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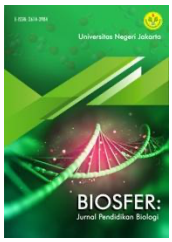

Learning seawater macroinvertebrates on Bama Beach, Indonesia, using the RCCDE model on students' cognitive abilities and collaboration skills

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ABSTRACT

Abstract, this research aims to reveal students' cognitive abilities and collaboration skills by studying marine macroinvertebrates at Bama Beach, Baluran National Park, using the RCCDE learning model. The type of research is quasi-experimental, one group design. The independent variable of this research is the RCCDE learning model, and the dependent variables are cognitive ability and collaboration skills. Cognitive ability is measured with a test after the learning activities, using 25 multiple-choice questions, each scoring 4 points for a correct answer and 0 points for an incorrect answer. Collaboration skills are measured using observation, employing an observation sheet adapted from Greenstein, 2012. The data from this research were analyzed using MANOVA with the help of SPSS v25. The results of the simultaneous influence analysis between the RCCDE model on cognitive abilities and collaborative skills obtained a significance value of 0.000 (>0.05), which means there is a simultaneous influence between the RCCDE model on cognitive abilities and collaborative skills. The results of the partial influence analysis between the RCCDE model on cognitive abilities and collaborative skills obtained a significance value of 0.000 (>0.05). Thus, there is a simultaneous influence between the RCCDE model on cognitive abilities and collaborative skills and a partial influence between the RCCDE model on cognitive abilities. There is a partial influence between the RCCDE model on collaborative skills. This research informs that there is a significant influence on the learning of marine macroinvertebrates at Bama Beach, Indonesia, using the RCCDE model on students' cognitive abilities and collaboration skills.

INTRODUCTION

Seawater macroinvertebrates are challenging to observe because of their habitat in seawater. One practical science-learning approach to studying animals whose habitat is in the water is empirical learning (Draganoudi et al., 2023) by directly observing specimens in their habitat (Hikamah, 2021, 2023). Marine macroinvertebrates live in coastal areas (Balisco et al., 2022), in the near-subtidal and intertidal zones (Suhendra et al., 2019), namely in seagrass beds (Muhammad et al., 2021; Ulaski et al., 2023). The distribution of macroinvertebrates is influenced by environmental conditions (Doong et al., 2021; Espinosa et al., 2019; Kurnianto et al., 2021), so the diversity of macroinvertebrates in a habitat is influenced by water quality (Hamid & Jehangir, 2021; Ilham et al., 2022). The results of research in Ono Lagoon, Southeastern of Côte d'Ivoire, show macroinvertebrate diversity is influenced by temperature, transparency, depth, conductivity, pH, dissolved oxygen, NH^{+4}, NO^{-3}, NO^{-2}, and PO_3^{-4} (Diarra et al., 2018). Macroinvertebrate animals are very selective about habitats because it benefits surviving eggs and larvae (Noorazhan & Azlan, 2021). Because the presence of macroinvertebrates in freshwater habitats is influenced by physical, chemical, and natural conditions, these animals are often used as bioindicators of water quality (Krisanti et al., 2020; Kurnianto et al., 2021).

In the Philippines, seawater macroinvertebrates in protected forest coastal areas are used for ecological studies, such as studying food chains (Bantayan et al., 2023). The majority of macroinvertebrates in the phylum Mollusca live in seagrass beds and mangroves (Andriati & Rizal, 2020; Rahmadina, 2019), as well as the phylum Echinodermata that live in coastal waters on various islands (Lalombombuida et al., 2019). One of Indonesia's beaches, a conservation area, is the Baluran National Park (TN), Indonesia. Therefore, this region has diverse marine life (Alfiah & Ratnawati, 2021; Ichtiarso, 2020; Marsyah & Ratyaningrum, 2019; Putra et al., 2022). The abundance of macroinvertebrates in their natural habitat can be used as a learning resource (Kundariati et al., 2020). The outdoors, namely the earth with everything in it, can be used as a teaching resource by integrating the natural environment into the educational approach (Orion, 2022). Learning by utilizing the natural environment can motivate students to participate actively in learning (Khoiruzzadi & Amalia, 2020). Nature as a learning medium can improve students' cognitive development. Because learning directly in nature can provide experiences and enjoyment while students study (Siregar et al., 2021). The surrounding environment and objects easily influence emotions, and in their response, they shape social-emotional interactions that can affect cognitive abilities and students' collaboration skills (Huang & Lajoie, 2023). Hands-on learning in nature supports the development of learning, warm, caring, and supportive student-faculty relationships; supports conceptual understanding, engagement, and motivation; and develops student metacognition (Darling-Hammond et al., 2020). Cognitive development and harmonious student-faculty and student-student relationships during learning in nature can lead to collaboration skills (Ellis et al., 2021).

