O EFEITO DA APRENDIZAGEM COLABORATIVA BASEADA EM PROJETOS NO DOMÍNIO DO CONCEITO DE COGUMELO: O CASO DE ESTUDANTES DE ENSINO MÉDIO NA INDONÉSIA**THE EFFECT OF PROJECT-BASED COLLABORATIVE LEARNING ON CONCEPT MASTERY OF MUSHROOM: THE CASE OF SENIOR HIGH SCHOOL STUDENTS IN INDONESIA**

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RESUMO

É altamente recomendável que o aprendizado de biologia seja apresentado contextualmente após experimentação e observação dos fenômenos diários. Este estudo, uma pesquisa quase-experimental utilizando um projeto de grupo de controle não equivalente pré-teste e pós-teste, objetivou entender o efeito do aprendizado colaborativo baseado em projetos no domínio do conceito de cogumelos. Os sujeitos do estudo foram 75 alunos da décima série do ensino médio na cidade de Surakarta, Indonésia, divididos em duas turmas: 38 alunos da turma experimental 37 da turma de controle. Na aula experimental, os alunos foram tratados com estratégias de aprendizagem colaborativa baseadas em projetos. Na estratégia de aprendizagem colaborativa baseada em projetos, os alunos foram desafiados a criar um projeto de cultivo de cogumelos ostra (*Pleurotus ostreatus*) com os resíduos de hortas como serragem, por exemplo. Na aula controle, os alunos foram tratados com instrução direta. O instrumento utilizado foi um teste e ensaio de múltipla escolha desenvolvido por pesquisadores para medir o domínio conceitual dos estudantes em relação aos cogumelos. Os dados da pesquisa foram analisados pelo teste t de amostra independente. Os resultados mostraram que o escore médio *n-gain* para as classes experimental e controle foi de 63,09% e 45,73%, respectivamente. Além disso, todos os indicadores de domínio do conceito de cogumelo mostraram os escores *n-gain* para a classe experimental maiores que a classe controle. A análise do teste t de amostra independente provou que existiram diferenças significativas entre a instrução direta e a aprendizagem colaborativa baseada em projetos para melhorar o conceito de domínio do cogumelo. Finalmente, esta pesquisa concluiu que a aprendizagem colaborativa baseada em projetos é mais eficaz para enriquecer o domínio do conceito do que a instrução direta.

Palavras-chave: *Aprendizagem Colaborativa Baseada em Projetos; Domínio de Conceito; Cogumelo; Biologia*

ABSTRACT

Biology learning is highly recommended to be presented contextually following daily experience and phenomena. This study, a quasi-experimental research using a pretest-posttest non-equivalent control group design, aimed to understand the effect of project-based collaborative learning towards the concept mastery of mushrooms. The subjects of the study were 75 tenth grade of high school students in Surakarta City, Indonesia, divided into two classes: 38 students in the experimental class 37 in the control class. In the experimental class, the students were treated with project-based collaborative learning strategies. In project-based collaborative learning strategy, students were challenged to create a project on oyster mushroom cultivation (*Pleurotus ostreatus*) With the media garden waste such as sawdust. In the control class, the students were treated with direct instruction. The instrument used was a multiple-choice test and essay developed by researchers to measure students' concept mastery towards mushrooms. Research data were analyzed by independent sample t-test. The results found that the average *n-gain* score for the

experimental and the control classes were 63.09% and 45.73%, respectively. Moreover, all indicators of mushroom concept mastery showed the n-gain scores for the experimental class higher than the control class. Analysis of independent sample t-test proved that the significant differences existed between direct instruction and project-based collaborative learning in improving the concept mastery of mushroom. Finally, This research concluded that project-based collaborative learning is more effective in enriching the concept mastery than direct instruction.

Keywords: *Collaborative Project-Based Learning; Concept Mastery; Mushroom; Biology*

1. INTRODUCTION:

Teaching and learning science focuses on joyful, meaningful, and contextual learning (Muammer, 2012; King & Henderson, 2018; Chin & Osborne, 2008). It means that science concepts, including biology, need to be associated with everyday problems or real-life phenomena (Ertikanto *et al.*, 2017). Contextual learning facilitates an opportunity for students to interpret events, conducting experiments and investigations in understanding the concepts (Suryawati & Osman, 2018; Yildiz & Baltaci, 2016; O'Sullivan, 2006; Klassen, 2006; Glynn & Winter, 2004). To introduce meaningful and contextual learning, project-based learning and collaborative learning are recommended to improve students' understanding of the concepts of science correctly including biology (Lee *et al.*, 2014; Donnelly & Fitzmaurice, 2012; Rogers *et al.*, 2011).

