of science and technology, as well as in all other areas of human endeavor. Meanwhile, to process biological local resources, required science and technology such as Biotechnology. Biotechnology knowledge can be implemented to create or modify the product [3].

Creative thinking skills can be developed through learning activities that contain the creative process. This learning structure should emphasize to how the student can produce the product [4]. The creative process of learning is generally passed through four processes, i.e. problem discovery, idea creation, implementation and evaluation [5]. Meanwhile, according to Crispeels [6] entrepreneurship education...
programs that can train creative thinking skills can be built through three phases, namely the concept formation phase, creativity and production phase and product socialization phase.

Several approaches and models has been proven can to improve creative thinking skills about biotechnology. such as a "service-learning" approach, that is learning by doing a project task that related to biotechnology [7], assignment of a group research project [8], doing University Masterclass & School visit [9], student debate [10], use of seminar methods (consisting of lectures from experts, reading related articles and hands-on demonstrations) [11], Project based learning [12], and scenario-based discussion approaches [13]. Besides being important to develop biotechnology products, creative thinking skills are essential for entrepreneurial activity [14]. Therefore no research program yet whose themed is how to combine biotechnology with entrepreneurship that trains creative thinking skills.

Biotechneur or Biotech-Entrepreneur is a biotechnology learning program that designed to integrate biotechnology and entrepreneurship. The Biotechneur program is built by synergizing between four creative processes according to Howard with three phases of creative entrepreneurial thinking according to Crispeels. The program consists of four phases, namely the concept forming phase (problem discovery included in this phase), the creativity phase (idea-making and idea evaluation), the production phase (product-making implementation) and the socialization phase. Through this activity we expected the students' creative thinking skill can be trained very well. Therefore, in this research, we want to know how the influence biotechneur program towards pre service students creative thinking skills.

2. Method
This type of research is quasi experiment method type one group pretest-posttest design. The subjects in this study is 34 biology education preservices students in the fifth semester who take biotechnology courses at the University of Wiralodra. The Instruments that used in this study is a creative thinking skill test in biotechnology which contains questions theme about "what products can be created from local resources through biotechnology processes". The test that used is essay type with 5 questions items, each of which represents the creative thinking skills indicators, namely fluency, flexibility, originality, elaboration, and sensitivity. The answers are then given a score using assessment guidelines rubric to obtain data in the form of a score of creative thinking skills at the time before learning (pre-test) and after learning (post-test). The data is then analyzed quantitatively, as a result we get n-gain and significance, the n-gain value is then interpreted according to the guidance to the Hake criterion [15] while the significance decision is obtained from the SPSS program. The lessons were held for 14 meetings, divided into four phases. Each phase contains learning strategies that support the formation of students' creative thinking skills.

| No | Phase | Strategy |
|----|-------|----------|
| 1  | Phase 1 <br>(Lectures 1-6) | In this phase the students trained to build the biotechnology concept through the theory review activity, reviewing the application of biotechnology (products and entrepreneurship), reviewing articles, discussions and presentations. |
| 2  | Phase 2 <br>(Lectures 7-8) | In this phase, students apply the cognitive scheme that has been formed into an idea and design of biotechnology products that made from local resources. |
| 3  | Phase 3 <br>(Lectures 9-10) | In this phase students are required to make a real product, based on the design that has been made. In this phase, making the product activities is done outside the lectures hours while guidance and evaluation process is done at the lectures hour. |
| 4  | Phase 4 <br>(Lectures 11-12) | In this phase students offer they products, and then they collecting the public respond of the product. Public respond data then analyzed along with calculation of costs production, marketing strategy and benefits of the product, and then presented the results in front of the classroom. |
3. Result and discussion

3.1. Recapitulation of n-gain scores average on each aspect of creative thinking skill

Based on data analysis of creative thinking skills test result which collected through pretest and posttest activities, we get normalized gain value (n-gain) and significance value. All these values and their categories and decisions can be seen in Table 2.

| Test   | Xideal | Xmin | Xmax | \( \bar{X} \)  | Normalized average gain score category <g> | Category | Sig.  | Decision |
|--------|--------|------|------|-------------|------------------------------------------|----------|-------|----------|
| Pretest| 100    | 23   | 62   | 43,57       | 0.363                                    | Medium   | 0.000 | Significant |
| Posttest| 100 | 41   | 89   | 64.40       |                                          |          |       |           |

Based on Table 2, it can be said that biotechneur program has been able to improve the creative thinking skill significantly with increasing value in the medium category. Furthermore, the increases in n-gain score from each aspect of creative thinking skill have the result as follows.

![Figure 1](image1.png)

**Figure 1.** Recapitulation of normalized gain scores on each aspect of creative thinking skills.

Based on the picture above, the n-gain of each aspect is on medium category. Fluency (flu) aspects has the highest value, and relatively much different than other indicators, but still in the medium category. While the other four aspects of flexibility (fle), originality (ori), elaboration (ela) and sensitivity (sen) have relatively the same value of each other with the medium category.

