Refining student’s creative thinking through problem oriented project-based learning and student team achievement division

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Abstract. One of the biggest calls for educators to take part in the 21st century learning is to make sure students equipped with creative thinking. To empower these skills, a variety of effective learning models can be implemented. The current study aimed to develop a learning model that has the potential to improve student creative thinking by integrating Problem-Oriented Project-Based Learning (POBPL) and Student Team Achievement Division (STAD), hence called POPBLSTAD. Plop design was used as the procedures for developing this product. It consisted of preliminary investigation, design, realization/construction, test, evaluation, and revision. The model was examined through a quasi-experiment. The participants’ creative thinking was evaluated based on five indicators: fluency, originality, elaboration, flexibility, and metaphorical thinking, using an essay test. The POPBLSTAD learning model was confirmed valid with a score of 3.47. The results of the ANACOVA analysis showed that the implementation of POPBLSTAD improved student creative thinking significantly. This finding suggests that POPBLSTAD can be used as an alternative learning model that is effective to refine student creative thinking.

1. Introduction
Designing an innovative learning model for biology instruction is crucial in preparing creative, critical, and competitive future generation who are capable of solving problems and making decisions in the 21st century. Creative thinking is one of the skills that need to be mastered by the students [1]. Among the other important skills, creative thinking plays the most dominant role in learning; thus, the development of student creative thinking is vital [2].

Creative thinking refers to the ability to uncover the truth, explore issues, discover ideas, and find the solution to the problems [3]. Creative thinking is a mental process that involves cognitive processing [4] or a cognitive activity performed by an individual in problem-solving [5]. Creative thinking is used to understand an object, formulate and test a hypothesis, and communicate the result [6]. Creative thinking is aimed at exploring student various ideas and stimulating student curiosity [7]. The indicators of creative thinking cover fluency, flexibility, originality, elaboration, and metaphorical thinking [8].

Research in Indonesia has highlighted issues in student creative thinking empowerment [9]. Some studies also reported student poor creative thinking skills [10], and poor mastery of creative thinking...
aspects (36.18%) [11]. These have originated from learning that provides no opportunity for the students to freely express their ideas [12]. Learning which is rarely focused on students is a primary factor leading to student low creative thinking [13].

One of the solutions to these issues is to implement an appropriate learning model in the classroom. Problem-Oriented Project-Based Learning (POPBL) is one of the examples of the learning models that have potentials to refine student poor creative thinking. POPBL is a collaborative learning model that incorporates problem-solving into project-based learning [14]. POPBL is part of problem-based learning (PBL) [15]. The major principles of POPBL include problem oriented, project-based, multidisciplinary approached, student-centered, and collaborative [16] [17]. POPBL has a primary benefit as a learning model that can support sustainable [18] and contextual education [19] as well as enhance student creative thinking [20]. However, in the real classroom setting, POPBL tasks only incorporate small parts of curriculum core and the characteristics of the materials are likely to be definite and fixed. The POPBL tasks are professionally realistic and big [21]. Another noticeable weakness of POPBL is the absence of the teacher’s material delivery in the beginning of the lesson. Instead of presenting the materials, the teacher directly assigns students to groups. The learning process of POPBL is entirely conducted by the teacher; thus, there is a chance that the teacher-centered learning activities exist in the classroom [14].

To complement POPBL shortcomings, Student Team Achievement Division (STAD) is introduced. STAD model is one of the simplest and most practical cooperative learning that is commonly used by the teacher at schools [22]. STAD emphasizes on establishing student interaction so that the students can motivate and help each other in accomplishing their goals [23]. STAD consists of five stages, including classroom presentation, group work, quiz, assessment, and rewarding [24]. STAD can be considered appropriate for biology instruction because biology contains a large number of concepts that require discussion and teamwork to understand [25]. STAD needs to be integrated into project-based learning in order that students can perform effective problem-solving. Research also showed that STAD can empower student creative thinking [26]. In this study, Problem-Oriented Project-Based Learning (POPBL) and Students Team Achievement Division (STAD) were combined to investigate the formula of how both learning models can complement each other. In addition, the effect of the POPBLSTAD model on student creative thinking skills was also examined.

