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ANALYSING STUDENTS' CRITICAL THINKING, COMMUNICATION, COLLABORATION, AND CREATIVITY SKILLS DURING ANIMAL PHYSIOLOGY COURSES

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Abstract

Animal Physiology with Project Based Learning (Pj-BL) was created to support 4Cs students' thinking skills (critical thinking, communication, collaborative and creativity). The study was aimed at qualitatively describing the 4Cs students' skills. At least 63 'odd' semester and 96 'even' semester Unnes biology students at during the 2018/2019 academic year was involved. Data was collected by observation, interviews, and questionnaires. Qualitative data analysis with triangulation and descriptive qualitative techniques was implemented. Finding showed 4Cs student skills were significantly indentified during (1) the material briefings, (2) developing project proposals, (3) conducting research, writting a written report, enriching material and (4) orally sharing the findings.

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INTRODUCTION

Animal Physiology with Pj-BL that has now been applied for more than 13 years in the Biology Department of Semarang State University is considered as the academics solutions for the limited cognitive knowledge, hard skills and soft skills and attitudes. This subject used to be presented by simple methods of teaching, lecturing and practicum without giving more opportunities to students to crictically think. However this alternative biologgy teaching never been analyzed in terms of students' 4cs. Animal Physiology is one of the compulsory Biology majors, taken in the odd semester (V) of the biology study program and even semester (IV) of the Biology Education study program. Animal Physiology has a course code of 15J00403 with 4 credits and the focus is on how the animal body works in maintaining homeostatic conditions (Department of Biology, 2016/2017).

The development of science and technology in the 21st century is increasingly sophisticated demanding that every individual has hard and soft skills tobe be accepted into the workforce and ready to compete with other individuals. (Lin *et al,* 2015).Project Based Learning (Pj-BL) is an innovative learning activity sufficient to teach many important strategies to support success in the 21st century (Bell, 2010 b). Pj-BL increases attractiveness and encourages innovative and explorative problem solving (Marasco & Behjat, 2013). Pj-BL is also able to improve the collaborative relationship between academic institutions and industry expectations is a significant process towards analytical thinking that connects the ability to understand theory with practical abilities (Chandrasekaran *et al*, 2013).

The analysis of student 4Cs student thinking skills needs to be done because the ability of 4Cs student thinking skills is very useful for students to get project work skills, creative concepts, and self-confidence to be creative (Zhou, 2012). Qualitative analysis is needed to study the processes experienced by students during learning (Frank *et al.,* 2003).How the students 'Cs skills be developed in Learning of Animal Physiology through project based? Which learning activities demonstrate the development of 4Cs student thinking skills. This case study aimed to describe quallitatively the emergence of 4Cs student thinking skills during Animal Phyiology courses grounded in Pj-BL All students portfolios were analysed the entend to which they were involved in critical thinking, communication, collaboration, and creativity activities.

METHODS

This descriptively qualitative study was conducted in the classroom of the Department of Biology (Building D1) and the Biology Laboratory (Building D11), Department of Biology, Faculty of Mathematics and Natural Sciences, Semarang State University. This research was conducted from August to November during odd semester and January-April in the pre-even semester and even semester of the academic year 2018/2019**,** 63 biology study program students from 2 study groups in the odd semester and will also be held on Biology Education study program students with 96 students from 3 study groups.

Table 1. Methods of teaching by Marianti *et al* (2013), as follows

Steps of Teaching
Introduction
• Teaching with well- prepared semester lesson plan (RPP)was implemented through discussion and practicum. Supported by learning CDs, textbooks and practical manuals.
• Project theme, provided for students for one semester, was carried out in groups of 4. The themes chosen were ones in accordance with the competencies that have been set. Examples of themes: the effect of different types of food on the composition of cow's urine, the effect of psychotropic substances on nerve and muscle work, the level of oxygen consumption in various types of animals