Learning that is currently rife in the era of society, 5.0 is digital-based (Suherman et al., 2020), so today's students are more familiar with cell phones than collaborating with friends. This habit results in decreased collaboration skills, contrary to one of the 21st-century skills demands that students are required to master 4C skills, one of which is collaboration skills (Saputri & Aminatun, 2021; Winaryati et al., 2022). The ability to collaborate plays an important role in learning and solving problems in human life (Azzahra & Fathoni, 2023; Ilma et al., 2022b) and is effective in learning the science process (Astutik et al., 2017; Indriwati et al., 2019). Collaboration skills are closely related to students' cognitive abilities, as cognitive abilities can influence their self-confidence, which in turn affects their collaboration skills. Students with high cognitive abilities are more active in collaborating (Cahya et al., 2023); through collaboration, students can learn effectively in teams, negotiate successfully, and make decisions collectively (Lestari & Rachmawati, 2024). The gap is the difficulty in studying marine macroinvertebrates and students' low cognitive abilities and collaboration skills. The solution presented is learning through the Reading Concept Map Connection Discussion Evaluation (RCCDE) model (Hikamah & Hariyanto, 2022; Himmah et al., 2021; Laili et al., 2019; B. S. Lestari et al., 2021; Unay et al., 2019; Wulandari et al., 2021), where students can directly observe the material being studied, namely specimens in their habitat supported by previously studied references. The first RCCDE syntax is read. Reading texts is an activity to understand the material for students as learners (Allington & McGill-Franzen, 2021; Anjulo et al., 2017; Bai & Wang, 2020; Saori, 2022). The second syntax is a concept map; learning using mind mapping can explore students' thinking abilities (Utami et al., 2021), and a mild map can improve students' writing skills (Arifa et al., 2022). The third syntax is connection. The

fourth syntax is discussion. Discussions can improve students' speaking skills (Fikrina et al., 2021) and collaboration skills (Rahmat et al., 2022). Hence, discussions help increase student learning achievement (Sudarmika et al., 2020) and student learning outcomes (Patni et al., 2020). The fifth syntax is evaluation. Evaluation helps make decisions regarding learning activities that have been carried out (Febriana, 2019; Rahman & Nasryah, 2019; Soulisa et al., 2022).

METHODS

Research Design

This study aims to uncover students' collaboration skills in marine invertebrate learning using the RCCDE model. The type of research is quasi-experimental, with one one-group design. The independent variable of this research is the Reading Concept Map Connection Discussion Evaluation learning model (RCCDE) (Hikamah & Hariyanto, 2022), and the dependent variables are cognitive ability and collaboration skills. In the control group, conventional learning was conducted, and in the experimental group, learning was conducted using the RCCDE model. Cognitive ability was measured with a test after the learning activities, using 25 multiple-choice questions, where each correct answer scored 4 points, and each incorrect answer scored 0 points. Collaboration skills were measured using observation, with an observation sheet adapted from (Greenstein, 2012). The scope of the material in this research includes Phylum Porifera, Phylum Coelenterata, Phylum Mollusca, and Phylum Echinodermata. RCCDE learning is conducted twice face-to-face, namely 2 X 150 minutes, by creating a concept map, one field study, and one post-test. The design of this research is shown in Figure 1.