2. Methods

2.1. Research design and method

This study employed the Research and Development (R&D) design [27] modified by Corebima [28]. It was carried out in four stages. The first stage was preliminary investigation which aimed to identify problems in biology instruction and other empirical facts found in the targeted schools as well as to analyze theories relevant to the development of the model to improve student creative thinking. At this stage, questionnaires were distributed. The second stage (design) aimed to design learning activities, learning environment, reaction principles, and systems to support the instruction and accompaniment impacts. At the third (Realization/Construction) stage, the prototype of the learning model was constructed. The fourth stage was to test, evaluation, and revision the prototype. Expert validation was performed at this stage by doctors and professors in biology education who have competences in learning model development. The expert validation was followed by revising the prototype to obtain a valid product.

Implementation stage was omitted from this study, so self-evaluation through small group trial was not conducted. Instead, the implementation stage was modified into a quasy experiment; therefore, it did not constitute a part of the R&D study. The quasi-experimental design used a pretest-posttest non-equivalent control group design. The experiment involved 129 tenth graders from four different public senior high schools in Sumbawa, Indonesia. Prior to sample determination, a placement test was conducted to analyze the students’ initial ability. The experimental, control positive 1, control positive 2, and control classes were taught using different models, namely POPBLSTAD, POPBL, STAD, and conventional, respectively. The instrument used in this study was
a creative thinking test with essay questions on Plantae, Animalia, ecosystem, and environmental changes. The test items had to undergo the validity and reliability tests. The Pearson Product Moment analysis showed that all of the test questions were valid (at a significance level of 0.00) and the Cronbach’s Alpha analysis indicated that all of the items were reliable (0.90). The results of the prerequisite analysis showed that the data were distributed normally (0.200) and homogeneously (0.989). The students’ test answers were evaluated using a creative thinking rubric [8] developed based on the following aspects of creative thinking: fluency, flexibility, originality, elaboration, and metaphorical thinking. The normality test was performed using Kolmogorov Smirnov and the homogeneity of the data was examined using Levene homogeneity test. ANCOVA statistics was run to investigate the effect of the learning model on student creative thinking. The control variables consisted of learning materials, teacher, time allocation, and instruments for data collection.

2.2. Research Subject and Location
The development of the POPBLSTAD learning model and learning tools was carried out at Universitas Negeri Malang, while the implementation of the learning model was conducted in senior high schools in Sumbawa, Indonesia.

3. Result and Discussion
3.1. The result of the learning model development
3.1.1. Preliminary investigation phase. The result of the preliminary investigation using a questionnaire suggested that the classrooms were mostly dominated by teacher lectures, instead of student-centered activities. In addition, the learning processes had not employed constructivism approaches which therefore led to the students’ unpreparedness to study. This finding was considered as the supporting theory to integrate the POPBL and STAD learning models to refine student creative thinking.

3.1.2. Design Phase. The design of the integrated POPBLSTAD was based on the results of the preliminary investigation. The syntax of the model was designed by incorporating the POPBL and STAD learning activities. At this stage, syllabus, lesson plans, student worksheets, and assessment worksheets were also developed.

3.1.3. Realization/Construction Phase. The realization/construction phase produced the prototype of the learning model which had been designed at the previous stage.

3.1.4. Test, Evaluation and Revision Phase. The result of the expert validation conducted in this phase confirmed that the learning model syntax and the learning tools were highly valid. The average score of the POPBLSTAD model and learning tools was 3.47. The result of the model validation is summarized in Table 1.

| Table 1. The Result of the Expert Validation |
|--------------------------------------------|
| Aspects to Evaluate | Score | Category |
| Learning Model | 3.43 | Highly Valid |
| Syllabus | 3.50 | Highly Valid |
| Lesson Plans | 3.47 | Highly Valid |
| Student Worksheets | 3.46 | Highly Valid |
| Average Score | 3.47 | Highly Valid |
3.2. The result of the quasi experiment

**Table 2. ANCOVA Analysis on the Effect of the Learning Model on Creative Thinking Skills**

| Source          | Type III Sum of Squares | Degrees of Freedom | Mean Square | F Ratio | Sig. |
|-----------------|-------------------------|--------------------|-------------|---------|------|
| Corrected Score | 10740.146 (a)           | 4                  | 2685.036    | 37.119  | 0.000|
| Intercept       | 11652.699               | 1                  | 11652.699   | 161.093 | 0.000|
| XB Creative     | 287.772                 | 1                  | 287.772     | 3.978   | 0.048|
| Models          | 9977.584                | 3                  | 3325.861    | 45.979  | 0.000|
| Error           | 8969.544                | 124                | 72.335      |         |      |
| Total           | 45590.1563              | 129                |             |         |      |
| Corrected Total | 19709.690              | 128                |             |         |      |

R Squared = 0.545 (Adjusted R Squared = 0.530). Table 2 shows that the learning model had an effect on student creative thinking skills (F calculated 45.979 and p-value = 0.000, with p <α (α = 0.05).