Steps of Teaching
• The briefing stage was held for 8 times face-to-face, to teach all Animal Physiology material (all materials are planned to be completed within 8 weeks). The material briefing ended with a midsemester exam. The material briefing period is also a period of developing project proposals according to the theme of each group.
Stage of project proposal development Students were given an opportunity to consult with lecturers (outside of lecture hours), and get direct guidance to develop research / observation proposals to be conducted. This could be done repeatedly, until approval. After approval, students were allowed to make observations.
Stage of Implementation of Project Research Investigation was carried out in the field or in the laboratory, according to the plan of each group. The results were prepared by following the thesis writing guidelines in the Biology department or at the FMIPA UNNES.
Stage of Project Result Presentation Each group collects research reports according to the stipulated time, in hard copy format, in 2 copies. Lecturers (2) studied the contents of written reports made by students, and each gave 3 written questions to students (take-home). Students presented the results of their research, and answer questions from lecturers using presentation slide media. Students explain the answers to these questions during the presentation. During the presentation, the two lecturers tested the student verbally, witnessed by all the participants of the lecture. The lecturer evaluates student competencies from aspects of performance, mastery of material, products (report quality and exposure material), and their attitudes, both individually and in groups. The instruments used were performance assessment sheets and product assessment sheets. The results of this exam were treated as equivalent to the final semester exam. Instruments used: observation sheet was used to record information about the implementation of the learning process; some instruments for recording learning activities by students such as Daily Journal of learning activities while compiling a 2nd instrument proposal, implementation of the 3rd instrument project, the 4th instrument project, Interview guide to explore information about learning activities carried out by students of the 5th instrument), Questionnaire to explore student responses about implementation Learning of Animal Physiology with Pj-BL and Environmental Approaches and the assessment process (6th instrument), and Implementation of the process of evaluating student learning outcomes, consisting of: Research report assessment sheet (7th instrument),PPT assessment sheet / material impression (8th instrument).Student performance assessment sheet when presenting the results of the project and answers to material deepening questions (9th instrument), Self-assessment sheet of student activities during observation or implementation of projects and preparation of reports (10th instrument).

Data Collection

The type of data taken was in the form of qualitative data (recorded voices, student performance recorded and some student porfolios) in the form of descriptions consisting of main data and supporting data. The main data was taken from the lecturers' responses, assistant responses, and exploration of project-based learning, laboratory facilities data, and student questionnaires using closed questionnaires. While supporting data in this study are laboratory responses.

Table 3 showed, based on real record some hard skills and soft skills could be developed, to support high level skills of 4Cs which consist of critical thinking, communication, collaborative and creativity. Oral communication occupies the first position, collaboration or teamwork occupies the second place, critical thinking occupies the fifth position and creativity ranks tenth. This showed that 4Cs are capabilities that must be mastered by the community in order to compete in the 21st century.

Table 2. Data and instrument types, methods and techniques of data analysis

Data	Data Types	Method	Instrument	Analysis Technique
a. The ability of 4Cs student thinking skills achieved by students	Nominal	Non-Test	Questionnaire Sheet	Triangulation
b. The response of students related to Learning of Animal Physiology with Pj-BL and Environmental Approaches	Nominal	Non-Test	Interview Sheet	Descriptive Analysis
c. The process of implementing Learning of Animal Physiology	Nominal	Non-Test	Observation sheet	Descriptive Analysis
Student activities during the preparation of proposals, conducting research / investigations and reporting on projects	Nominal	Non-Test	Daily Journal	Descriptive Analysis
Supporting Data	a. Final assessment results of Animal Physiology Projects	Non-Test	Observation sheet	Descriptive Analysis

RESULTS AND DISCUSSION

Table 3. Hard Skills and Soft Skills developed in the learning of Project-based Animal Physiology

No	Hard Skills	No	Soft Skills
1	Rounding (inserting food orally) in mice and mice 1	1	Working in group to look for scientific articles in journals relevant to learning resources
2	Dissecting experimental animals well (not about their blood vessels)	2	Collaboration in groups / teams to complete project tasks
3	Calculating the number of Erythrocytes and Leukocytes using countable chambers	3	Coordination with related parties / institutions to carry out research
4	Calculate Hb levels in mouse blood	4	Responsible for carrying out research and working on reports
5	Making blood smears of mice and mice to be observed for erythrocytes and leukocytes	5	Care for the team while working on project tasks
6	Making vaginal smears of female mice to determine the estrus period	6	Caring for experimental animals used for project work
7	Choose experimental animals with good quality		
8	Provide food and change the place to stay for experimental animals to reduce stress in experimental animals		
9	Hold experimental animals correctly (especially holding rats and mice)		
10	Give anesthesia to experimental animals (mice, mice, frogs)		
11	Take blood samples from experimental animals		
12	Use microscopes properly and correctly to help with project tasks		

1. Student Thinking Skills Student 4Cs in Pj-BL Learning of Animal Physiology through

Table 4. The results of the analysis of students' 4Cs student thinking skills abilities related to the types of activities carried out in Animal Physiology learning.

