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Mangrove Biodiversity of Bunaken National Park in Project-Based Learning to Improve Students' Competitive Skills during the COVID-19 Pandemic

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Abstract: Mangrove Biodiversity of Bunaken National Park in Project-Based Learning to Improve Students' Competitive Skills during the COVID 19 Pandemic. College graduates in the era of the industrial revolution 4.0 are required to have strong competitive abilities. Competitive skills can be measured from the science process skills possessed. **Objectives:** This study aims to obtain a competitive profile of students' skills through a project-based learning method on mangrove biodiversity in Bunaken National Park, North Sulawesi. **Methods:** The research subjects were students who took Sulawesi biodiversity courses in 2020/2021. Fourteen science process skills were measured using a rubric **Findings:** The results showed that students' mastery of science process skills was high in the Sulawesi biodiversity course. **Conclusion:** . The application of project-based learning to the problem of mangrove biodiversity in Bunaken National Park can induce students to develop problem-solving skills, collaboration, creativity, and literacy skills.

Keywords: biodiversity mangrove, competitive skills, project-based learning.

Abstrak: Keanekaragaman Hayati Mangrove Taman Nasional Bunaken pada Pembelajaran Berbasis Proyek untuk Meningkatkan Keterampilan Bersaing Siswa selama Pandemi COVID 19. *Lulusan perguruan tinggi di era revolusi industri 4.0 dituntut memiliki kemampuan bersaing yang kuat. Keterampilan bersaing dapat diukur dari keterampilan proses sains yang dimiliki.* ***Tujuan:*** *Penelitian ini bertujuan untuk memperoleh profil kompetitif keterampilan siswa melalui metode pembelajaran berbasis proyek pada keanekaragaman hayati mangrove di Taman Nasional Bunaken, Sulawesi Utara.* ***Metode:*** *Subjek penelitian adalah mahasiswa yang mengambil mata kuliah keanekaragaman hayati Sulawesi tahun 2020/2021. Sebanyak 14 keterampilan proses sains diukur dengan menggunakan rubrik* ***Temuan:*** *Hasil penelitian menunjukkan bahwa penguasaan keterampilan proses sains siswa pada mata kuliah keanekaragaman hayati Sulawesi tergolong tinggi.* ***Kesimpulan:*** *Penerapan pembelajaran berbasis proyek dengan masalah keanekaragaman hayati mangrove di Taman Nasional Bunaken mampu mendorong siswa untuk mengembangkan keterampilan pemecahan masalah, kolaborasi, kreativitas dan keterampilan literasi.*

Kata kunci: *keanekaragaman hayati mangrove, keterampilan kompetitif, pembelajaran berbasis proyek.*

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INTRODUCTION

North Sulawesi is the northernmost part of the island of Sulawesi in the Wallacea zone. The Wallacea zone has a very high level of endemic biodiversity (Mokosuli, 2013). Bunaken National Park has long been known as a center for marine biodiversity. Bunaken National Park represents tropical aquatic ecosystems located in the center of marine biodiversity in the Indo-Pacific (Anthoni et al., 2017). One part of the Bunaken National Park is the mangrove ecosystem area. Mangroves are unique communities because they grow and occupy coastal areas to tidal areas (Tabba et al., 2015; Sapsuha et al., 2018).

The mangrove forest area of Bunaken National Park is part of the Minahasa Regency, among others. The South Coast of Bunaken National Park stretches along the coast with 10 buffer villages which include Poopoh Village, Teling Village, Kumu Village, and Pisungkulan Village, Tombariri District in Minahasa Regency and Rap-Rap Village, Arakan Village, Sondaken Village, Pungkol Village, Wawontulap Village and Popareng Village in Tatapaan District in South Minahasa Regency (Yuningsih, et. al. 2014).

The mangrove forest is an ecosystem with high biodiversity because it is a habitat for various animals, including mollusks, worms, arthropods, echinoderms, reptiles, birds, and other animals. The diversity of plants, especially mangroves, is *Sonneratia alba, Rhizophora apiculata, Soneratia sp., Avicennia marina,* and *Bruguiera sp* (Tabba et al., 2015; Djmamaluddin, 2018). With the high diversity of species, the mangrove ecosystem is very appropriate to be the object of study to study biological and biodiversity phenomena.