**Table 3. The Result of the LSD Test on Student Creative Thinking Skills**

| No | Models   | XCreative | YCreative | Difference | BKrCor | LSD Notation |
|----|----------|-----------|-----------|------------|--------|--------------|
| 1  | POPBLSTAD| 30.3542   | 70.2083   | 39.8541    | 70.067 | a            |
| 2  | POPBL    | 30.1562   | 59.1797   | 29.0235    | 59.09  | b            |
| 3  | STAD     | 30.0417   | 55.7083   | 25.6666    | 55.648 | b            |
| 4  | Conventional | 28.5887 | 45.4435   | 16.8548    | 45.759 | c            |

Table 3 shows that the POPBLSTAD learning model obtained a significantly higher score compared to the other learning models. There was no significant difference in the LSD notation between the POPBL and STAD classes. The lowest score on creative thinking was found in the conventional class. This finding suggests that POPBLSTAD has the potential to refine student creative thinking. As reported by [11], [29], [30], student creative thinking can be improved through the integration of different learning.

The difference in the student’ creative thinking scores tested in this study has corroborated that POPBLSTAD possesses a higher level of interference and is more effective in refining student creative thinking skills. The integration of the POPBL and STAD learning activities is the primary reason why the students were able to achieve high creative thinking scores. The first stage of the POPBLSTAD model is classroom presentation. At this stage, the teacher describes the learning objectives to the students. This activity aims to provide students with initial understanding of the materials so that the students’ creative thinking can be promoted. Classroom presentation is done to accomplish the goals of the analysis, synthesis, and evaluation processes [25]. Student creative thinking can be enhanced through analytical thinking, ideas association, and problem evaluation [31]. Students will be able to think creatively if the learning atmosphere can provide an opportunity for them to develop creative ideas [32].

The second stage of the POPBLSTAD model is problem orientation. At this stage, the teacher presents a phenomenon through discourse and asks students questions related to the problem. The questions are aimed to stimulate student creative thinking skills. Inquisition is crucial in learning [33]. Asking questions in the beginning of the lesson can train student creative thinking and invigorate students to interact with one another [25]. Bruner’s theory underlying this stage suggests that in order to create effective learning, the teacher must provide a platform where s/he can initiate an interaction with the students by, for example, making an inquiry.

The third stage where the students are required to work in groups is based on the cognitive apprenticeship concept. The students work and interact with their peers in groups to determine
problems to be solved and organize a schedule before conducting data collection and data analysis, as the initial step of their project work that is going to be conducted outside the classroom hours (Stage 4). The group activities can support student academic achievement by enhancing their creative thinking [25].

Problem-solving constitutes the fifth stage of the POPBLSTAD model. At this stage, the teacher assists the students in solving the problems based on their hypothetical findings. Problem-solving is an essential learning activity to improve student creative thinking skills [5]. Students will be able to develop their creative thinking if the learning process is able to accommodate student creative ideas [34], and intelligent ability, especially in biology [35].

The evaluation and reflection stage allows the teacher to facilitate the students’ report presentation which is based on their group temporary findings. At this stage, the teacher also assists the students in doing a reflection on the investigation process they have carried out. In addition, to evaluate the students’ goal achievement, a test or a quiz is conducted. The final stage of this model is to give reward to the student individuals or groups who are able to attain the highest score. Through this activity, the students may be able to learn that all learning experiences they gained through the process can provide them guidance to act better in the future [36].

4. Conclusion
The integration of Problem-Oriented Project-Based Learning and Students Team Achievement Division, or POPBLSTAD was developed in this study. The learning model, the learning tools, and the instrument used in this study were confirmed valid. The findings of the quasi experiment showed that students who learned using the POPBLSTAD model achieved higher in creative thinking compared to those who learned using conventional, POPBL, or STAD learning model. In conclusion, the implementation of POPBLSTAD as an effective model to refine student creative thinking in biology instruction is very advisable.

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