No	Activity Type	*Student Thinking Skills 4Cs*										
		Critical Thinking			*Communication*			*Collaborative*			*Creativity*	
		C (%)	T (%)	TJ (%)	J (%)	P (%)	TR (%)	J (%)	D (%)	TJ (%)	C (%)	T (%)
1.	**Proposal Compilation Activities**											
	a. Prepare a proposal	91	64	91	68	64	86	68	91	91	91	64
	b. Consultation	91	73	86	81	50	68	81	91	86	91	73
	c. Revised proposal	77	68	77	64	68	68	64	81	77	77	68
	Average each Component	**86.3**	**63.8**	**84.6**	**71**	**60.6**	**74**	**71**	**87.6**	**84.6**	**86.3**	**63.5**
	Average		**78.23**			**68.53**			**81.06**		**74.90**	
2.	**Observation and Investigation Activities**											
	a. Selection of research sites	73	64	77	54	59	73	54	73	77	73	64
	b. Licensing	54	59	77	77	54	59	77	73	77	54	59
	c. Observation	59	73	73	68	68	64	68	73	73	59	73
	d. Library search	77	54	68	68	54	68	68	68	68	77	54
	e. Determine the timing of activities	77	73	86	73	81	91	73	77	86	77	73
	f. Prepare tools and materials	77	86	91	77	77	73	77	81	91	77	86
	g. Collecting data	91	86	91	86	86	91	86	86	91	91	86
	h. Data analysis	91	81	86	91	81	73	91	77	86	91	81
	i. Consultation	9	9	9	9	9	9	9	9	9	9	9
	Average of each component	**67.5**	**65**	**73.1**	**67**	**63.2**	**66.7**	**67**	**68.5**	**73.1**	**67.5**	**65**
	Average		**68.53**			**65.63**			**69.53**		**66.25**	
3.	**Reporting Activities and Project Presentations**											
	a. Write down the report	91	77	91	91	77	73	91	91	91	91	77
	b. Print report	59	81	91	55	59	50	55	86	91	59	81
	c. Prepare material for the show	86	68	91	73	77	68	73	91	91	86	68
	d. Submit report	59	68	91	68	73	50	68	91	91	59	68
	e. Receive deepening questions	91	77	86	73	68	59	73	81	86	91	77
	f. Looking for references to answer deepening questions	91	91	91	86	68	54	86	86	91	91	91
	g. Answer deepening questions	91	77	91	86	68	64	86	77	91	91	77
	h. Write answers to questions in the form of words	86	68	86	73	73	68	73	81	86	86	68
	i. Write down the answers to questions in the form of PPT	73	68	77	55	68	73	55	73	77	73	68

No	Activity Type	*Student Thinking Skills 4Cs*										
		Critical Thinking			*Communication*			*Collaborative*			*Creativity*	
		C (%)	T (%)	TJ (%)	J (%)	P (%)	TR (%)	J (%)	D (%)	TJ (%)	C (%)	T (%)
	j. Project presentation	91	81	86	68	73	77	68	81	86	91	81
	k. Answering confirmation questions from lecturers verbally	86	73	86	77	73	68	77	68	86	86	73
	l. Receive feedback from the lecturer	77	68	77	68	68	81	68	73	77	77	68
	Average of each component	**81.7**	**74.7**	**87**	**72.7**	**70.4**	**65.4**	**72.7**	**81.5**	**87**	**81.7**	**74.7**
	Average	**81.13**			**69.50**			**80.40**			**78.20**	

Information:

C	: Smart	T	: Strong
D	: Discipline	TJ	: Responsibility
J	: Honest	TR	: Tolerance
P	: Care		

Table 2 showed that the ability of 4Cs student thinking skills used in Learning of Animal Physiology starting from the activity of compiling proposals, observing and investigating and reporting and presentation of projects. In the activity of compiling the proposal as well as observing and investigating the ability of 4Cs student thinking skills that is dominantly developed was collaborative, while the dominant ability in reporting activities and project result presentation s was critical thinking. Nonetheless, all 4Cs student thinking skills were developed well in the learning process of Animal Physiology.