3.2. Discussion of Students creative thinking skill through biotechneur programs

The biotechneur program has been done, and as a result is the creative thinking skills were all well developed for all categories. These results suggest that biotechneur programs can improved the creative thinking skills of preservices students.

Studies have shown that to improve creative thinking skill can be trained through four learning phases, namely the process of problem discovery, idea creation, implementation and evaluation [5], or through three phases: concept formation, creativity, production and socialization [6]. In addition, other studies have shown that to train creative thinking skill, the learning process should emphasize how students can produce the products [4].

The biotechneur program can improve creative thinking skills because it is built by synergizing between four creative processes according to Howard with three phases of creative entrepreneurial thinking according to Crispeels. The phases is concept-forming phase (in which there is also the discovery of the problem), the creativity phase (ideas and idea evaluation), the production phase and the...
socialization phase (implementation ideas), and can to produce the biotechnology product as its learning outcome.

Phase 1 is concept formation. In the biotechneur program, building knowledge or cognitive structure is the first and most important thing that must be given to the students. According to Beetlestone [16] knowledge is the one of most important thing to support the creativity. The formation of this new knowledge structure can be seen from the quiet high increase in the value of fluency indicators, where the students are asked to answer the question "what biotechnological products can be created from local resources?" as much as they can, and the increased value of flexibility indicators, where students have been able to categorize between biotechnology and non-biotechnology. In addition, students are given the task to identifying biological local resources through field survey method to build sensitivity, because sensitivity is necessary in order to identifying local problems or opportunities. An important part of entrepreneurship is a survey, to analyze what market needs in order to produce the products or services that are needed and marketable [17].

In this program, after the students / learners having knowledge, then they are invited to apply the concept into a creative idea, so the second phase of the program is the creativity phase. In this phase, the student applying cognitive scheme that has been formed into an idea and design of biotechnology products made from local resources. In this phase it is primarily to train the aspect of originality where students are able to create their own ideas. Once students have an idea, then discussed, "incubated" in the subconscious where the shortcomings, which innovation to be developed, and how to really apply. Discussing ideas is a form of brainstorming that can train creative problem solving [18]. Idea a re then evaluated to improve the quality of ideas through the addition of new knowledge or combine with existing knowledge.

The third phase of the program is to create biotechnology products, where they realize the idea that has been owned into a product. First, make the product design and detailing, this designing activity can improve the student elaboration aspect. Then they making the product based on the design results within a limited time (1 month). According to Guilford [19] creative people will be able to create something in a very limited time. The activities in phases 1, 2 and 3 above are similar to Nicholl [20] theory that the steps that people do to be creative are: gathering as much information as possible, thinking in all directions, generating ideas, finding the best combination of ideas, deciding which is the best combination and taking action.

The last or fourth phase in this program is socialization, where they are selling the product that has been created while analyzed the market view of their products, mainly to know the prospective user's view whether the product is feasible or not? Useful or not? How much is suitable price for this product etc. Campbell [20] says that Creativity is a new, novel, useful and understandable activity. The third and fourth phases are designed as part of a series of entrepreneurial processes, because just having knowledge in science is not enough if you want to be an entrepreneur, because entrepreneurship must be accompanied by real action [2]. As for the example of product and the socialization activity can be seen in figure 2.

Figure 2. The example of product: Vape = Varian Tempe (left); and the socialization activity (Right).
Another finding of this study is besides the program can to improve all the indicators of creative thinking skill. The program also looks able to train students' analytical thinking skills, this can be seen from the idea evaluation worksheet in phase 2, where on the worksheet 80% items have been analyzed correctly. Creative thinking is related to each other with analytical thinking because a creative person can use his analytical skills to evaluate and ensure that his idea is applicable [21]. Generally, the phase 1 can be seen as the most successful phases to improving the creative thinking skill aspect, because the fluency aspects have the highest score and almost all the ideas that are selected become the product are built from the knowledge which formed from this phase. The resulting product is generally in the food and healthcare category making it relatively easy to socialize and relatively quickly sold. In the socialization phase, many respondents who feel enthusiastic about the product and say that there has been no such product before.

This research has generally revealed that biotechnology programs can be combined with entrepreneurship, the program is in the form learning activities that designed with creative processes. Besides can to improve student creative thinking skills, in other hand many biotechnology products can be made from local resources and the product have a high economic value.

In the future research on science field that combined with entrepreneurship will be a new learning model if conducted more comprehensive research. Furthermore, assistance and support to product development becomes the next challenge for researcher to continuation of this program in the next time.

4. Conclusion
Based on the results of the data analysis can be concluded that biotechnology program can influence towards preservices creative thinking skill. All aspects of preservices creative thinking that include fluency, flexibility, originality, elaboration and sensitivity have been well developed. This research has revealed that biotechnology programs can be combined with entrepreneurship, through a learning that designed with the creative process can produce an outcome not just an enhanced creative thinking skill but also produce biotechnology products that made from local resources and have high economic value.

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