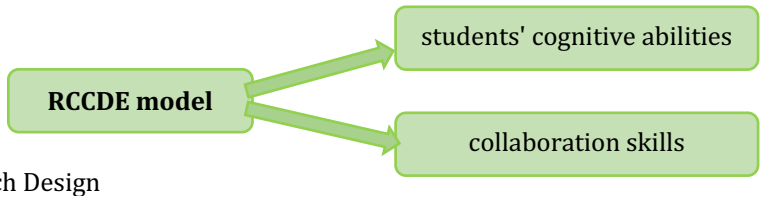

Figure 1. Research Design

Population and Samples

The population of this study was 158 Biology Education Study Program students at private universities in Jember, Indonesia. The sample of this study was 35 students taking an odd-semester invertebrate zoology course in the 2022/2023 Academic Year. The determination of this sample was based on the results of a needs analysis that students who took the invertebrate zoology course that semester had collaboration skills that were below expectations; this is because seawater invertebrates are material that is difficult to observe because of their habitat in seawater, so students study this material individually from online media. Learning by observing specimens directly in their habitat is optimizing cognitive abilities and fostering collaboration skills.

Instrument

The instrument in this study was an observation sheet adapted from (Greenstein, 2012). These collaboration skills involve four indicators: 1) work productively; 2) show respect; 3) compromise; 4) shared responsibility: all students contribute. Each aspect has a score of 1 to 4. The instrument is shown in Table 1-4.

Table 1
Collaborative Skills Instrument Aspects of Working Productively in Learning Seawater Invertebrates at Bama Beach, Baluran National Park, East Java, Indonesia

Aspect	Score	Criteria
Work productively	4	Example Group members use their time efficiently to stay focused on the task and produce the work needed. Each student performs assigned tasks and sometimes more.
	3	Expert Group members work well together, and most stick with the task until it is completed. Each student does almost all of his assignments.
	2	Basic Group members sometimes work together, but not all students contribute to doing the work; some students make it difficult to complete.

Aspect	Score	Criteria
	1	Beginner Group members need to work better together. Every student wants to do their own thing and tell others what to do instead of focusing on the assignment.

Table 2
Collaboration Skills Instrument Aspect Showing Respect in Learning Seawater Invertebrates at Bama Beach, Baluran National Park, East Java, Indonesia

Aspect	Score	Criteria
Show respect	4	Example Each member respectfully listens and discusses the ideas being shared.
	3	Expert Group members listen and interact respectfully most of the time.
	2	Basic Some group members needed help respecting other students' ideas.
	1	Beginner Group members want to avoid listening to other students and arguing with teammates.

Table 3
Compromise Aspect Collaborative Skills Instrument in Learning Seawater Invertebrates at Bama Beach, Baluran National Park, East Java, Indonesia

Aspect	Score	Criteria
Compromise	4	Example Each group member is flexible in working together to achieve a common goal.
	3	Expert Group members are usually able to compromise to advance their work.
	2	Basic Only a few group members can compromise.
	1	Beginner There is much disagreement, and some group members want it only in their own way.

Table 4
Collaboration Skills Instrument Aspect Shared responsibility: All Students Contribute to Marine Invertebrate Learning at Bama Beach, Baluran National Park, East Java, Indonesia

Aspect	Score	Criteria
Shared responsibility: All students contribute	4	Example Each group member performs the work of shared responsibility; all students contribute their best and follow up on assigned tasks.
	3	Expert Most of the group members do their tasks.
	2	Basic It takes work to get all group members to do their tasks.
	1	Beginner Group members really can only depend on some students to do their assignments.

Procedure

The research started with students reading references about marine macroinvertebrates and making concept maps of the material they had read. Learning was continued by conducting field studies at Pantai Bama, Baluran National Park, Situbondo, East Java, Indonesia. This field study was carried out during optimal low tide, to be precise, on November 26, 2022. The search for specimens was carried out at 04.30 to 08.00, photographed sessile specimens, while solitary specimens were taken and put in a bucket containing sea currents. In this specimen search activity, students make connections between the concept map that has been prepared and the specimens found in their natural habitat. The next activity is a group discussion discussing the specimens that have been found and based on the references that have been prepared beforehand. The lesson ends with conducting a joint evaluation, all students and lecturers in charge of the course, and returning the specimens to their habitat. The learning steps

with RCCDE are shown in Figure 2. This study involved eight observers, with five observers each observing four students and three observing five students.