2. Learning stages of Animal Physiology through Pj-BL promoting the ability of 4Cs student thinking skills.

Student learning activities in Learning of Animal Physiology through project based and environmental approaches proved to be able to grow and develop 4Cs student thinking skills. The ability of 4Cs student thinking skills is developed in 6 learning stages which include: 1) material briefing, 2) project proposal development, 3) research implementation, 4) project result reporting (in writing), 5) material enrichment, and 6) presentation of project result. From Table 3 below, it can be seen that the ability of 4Cs student thinking skills can develop at 6 learning stages, each with a good level (51-75) and very good (> 75).

Table 5. Learning stages of Animal Physiology through project based approaches which show the ability of 4Cs student thinking skills.

No	Learning Phase	Ability of Student Thinking Skills 4Cs Observed			
		Critical Thinking (%)	Communication (%)	Collaborative (%)	Creativity (%)
1	Debriefing of Materials	82.00	72.66	83.33	78.00
2	Development of project proposals	78.23	78.23	81.06	74.90
3	Research implementation	77.00	74.09	78.42	75.00
4	Reporting of project results (in writing)	68.00	60.33	70.72	63.00
5	Material Enrichment	81.00	70.04	78.61	80.00
6	Presentation of	81.00	72.55	76.00	79.00

project result

Table 5 showed the ability of 4Cs student thinking skills were identified in 6 stages of learning during lectures in Animal Physiology it is known that the stages of learning Animal Physiology. The demonstrated ability of 4Cs student thinking skills dominates in each of the different learning stages, for example in the stage of material briefing, project proposal development, implementation of research to reporting the results of the 4Cs student thinking skills ability that is the best collaborative. Material enrichment stage and report presentation 4Cs student thinking skills ability was the best.

DISCUSSION

As presented by data indicating the positive correlation between the implementation of Pj-BL and the improved learning achievement, this findings were still supported by some similar study on Pj-BL. Tammin (2013) already identity why Pj-BL is potential for improving students' learning achievements. This model of teaching provide more opportunities to more be self-directed. They become more motivated in their learning, and motivation is a new energy of doing more. Similar findings were also presented by Bas (2013), that students who were studying in Pj-BL were likely to be better rather than those studying in tradisional cources.Other researchers also reported thepositive effect of the useof Pj-BL on students learning.

Pj-BL was considered as an innovative teaching activities for supporting success in the 21st century (Sasson, 2018). Pj-BL attracts students to be involved in explorative problem solving (Marasco & Behjat, 2013). Pj-BL was also able to improve the collaborative relationship between academic institutions and industry, a significant process towards analytical thinking that connects the ability to understand theory with practical abilities (Chandrasekaran *et al*, 2013).The development of science and technology in the 21st century is increasingly sophisticated demanding that every individual has hard and soft skills tobe be accepted into the workforce and ready to compete with other individuals(Lin *et al,* 2015). Because of its pontentiality as a challenging teaching models, PJBL was also used in language study (Huzairin, 2018).

In realiy it is not alwasy easy to manage Pj-BL. It needs more times for preparation. First, because of a variety of definition of Pj-BL, many experts of science educattors asked themself whether it is Pj-BL or not. Did students really learn during this kind of leaning model? Second, university teachers need more time to select some topics to satisfy Pj-BL, not all topics in biology curriculum could be implemented by Pj-BL. Finally, collaboration among teaching staff, students and laboratory staff are another chalengging tasks.

A part of limitions, the findings showed that the implementation of Pj-BL could support students to be more active in their learning. Learning of Animal Physiology through project based approaches promoted the ability of 4Cs student thinking skills, critical thinking, communication, collaborative and creativity. It is suggested that Pj-BL can be one of the alternative solutions for improving the quality of the biology teaching. What ever the cost ant time, it is a time for biology educators to implement some more rich tasks for their students.

CONCLUSION

Learning of Animal Physiology through project based approaches promoted the ability of 4Cs student thinking skills, which consists of critical thinking, communication, collaborative and creativity. The ability of 4Cs student thinking skills shows a number of good and very good. Learning stages of Animal Physiology through project based shows that the ability of 4Cs student thinking skills can be seen from various activity. Those activity were the material briefing stage, developing project proposals, conducting research, reporting project results in writing), material enrichment, and presentation of project results.

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