The reorientation of the independent curriculum to learn separate campuses includes applying project-based and case-based learning methods (Hung, 2011; Brahma et al., 2020). The two learning methods are one of the leading performance indicators of higher education institutions. Learning with project-based and case-based methods is considered capable of reducing the competitive skills needed in industrial revolution 4.0. (Yustina, et.al., 2020; Amin dan Muliadi, 2021). Graduate learning outcomes are achieved through a learning process that prioritizes the development of creativity, capacity, personality, and student needs and develops independence in seeking and finding knowledge (Kusumawardani and KPT Dikti Team, 2021).

Project based learning is a model where to learn students learn by investigating complex questions, problems or challenges (Mutakinati et. al. 2018; Sumarni and Kadarwti, 2020). The Buck Institute for Education defines project-based learning as teaching systematic approach that involves students in learning knowledge and skills through a structured process of inquiry into complex, authentic, and product questions and carefully designed tasks (Markham, Larmer, & Ravitz, 2003). Furthermore, Krajcik and Blumenfeld, 2006) stated that learning project-based is also stated as one of the models that "deviates" from the method transmission of traditional learning and support knowledge construction, and potentially to improve the knowledge of the subject matter and students' thinking.

Project-based learning has the following eight important components.1. Authentic problems for students and their communities.2. Cross-curricular learning based on content standards. 3. Knowledge and skills that can be applied outside of school, also known as 21st century skills. 4. Inquiry-based learning. 5. Mentoring more experienced people. 6. Assessment through final product, exhibition, or portfolio (in addition to assessment "usually". 7. Student choice. 8. Ongoing reflection and revision (Chen et. al. 2019; Grossman et. al. 2019)

Project-based learning is innovative learning to practice many of the strategies essential to success in the 21st century. Students are

stimulated to learn through inquiry, work collaboratively to research and create projects that reflect knowledge they. Students are trained to use skills to utilize technology, to become communicators and problem solvers, and students benefit from learning the. Project-based learning provides opportunities for students to learn in-depth knowledge or content and 21st century skills. Learning practice project-based varies depending on grade level and field of study, projects must be carefully planned, managed and assessed to link academic content with 21st century skills (such as collaboration, communication & critical thinking) through the development of a high quality and authentic product and presentation (Wellen, 2018; Vijayalakshmi and Raikar, 2021; Ravits, Hixson, English, & Megendoller, 2012).

In the 21st century students need to have the skills to help them succeed in a competitive and technologically advanced world. Project-based learning help students by training them to think critically and solve problems,work well with others, and manage themselves effectively (Gabuardi, 2021). In addition to the job skills learned in the classroom through work projects, there are other learning opportunities for students to experience situations in the workplace outside class (Vogler et. al. 2018). Being in a culture of hard learning and continuous learning based on project, contribute to the development of many soft skills that will later be useful on the spot jobs that are likely to meet the needs of the 21st century job market (Succi and Canovi, 2020; Mufti, Latiff, & Amin, 2012).

Project-based learning allows students to practice 21st century skills as they work in groups and have the opportunity to collaborate with friends to achieve the final goal. Working in groups will empower students and increase their belief that they can succeed in learning, which in turn leads to a more positive attitude towards their learning (Tang et. al. 2020; Lord, 2001). Project-based learning is able to provide students experience related to various modern skills that help them become more success in the real world. Project-based learning not only provides understanding who are more in-depth about the content but also the important skills they can bring outside of the classroom (Sopa et.al. 2020; Wilson, 2021; Hawari et. al. 2020).

Based on the advantages of project based learning in learning in the era of the industrial revolution 4.0, in this study it is integrated with the potential of local biodiversity as the object of project development. The mangrove ecosystem is the object of the student project-based study in this study. Students analyze existing problems and develop them into a research project for one semester. This study aims to obtain a profile of student science skills by applying project-based learning in Sulawesi biodiversity courses.

METHODS

Participants

Participants in this study were fifth semester students, study programs for the Bachelor of Biology Education and Bachelor of Biology at the State University of Manado for the academic year 2020/2021. The total number of fifth semester students is 175 students.

Research Design and Procedures

This research applies the descriptive research method. The research stages consist of 1). planning, namely designing project-based learning syntax using the mangrove ecosystem, 2). The implementation of the research was a meeting of instrument socialization with the class that became the object of study, in this case, the 21 students who took Sulawesi biodiversity courses. 3). Implementation of Project-based learning. The implementation is carried out for one semester, where the final product is a project activity report selected by a student group.