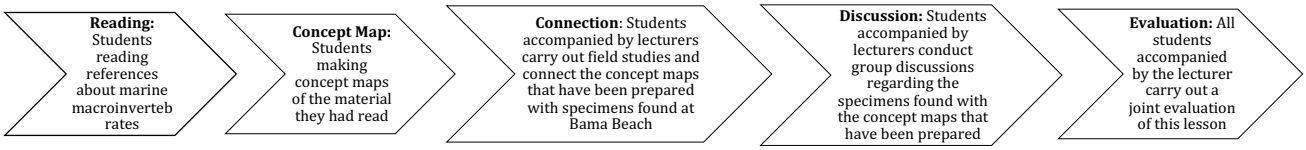

Figure 2. RCCDE Learning Steps on marine macroinvertebrates at Bama Beach, Indonesia

Data Analysis Techniques

The data from this research were analyzed using Multivariate Analysis of Variance (MANOVA) with the help of SPSS v25.

RESULTS AND DISCUSSION

Research Site Map

This lesson occurred at Bama Beach, Baluran National Park, East Java, Indonesia. Figure 3 below is a map of Bama Beach, National Park.

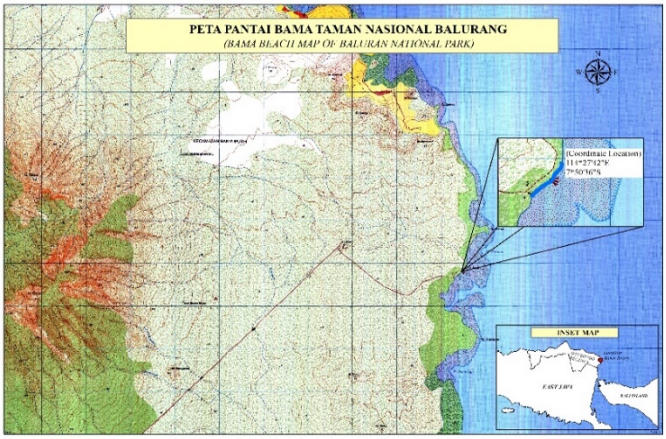

Figure 3. Map of Bama Beach, Baluran National Park, East Java, Indonesia

Homogeneity Test Results

The results of the homogeneity test using Levene are presented in Table 6.

Table 6
The Results of The Homogeneity Test

Box's Test of Equality of Covariance Matrices	
Box's M	3.699
F	1.194
df1	3
df2	832320.000
Sig.	.310

Based on the data in Table 6, a significance value of 0.310 was obtained, which is greater than 0.05. Therefore, it is concluded that the data from this study is homogeneous.

MANOVA Test Result

The results of the MANOVA analysis on the simultaneous effect of the RCCDE model on cognitive abilities and collaborative skills, focusing on Wilk's Lambda results, are displayed in Table 7.

Table 7 shows a significance value of 0.000, indicating less than 0.05. Thus, it is concluded that the RCCDE model simultaneously influences collaborative skills, cognitive abilities, and collaboration skills.

Table 7
Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.994	5647.513[b]	2.000	67.000	.000
	Wilks' Lambda	.006	5647.513[b]	2.000	67.000	.000
	Hotelling's Trace	168.582	5647.513[b]	2.000	67.000	.000
	Roy's Largest Root	168.582	5647.513[b]	2.000	67.000	.000
Group	Pillai's Trace	.805	138.369[b]	2.000	67.000	.000
	Wilks' Lambda	.195	138.369[b]	2.000	67.000	.000
	Hotelling's Trace	4.130	138.369[b]	2.000	67.000	.000
	Roy's Largest Root	4.130	138.369[b]	2.000	67.000	.000

a. Design: Intercept + Group
b. Exact statistic

The results of the MANOVA test on the partial effect of the RCCDE model on cognitive abilities and collaborative skills focusing on group outcomes are displayed in Table 8.