Project-based collaborative learning (PBCL) is learning to integrate project-based learning with cooperative learning strategies (Sankaranarayanan, 2019; Avouris *et al.*, 2010; Chan & Chen, 2010; Ellis & Hafner, 2017; Jeremić *et al.*, 2009). PBCL strategy was conducted with project-based learning phase with a form of teamwork through a collaborative approach. According to Jeremić *et al.* (2009) said that when teachers use project-based learning by way of individual work, students do not have the ability to Collaboration. It makes collaborative learning is also necessary for carrying out duties on project-based learning. Integrate project-based learning to collaborative learning produces positive results for students is one learning outcome students' understanding of concepts (Baser, Ozden, & Karaarslan, 2017). Many studies have shown how project-based collaborative learning activities can improve students' understanding of the idea (David, 2018; Baser, Ozden, & Karaarslan, 2017; Donnelly & Fitzmaurice, 2012). PBCL is the potential to create a learning environment that develops the knowledge and skills needed for the twenty-first century, and features of the learning environment plays a vital role in achieving this potential (Garba, Byabazaire, & Busthami, 2015).

Problem-based collaborative learning (PBCL) has advantages such as: involving learners to be active in education, improve cooperative skills, improve academic skills, develop higher-level thinking skills and build positive relationships between students and teachers (Jalinus & Nabawi, 2019). This learning strategies suitable to be applied in learning biology because the material requires skills in problem-solving and creative thinking skills that can be understood by the learner.

In studying the biology subject matter, especially mushroom, students often find it challenging to master the material. According to Çimer (2012), biological materials such as Mushroom have a lot to learn and too complicated. Also, several types of mushroom cannot be observed directly, and the content is a widely used term that is difficult to understand the students. Many students who have misconceptions on biological materials such as morphology and physiology of low-level plants such as mushroom (Karagoz & Cakir, 2011; Shinysheroova, 2018; Bulunuz, Jarrett, & Bulunuz, 2008), Another difficulty experienced by students in learning biology is to apply the knowledge gained in school to real life. When students learn a new knowledge in the classroom, they do not understand what is learned (Bahar, 2003; Çimer, 2012), They memorize the material that makes them bored (Chavan & Patankar, 2018). In mushroom material, students are required to master the competencies such as identifying characteristics of mushroom, explaining how mushroom obtain nutrients, disclose how the reproduction of fungus and explains the role of mushroom in life. Therefore, to achieve these competencies, the project needs to be done to cultivate mushrooms by implementing strategies collaborative project-based learning in biology.

2. MATERIALS AND METHODS:

2.1 Research design and sample

This research was a quasi-experimental study with a pre-test post-test non-equivalent

control group design. Research subjects were high school students in class X Surakarta, Indonesia. The number of students involved was 75, with 37 students in the control group and 38 students in the experimental group. All the participants have filled the agreement to participate in this research as research sample. The experimental group was treated with a Project-based collaborative learning strategy while the control group was treated with direct instruction.

At the research implementation stage, data collection activities were carried out by providing a pretest in the experimental class and the control class to measure students' initial abilities. In the experimental group (PBCL strategy group), students create a project in the form of oyster mushroom cultivation (*Pleurotus Ostreatus*) within four weeks. While in the control class (direct instruction), students do not make projects, but students work on assignments given by the teacher.

The procedure used a strategic research PBCL through five stages adapted by Baser *et al.* (2017) namely: (a) dividing the working groups and identify problems; (b) designing the project and create the project schedule; (c) carry out the project; (d) presenting the project in front of the class; (e) evaluate the project. Students were given a worksheet to guide students' projects.

During the first week, students created a small group of four people. Teachers provided stimulus-related projects. Teachers gave explanations about the plans to be undertaken. Afterward, at the stage of identifying, students were asked to solve the problem of a nutrient-rich food source. They were given the challenge to the issue: "What should be done by high school students to utilize the biological sciences in the field of food and industry?". The next stage, students designed a project and made project schedule activities.

In the second and third weeks, the students carried out the project. Students chose a type of mushroom, the planting medium, and material tools used in the project. All the activities carried out by a group discussion. At this stage, students created a planting medium with the material of sawdust, and oyster mushroom was selected. Furthermore, the students planted seedlings mushroom into sterilized media. All the project activities were recorded and monitored every day.

At the present stage of the project was done in the fourth week. Each group was required to present the results of the project to the class.

The other group provided feedback in the form of suggestions and criticism. Furthermore, teachers gave advice and evaluate the results of the student project. At the end of the meeting, teachers provided post-test evaluation form understanding of the concept to measure student success in learning.

The control group (direct instruction) had four stages according step (Baghcheghi, Koohestani, & Rezaei, 2011) namely (a) the teacher to the learning objectives, (b) teachers ask information to students about the material being studied, (c) the teacher check student understanding and provides feedback and (d) the teacher gives an evaluation. In this research, this learning activity was conducted for four weeks, and in the last week, teachers offered post-test students' understanding of the concept.