Project reports are written in the form of written reports and videos. The research data were obtained through observation and rubrics for assessing students' science skills (Table 1).

Instruments

The instruments used in this study were the science process skills rubric and the student output project based learning assessment rubric.

Table 1. Science process skills

No	Science Process Skills	rubric score
1	Observation	4
2	Clasification	3
3	measure	3
4	Using the time/time relationship	3
5	Using numbers	3
6	Inference	3
7	Communication and collaboration	3
8	Prediction	3
9	Identification / variable control	6
10	Data interpretation	3
11	Formulating a hypothesis	5
12	Define operationally	3
13	Experiment	5
14	Science literation	4
	Total score	**51**

Final Value of Science Process Skills (VSP)

$$VSP = \frac{\text{Total student scores}}{\text{Total score}}$$

The classification of science process skills achievement was determined based on the science process skills assessment rubric (Table 2).

Table 2. Classification of measurement of science process skills (Arikunto, 2006)

No	Score	Category
1	86-100	Very good
2	76-85	Good
3	66-75	moderate
4	56-65	Not enough
5	≤ 55	Very less

Data Analysis.

Analysis of research data, namely the rubric of science process skills and the rubric of project based learning output data were analyzed descriptively.

■ RESULT AND DISCUSSIONS

Planning

In planning activities, the research team determines the courses used to apply project-based learning with the object of learning on mangrove biodiversity in Bunaken National Park. Project-Based learning is applied to Sulawesi biodiversity courses. This course is a research specialization course in the Biology Study Program, State University of Manado. The primary purpose of research interest courses is for students to develop research ideas into thesis research proposals based on the field of study of the subject. Besides that, research interest

courses aim to provide research experience for prospective undergraduate biology students. The Sulawesi Biodiversity course was chosen because the object of study for this course emphasizes the biodiversity of the Wallacea zone, where most of the Wallacea zone is on the island of Sulawesi. The Wallacea zone has specific characteristics, including having many endemic species (Mokosuli, 2013). The syntax for problem-based learning based on mangrove biodiversity in Bunaken National Park was developed (Table 3).

Table 3. Project-Based Learning syntax adapted to the theme of the Bunaken National Marine Park Mangrove Ecosystem

No	Syntax	Activity	
		Lecturer	**Students**
1	Starting with the essential questions	Stimulate students by providing exposure (pictures/videos) to the function and role of the mangrove ecosystem	Formulating problems, asking questions how is the role of mangroves in the continuity of biological functions in Bunaken National Park, asking questions about the use of mangroves for food, medicine, and other purposes
2	Design a project plan	Ask students to design projects about: the role and function of mangrove forests for tidal ecosystems, the potential of mangrove plants for the health and food sector	Students make project designs including title, background, problem identification, problem formulation, objectives, work methods and procedures, data and data analysis
3	Create a project schedule	Ask students to make a comprehensive schedule of project activities, complete with timetables and division of tasks in groups	Arrange schedules and division of tasks
4	Monitoring the achievement of project implementation	Monitor project activities	Carry out projects, make progress report instruments
5	Result assessment	Assess product performance on google drive	Presenting activity achievements
6	Project implementation evaluation	Provide project evaluation and appraisal	Fix deficiencies and improve the Project.

The Biodiversity course consists of 16 meetings, consisting 14 theory/practice meetings, one midterm exam meeting and 1-semester end exam. The midterm exam was conducted in a project progress report presented in this study. The final semester exam was a project-based learning final presentation according to the project topic per group of students.

The project outputs that are billed are project implementation reports in pdf files and project videos uploaded on the google form. Meanwhile, monitoring of project progress is carried out through the Zoom application every meeting week. The presentation of the progress report is done through the zoom application and the production of the final information.

Implementation of Project-Based Learning

An online lecture was given at the first meeting about Sulawesi's biodiversity. Students are also asked to participate in the google classroom created by the lecturer team to monitor project activities and supplement required materials based on the results of discussions at each meeting. At the second meeting, the project-based learning syntax was introduced to students. Students then form project groups by independently choosing the project theme offered by the researcher. Before determining the project title, students are asked to do journal literacy based on the selected theme and then determine the Project chosen title (table 4).