Table 8
Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Collaboration Skill	330.057[a]	1	330.057	268.101	.000
	Cognitive Ability	2378.057[b]	1	2378.057	40.566	.000
Intercept	Collaboration Skill	8382.229	1	8382.229	6808.773	.000
	Cognitive Ability	389859.657	1	389859.657	6650.416	.000
Group	Collaboration Skill	330.057	1	330.057	268.101	.000
	Cognitive Ability	2378.057	1	2378.057	40.566	.000
Error	Collaboration Skill	83.714	68	1.231		
	Cognitive Ability	3986.286	68	58.622		
Total	Collaboration Skill	8796.000	70			
	Cognitive Ability	396224.000	70			
Corrected Total	Collaboration Skill	413.771	69			
	Cognitive Ability	6364.343	69			

a. R Squared = .798 (Adjusted R Squared = .795)
b. R Squared = .374 (Adjusted R Squared = .364)

Based on Table 8, the significance values for cognitive ability and collaboration skills are 0.000, indicating less than 0.05. Thus, there is a partial effect of the RCCDE model on cognitive ability and a partial effect of the RCCDE model on collaboration skills.

Cognitive ability is the brain's skill in performing tasks, ranging from simple tasks to complex ones. Cognitive ability has various domains, including reasoning, memory, numerical ability, verbal ability, and problem-solving skills (Ezema et al., 2022; Saddiqa & Malik, 2024). This cognitive ability is related to the brain's capacity to receive and process information obtained from the senses (Otero et al., 2022). Learning with RCCDE invites students to study marine macroinvertebrates in their natural habitat directly, and then, students connect with the concept map they have previously created. They study animals that belong to the Phylum Porifera, such as *Euspongia* sp., Phylum Coelenterata such as *Fungia* sp., *Acropora* sp., Phylum Mollusca such as *Conus* sp., *Strombus* sp., Phylum Echinodermata such as *Linckia* sp., *Holothuria* sp., and other species they find during field studies. Therefore, through RCCDE learning, students fill their memory and reasoning and practice problem-solving, honing their cognitive abilities. In addition to cognitive abilities, learning with RCCDE also affects collaboration skills. This is because cognitive abilities influence collaboration skills (Cahya et al., 2023; I. D. Lestari & Rachmawati, 2024; Siregar et al., 2021).

Students in the 21st Century need collaboration skills to fulfill the expected learning outcomes (Azzahra & Fathoni, 2023; Ilma et al., 2022b; Kurniawati et al., 2019; Saputri & Aminatun, 2021; Winaryati et al., 2022). In addition, these skills are also very much needed when students enter society (Hairida et al., 2021; Hidayati, 2019). Working collaboratively can raise enthusiasm, complement each other's deficiencies, and give each other positive energy (Sidgi, 2022). Learning using this RCCDE model in each syntax involves students collaborating, starting from reading in groups, then making a concept map of the material that has been read, and then making connections through field studies. During the field study, they directly observed macroinvertebrate specimens in their natural habitat; this observation was carried out at optimal low tide so that animals could be observed easily. Observations

included habitat, life patterns including sessile, colonized, or solitary, morphological characteristics, and behavior. At the discussion stage, they discuss the results of the field observations with the concept map they have written. The lesson ends with an evaluation of the series of lessons they have carried out. Through learning with the RCCDE model with field studies at Bama Beach, Baluran National Park, East Java, Indonesia, student collaboration skills exceeded expectations. Previous research informs that hands-on learning can provide practice and develop students' collaboration skills (Hasan et al., 2023). Therefore, collaboration skills can support students' academic and career success (Cheruvelil et al., 2020; Saputri & Aminatun, 2021). Collaborative skills include working productively, showing respect, compromise, and shared responsibility; everyone contributes.

Working productively (Work productively) is one of the roles of education in developing human resources and encouraging broader productivity and value growth. The values in question include providing the basis for preparing for success in the labor market, contributing to welfare, and contributing to civic values (Anonymous, 2022a). Positive motivation and the environment support the success of working productively (Jusman & Rohani, 2021; Kurniawan & Rimas, 2021). This aligns with previous research that implementing learning strategies can directly increase productive learning (Fatkhurrokhman et al., 2018). Problem-solving and productive working skills are considered important for student's future in the workplace. Before accepting an employee, policymakers and practitioners need to know how well a person can demonstrate collaborative working skills (Fiore et al., 2017). Therefore, these skills need to be trained so that students are skilled in doing so in the future.