2.2 Data Collection Tools

The measurement scale of the data tool consisted of 35 items adjusted to achieve the research objectives. The items consisted of 30 multiple choice questions and five essay item questions originating from literature reviews related to biology subjects, especially mushroom material. Assessment This measurement instrument is used to measure the effectiveness of learning in the classroom. This instrument consisted of 35 items that measure six concepts explained in the literature, namely: identifying the characteristics of mushroom (6 items), describing body structure (5 items), describing how mushrooms obtain nutrients (7 items), explaining how to reproduce mushroom (7 items), interpreting mushroom classification (5 items), and describe the role of fungi in economics (5 items). Validity and reliability were investigated by biologists and learning technology experts.

2.3 Data Analysis

This research is a quantitative research with a descriptive approach. Biologists and educational technologist have analyzed validity and reliability. Analysis of the data used is the Independent Sample T-Test to see differences in the average value of concept understanding between the experimental class and the control class. Research data were analyzed using a statistical tool that is SPSS 24.0, with a statistical significance value of 0.05. Before the t-test was carried out, the homogeneity test stage was carried out with the Kolmogorov-Smirnov test and the data normality test stage used the Levene test.

3. RESULTS AND DISCUSSION:

The results of this study describes the oyster mushroom cultivation project undertaken PBCL students through learning and student learning outcomes after completing the learning.

3.1 The oyster mushroom cultivation project

According to Chitamba *et al.* (2012), there are several steps in the cultivation of oyster mushrooms; (a) renders the seeds; (b) renders a spot fungus; (c) the manufacture of mushroom growing media; (d) sterilization of the media park; (e) seed inoculation; (f) incubation; (g) harvesting. The prepared mushroom seed is F3. Mushroom growing media using necessary materials of sawdust mixed with limestone (CaCO_3), rice bran, TSP, mixed with water evenly. Once evenly mixed, media is inserted into the plastic (poly) measuring 25x30cm.

The next process was done with steamed Sterilization 95-100°C temperature for 12 hours. Sterilization was performed to avoid any contamination of other organisms that can affect the growth of mushroom. After that, seed inoculation process. Inoculation is a step to fill mushroom seed into the planting medium already cold. The next process is incubation. In this process, polybag arranged in the room with the sleeping position. The room temperature was set 0-26 C. During the incubation process, performed maintenance. Within one month of mycelium, already meet the polybag. If the mycelium already reaches polybag, a cotton cap can be opened. The last stage is harvesting. Harvesting should be done early morning by removing the entire body of the fungus, and then cleaned.

Oyster mushroom cultivation process takes approximately four weeks. Fungal seedling growth in the first week, day 5 (Figure 1a) looks hyphae began to emerge. Hyphae are tubular fungal structures formed from spore growth. Hyphae that appears can be seen clearly when viewed using a microscope. On week 2, on the 15th day (Figure 1b), mycelium was seen. Mycelium is a collection of hyphae. Mycelium can be seen with the eye without the aid of a microscope. At week 3, day 25 (Figure 1c) a fruit body was formed. The fruit body is a collection of hypha that arises from the planting media. Fruit bodies on white oyster mushrooms with a length of 3 cm. Day 29 (Figure 1d) fruitbody length of 5 cm and mushroom hood began to appear with a diameter of 1 cm. At week 4, day 32 (Figure 1e), it was seen that the fruit body began to elongate by

8 cm and the hood began to widen with a diameter of 4 cm. As for the characteristics of oyster mushrooms that can be observed are shaped like a hood/umbrella, growing in groups, and white, the fruitbody has a stem that grows sideways.

3.2 Assessment of Concept Mastery

Learning outcomes are abilities that have been achieved by students after the learning process has been completed. In this study, learning outcomes are the understanding of the concept of mushroom material in biology subjects obtained by students, both those taught using PBCL strategies and those shown with direct instruction. The concept mastery of students in experimental and control classes can be seen in Figure2.

From Figure 2, it can be observed that the n-gain of the experimental class is higher than the n-gain of the control class for all indicators of concept mastery of mushroom. In more detail, the n-gain scores of the innovative class and the control class for the identifying characteristics of function indicators are 81.14 and 75.18, describing the structure of the body are 78.67 and 72.41, the index explaining how to function nutrients is 78.44 and 70.28, signs explain how reproduction of mushroom are 79.57 and 67.63, indicators defining the classification of fungus are 80.57 and 69.67, and indicators describe the role of mushroom in economics 83.28 and 73.06, respectively.

Moreover, the data from the pretest and posttest were analyzed using the Kolmogorov-Smirnov for normality test and a Levene test for homogeneity analysis. The statistical result showed that the significance value for the normality test (p-value) of the control and experimental classes was 0.200 ($p > 0.05$). It means that the data resulting from concept mastery test were normally distributed. As for the homogeneity test of the Levene test, each in control and experimental classes was 0.268 and 0.207 ($p > 0.05$). It means that the research data in the control and experimental classes are homogeneous. Based on this prerequisite test, hypothesis testing can be done.