Table 4. Project-based learning activities for sulawesi biodiversity course

No	Meeting	Activity	Lecture Application
1	Meeting 1	Introduction to Sulawesi Biodiversity	Online lectures via the zoom app
2	Meeting 2	Introduction of Project-Based Learning Syntax based on mangrove biodiversity in Bunaken National Park. Formation of project groups.	Online lectures via the zoom app Supplementation via Google Classroom
3	Meeting 3	Independent literacy studies by each group according to the chosen theme and determining the title of Project-based learning based on mangrove biodiversity	Google Classroom What's App Zoom
4	Meeting 4-7	Project implementation by student groups	Google Classroom What's App
5	Meeting 8	Project progress report presentation	Zoom Google Classroom
7	Meeting 9-13	Advanced Project by a student group	Projects by student groups
8	Meeting 14	Preparation of the Final Project Report Consultation on report preparation by students / Guidance by the Lecturer/Researcher Team	Google Classroom What's App Zoom
9	Meeting 15	Submitting Project Final Report via Google Form	What's App Zoom
10	Meeting 16	Final project presentation	Zoom Google Classroom What's App

Evaluation of the Implementation of Problem Based Learning

The problem-based learning evaluation instrument uses a rubric for assessing the science skills achieved by students in the application of Project-based learning. The achievement scores for each parameter of science skills are classified as good for the 14 parameters of science skills (Table 5).

Based on the type of science process skills measured, the smallest percentage of students who got the maximum score was the ability to identify/control variables (15.79%). While the largest percentage of students who get the maximum score is the ability to use numbers (94.74%) (Table 6). This shows that students who take Sulawesi biodiversity courses and participate in problem-based learning based on Sulawesi

Table 5. Value of science process skills

No.	Students	Aspects of science process skills														Total score	Score
		1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1	M1	3	3	3	3	2	3	3	3	5	2	3	3	5	3	44	86.27
2	M2	3	3	2	3	3	2	3	3	4	2	3	3	4	3	41	80.39
3	M3	3	3	3	3	2	2	3	3	4	2	3	3	5	3	42	82.35
4	M4	4	3	3	3	3	3	3	3	4	2	3	2	5	3	44	86.27
5	M5	3	3	3	3	2	3	3	3	5	3	3	3	4	3	44	86.27
6	M6	3	3	3	3	3	3	2	3	5	2	2	3	5	4	44	86.27
7	M7	3	3	3	3	3	3	2	3	4	2	3	3	5	4	44	86.27
8	M8	4	3	3	3	3	3	2	2	4	2	3	2	5	4	43	84.31
9	M9	4	3	3	3	3	3	3	2	5	3	3	3	5	3	46	90.2
10	M10	4	2	3	3	3	3	3	3	5	3	3	3	5	3	46	90.2
11	M11	3	3	2	3	3	3	3	3	6	3	3	3	5	3	46	90.2
12	M12	2	3	3	2	3	3	3	2	4	2	3	2	4	3	39	76.47
13	M13	3	2	2	3	3	3	2	3	4	3	2	3	4	3	40	78.43
14	M14	3	2	2	3	3	3	2	3	5	3	2	3	4	3	41	80.39
15	M15	3	2	2	3	3	3	3	3	5	2	3	3	5	4	44	86.27
16	M16	4	2	2	3	3	3	3	2	6	3	3	3	4	4	45	88.24
17	M17	3	3	2	3	2	3	3	2	6	3	3	3	5	3	44	86.27
18	M18	3	3	2	3	3	2	3	3	4	2	3	3	4	3	41	80.39
19	M19	4	3	2	3	3	3	3	3	5	2	2	3	5	4	45	88.24
	Total	**62**	**52**	**48**	**56**	**53**	**54**	**52**	**52**	**90**	**46**	**53**	**54**	**88**	**63**	**823**	**1,613.73**
	Average	**3.26**	**2.74**	**2.53**	**2.95**	**2.79**	**2.84**	**2.74**	**2.74**	**4.74**	**2.42**	**2.79**	**2.84**	**4.63**	**3.32**	**43.32**	**84.93**
	STVDV	**0.56**	**0.45**	**0.51**	**0.23**	**0.42**	**0.37**	**0.45**	**0.45**	**0.73**	**0.51**	**0.42**	**0.37**	**0.5**	**0.48**	**2.0831**	**4.08445**

biodiversity have good abilities in terms of: Calculating results from rough data, Using number values in variables, and vice versa to generate meaning and to solve theoretical problems to improve academic ability by using pictures/ mathematics to show scientific meaning. However, based on the items in the rubric used, students still have low abilities in terms of Identifying independent variables, dependent variables, and control variables, identifying

variables that can affect experimental results, keeping most of them constant during manipulation except for independent variables and Identify the variables that might affect the dependent variable as stated in the problem. This study indicates that for students of the biology study program, it is necessary to strengthen courses that teach the ability to identify and control variables, including biostatistics, experimental design, and research methods.