Showing respect is a skill related to forming good sentences, expressing opinions, and choosing the right words for rebuttals in academic discussion forums (Ilma et al., 2022b) and professional conversations (Anonymous, 2022b). This skill can occur when two or more people work together to achieve a goal (Saputri & Aminatun, 2021). During this collaborative process, they should be able to respect the opinions of their friends, not scoff at opinions that are less relevant to the topic of discussion but be able to direct to the appropriate topic with a strong reference base, using polite, reasonable and correct language, to provide positive energy in learning. This research informs that students' respect for friends' opinions is in the satisfying category and has the lowest score compared to the other categories. This is related to Generation Z children who are active in cyberspace and prioritize their egos. Therefore, they must learn to understand and show respect for others (Fridayani et al., 2023).

A compromise is an agreement between various parties in a discussion (Saputri & Aminatun, 2021). Studying in groups can be used to compromise; this is necessary to increase collaboration to achieve the expected goals together (Khasanah et al., 2023; Saputri & Aminatun, 2021). Students use compromise as an appropriate way to resolve conflicts because it is one of the safest solutions to maintain good relationships between friends, the easiest way to do it, and the fastest way to get results. Collaboration should require students to brainstorm, solve problems constructively, and deliberate to reach a mutual agreement. During this collaboration, differences that arise are compromised based on observations in the field and references to up-to-date research results to obtain mutually beneficial decisions to resolve conflicts and make decisions. Learning macroinvertebrates by observing specimens in their natural habitat requires compromise from students to achieve learning goals together. This aligns with previous research that direct learning can increase compromise between learners (Ilma et al., 2022b).

Shared responsibility: Everyone contributes (Shared responsibility; everyone contributes), and students carry out roles and tasks to contribute to learning. They contribute energy and thought to each other, establish good relationships between group members, help group members who experience difficulties, and learn cooperatively to obtain the expected results (Azzahra & Fathoni, 2023). Collaborative learning is essential because by collaborating, they can carry out problem-solving tasks that are too complicated to be done independently so that by collaborating, they can get better solutions when solved together in a team. Teamwork is more important in organizations than work done individually to get efficient and effective results (Assbeihat, 2016; Fiore et al., 2017). Each student's diversity of information, expertise, and experience can be realized (Fiore et al., 2017). Previous research shows that if all group members contribute, good collaboration will occur; this provides a learning experience that empowers students' collaboration skills (Ilma et al., 2022a). This aligns with research results that collaboration activities are realized through integrating design and process (Davidsen et al., 2020).

CONCLUSION

Learning about marine macroinvertebrates using the RCCDE model affects students' cognitive abilities and collaboration skills. This is because this learning model has a syntax that can facilitate students in understanding the material through reading and creating concept maps followed by field studies so that students can directly study macroinvertebrate animals from the Phylum Porifera such as *Euspongia* sp., Phylum *Coelenterata* such as *Fungia* sp., Acropora sp., Phylum Mollusca such as *Conus* sp., *Strombus* sp., Phylum Echinodermata such as *Linckia* sp., *Holothuria* sp., and other species. Furthermore, the learning of marine macroinvertebrates on Bama Beach, Indonesia, using the RCCDE model also influences collaboration skills. This is because, during the learning process, students compromise and work productively. Learning about macroinvertebrates directly in their natural habitat, students make compromises during specimen collection, observation, discussion, and the return of specimens to their habitat. In addition, in this learning process, students work together, help, and support one another. Learning in the open air, in a new field, can foster collaboration to achieve the desired results. In this study, the lowest aspect of collaborative skills is showing respect, indicating that efforts need to be made to motivate students to have respect for others. Therefore, they must learn to understand and show respect to others to achieve maximum collaborative skills. Recommendation: Research should be conducted using the RCCDE model with field studies on materials other than macroinvertebrates and other locations.

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