Hypothesis testing is done by using an independent sample t-test to determine the difference between before and after treatment in each control class and experimental class. Table 1 showed the posttest value of the experimental and control classes using the value in the first row is 0.000. Furthermore, the t-value of 4.614 is compared with the T_f table of 1.993 with $\alpha = 0.05$.

It can be concluded that there is a significant difference in understanding the concept of mushroom material between the experimental group taught with PBCL and the control group trained with direct instruction.

Therefore, we can conclude there are differences in the results understanding the concept of learners who learn to use project-based collaborative learning with direct instruction. Students are learning to use strategies. Collaborative Project-Based Learning has an understanding of the idea of higher than students learning with direct instruction. The results are consistent with previous research that the implementation of project-based learning strategies integrated with collaborative learning, improve student learning outcomes (Ellis & Hafner, 2017; Holmes & Hwang, 2016; Shadiev, Hwang, & Huang, 2015; Jamal, Essawi, & Tilchin, 2014; Donnelly & Fitzmaurice, 2012; Avery *et al.* 2010).

Project-based learning and collaborative learning have characteristics such as solving and exploring the projects faced, learning outcomes in the context of student life, and using teams (Abdulwahed *et al.*, 2015). In this learning scheme, students have many opportunities to generate and discuss ideas, make plans, exchange ideas, find solutions, create projects, satisfy curiosity, and develop creativity. This is different from direct instruction where students tend to learn individually and more passive in receiving information from a teacher or just student worksheets (Nayereh *et al.*, 2011).

PBCL is learning the design stage of the project. This stage involves an attempt by the students to apply the knowledge that students master concepts with or without the guidance of teachers (Baser *et al.*, 2017; Kai *et al.*, 2017), Activity oyster mushroom cultivation project work starts from identifying the problem, reviewing the literature, formulate a problem-solving or design products, collect materials, conduct experiments, and evaluation can encourage students' creativity and motivation that affect their competence in solving problems. Additionally, PBCL applied correctly can make students active in class, providing an opportunity for students to integrate theory that has been obtained, learn to solve a contextual, work collaboratively, to help students learn in a fun way, helping them gain the depth of the concept of a material and help them to use higher-order thinking (Lee, Huh, & Reigeluth, 2015),

PBCL strategy is suitable to be applied in

high school. This is because learning biology regarding how the discovery and apply the knowledge gained. Thus, biology is not just about the mastery of experience in the form of a collection of facts, concepts, or principles but also about the application process. Biology education is expected to be a tool for students to learn about themselves and their environment to implement them in their daily life (Peterson & Myer, 2011).

Project-based collaborative learning can bring the students active and feel a more intellectual challenge. This strategy encourages students to work together in groups, exchanging ideas to solve problems, increase self-confidence, as well as train students to appreciate the differences and the lack of other students, so the role of peers in the group will encourage the spirit of learning, as well as reducing the dominance of the individual. Based on these results, the researchers recommend the adoption of PBCL, especially for biology, to improve students' understanding of the concept.

4. CONCLUSIONS:

The oyster mushroom cultivation project with sawdust waste media has been successfully designed by students in the scheme of PBCL strategy. PBCL strategy showed a better improvement of the concept mastery of the biology students in the topics of mushroom compared with the direct instructions. The highest concept mastery score has been found on the indicator of the role of mushrooms in economics and identification of mushroom characteristics. Although the implementation of PBCL strategy required more time than direct instruction, it gave a better and positive impact on students learning. PBCL strategy made learning more fun, creative, effective, fostering mutual cooperation, and adaptive to the real-life situation.

The recommendation for further research is that PBCL can be applied to primary and junior high school students. Also, in implementing PBCL, it is also necessary to consider external (family, economic capability, and environment) and internal (motivation, talent, and independence) factors. Furthermore, future research needs to explore the implementation of PBCL to improve students' thinking as higher-order thinking and creativity.

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Figure 1. Oyster mushroom cultivation process. (a) Observation day 5, (b) day 15, (c) day 25, (d) day 29, (e) day 32

Figure 2. n-gain score of experimental (blue) and control (red) classes for each indicators

Table1. The result of independent samples T-test

	Levene's Test for Equality of Variances		T-test for Equality of Means		Sig. (2- tailed)	Mean Difference	SE Difference
	F	sig	T	df			
Equal variances assumed	1.622	.207	4.614	73	.000	8.05477	1.74554
Equal variances not assumed			4.629	69.909	.000	8.05477	1.73997

Note: F = Fisher test or Fisher distributions; Sig = significance; T = Tukey test or Tukey distributions; df = degree of freedom; SE = standard error