Table 6. Recapitulation of students who achieved the maximum score of science skills

No	Science Process Skills	Rubric's maximum score	Number of students	Total of students	Persentation
1	Observation	4	6	19	31.58
2	Clasification	3	14	19	73.68
3	measure	3	10	19	52.63
4	Using the time/time relationship	3	11	19	57.89
5	Using numbers	3	18	19	94.74
6	Inference	3	16	19	84.21
7	Communication and collaboration	3	14	19	73.68
8	Prediction	3	14	19	73.68
9	Identification / variable control	6	3	19	15.79
10	Data interpretation	3	8	19	42.11
11	Formulating a hypothesis	5	6	19	31.58
12	Define operationally	3	16	19	84.21
13	Experiment	5	12	19	63.16
14	Science literation	4	6	19	31.58

In 2020, Indonesia will reorient the higher education curriculum to implement the MBKM short independent campus learning. This curriculum reorientation recommends two methods in higher education learning: the case method and the project method (Elihami and Melbourne, 2022). The main goal is to improve the soft skills of graduates who are adapting to the life skills of the 21st century (Hakim et al., 2022). In this study, the project method can induce students' science process skills by taking Sulawesi biodiversity courses. In the presentation of the project report, it was seen that the students' ability to use observation techniques, classify and use measurement instruments, use statistics, infer data was in the excellent category. Prabowo (2012), stated that project-based learning could improve students' understanding of statistical problems in case study lectures and seminars. Furthermore, Project-based learning using the mangrove biodiversity of Bunaken National Park as a research study taxi can improve communication skills, collaboration, hypothesis formulation, experimental design, and students' scientific literacy skills. The ability of these science skills, on average, is in the excellent category.

Previous research has proven that mangrove biodiversity is effective as an object of study for learning biology concepts. Mangrove biodiversity is an effective source of learning materials for high school students (Kartuti et al., 2021; Tanit et al.,

2021). Mangrove ecosystems can be a source of learning for students where students can learn actively by applying the principles of science (Purwanti and Prihanta, 2016; Soekirno et al., 2020). Because the mangrove ecosystem is vulnerable even though its ecological function is considerable, involving students or students learning about mangrove ecosystems can increase students' awareness of campaigns for biodiversity conservation (Majid et al., 2016; Suryaningsih, 2018).

Project-based learning can improve students' science process skills in studying natural phenomena (Wijanarko, 2017; Anggriani, 2019; Sumampouw et al., 2017; Wurarah and Mokosuli, 2019). Project-based learning can develop students' critical thinking and problem-solving skills (Chasanah, 2016). Science process skills in project-based learning can stimulate students to apply STEM in solving project problems (Suryaningsih and Nisa, 2021). Thus the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia program in implementing Merdeka Learn Campus Merdeka where the learning method using the case method and project method is very appropriate in improving the science skills needed in the era of the industrial revolution 4.0 (Vebrianto and Murniyati, 2021; Sonalitha et al., 2021; Kamil et al. 2020). Furthermore, implementing project-based learning on local biodiversity can stimulate students' entrepreneurial abilities to empower the potential of local natural resources (Roini, 2018).

However, it is necessary to conduct a future study of the application of project based learning with cross-semester student participation which has not been carried out in this study. Students participating in this research are fifth semester students who already have a sufficient scientific basis in the field of biology. It is also necessary to implement project-based learning based on local biodiversity for first-year and even final year students of the Biology and Biology Education undergraduate programs.

CONCLUSIONS

Project-based learning using the study object of mangrove biodiversity in Bunaken National Park can induce and improve students' science skills in Sulawesi biodiversity courses. Project-based learning can train students' research skills. Based on the potential of local characteristics, lecturers and teachers can apply Project-based learning. This learning process can teach students soft and hard skills according to the demands of the current era of disruption of the industrial revolution 4.0. This learning is also appropriate for the current covid 19 pandemic and even after the covid 19 pandemic.

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