RESEARCH ARTICLE

Improving the creative thinking and collaborative skills of prospective biology teachers using the EMKONTAN learning model in environmental science courses

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Abstract: The implementation of the Environmental Science learning process so far has shown a lack of encouragement to improve students' 4C skills. The EMKONTAN learning model is one of the models that is believed to improve students' creativity, collaboration skills, and environmental literacy. This study aims to analyze the effectiveness of the EMKONTAN learning model in improving critical thinking and collaborative skills for prospective biology teacher students. EMKONTAN is a student-centered learning model (students' active learning), oriented to creative learning, problem-based learning, collaborative learning, and provides opportunities for students to improve environmental learning. This research was conducted in the event semester of the 2020/2021 academic year at IKIP Budi Utomo Malang and FTTE Universitas Muhammadiyah Malang-Indonesia, involving 150 second-semester students through total sampling. Data was obtained through observation, questionnaires, and tests. The research used a pretest-posttest non-equivalent control group design. Data collection in this study was carried out using Google Forms, Google Classroom, Google Meet, and WhatsApp. Data analysis using statistical product and service solutions (SPSS) version 23 software. The analysis of covariance (ANCOVA) analysis results showed that EMKONTAN, PBL affected students' creativity and collaboration skills in biology teacher candidate students with a value of $p<0.005$. The least significant difference (LSD) result was significantly different in improving students' creativities thinking, and collaboration skills. The EMKONTAN class gained the highest post-test score. Therefore, EMKONTAN could be applicable to improve students' creative thinking and collaborative skills outcomes in environmental learning.

Keywords: collaboration; creativity; EMKONTAN; prospective biology teachers

Introduction

One of the important targets of the Sustainable Development Goals (SDGs) is the quality of education, which particularly needs to be addressed in Indonesia and requires sustainable development.

Indonesia needs to improve the quality of education to become a developed country and create a glorious "Golden Indonesia" according to the ideals of the Indonesian nation (Chhajer, 2022; Unilever, 2017). Indeed, progress in various sectors such as agriculture, fisheries, resources, technology, economy, culture, defence, etc begins with the advancement of the quality of education (Nambiar et al., 2019; Nyhus, 2016; OECD & ADB, 2015).

During the 21st century, there has been a fundamental change in the level of philosophy, direction, and purpose in education (Kim et al., 2019; Malik, 2018). Indeed, knowledge is the main basis for all aspects of life, influencing education, science, technology, and employment (Kereluik et al., 2013; van Laar et al., 2020), so efforts are required to fulfill the need for knowledge-based education, economic development, social empowerment and development and knowledge-based industry development (Chauhan, 2020; Hudson, 2011; Rohimah, 2021).

The quality of higher education as part of the education system in Indonesia is required to produce human resources (HR) to face challenges in the global era (Adam & Negara, 2015; Amalia, 2012). Universities must prepare students competent in knowledge and skills, attitudes and work spirit, communication skills, interpersonal, leadership, and teamwork known as Experimental 5Cs: critical thinking, communication, collaboration, creativity, and compassion (Al-Kaabi, 2016; De Prada et al., 2022).

Creative thinking involves finding ways of thinking to overcome existing problems in unusual or new ways (Birgili, 2015; Gafour & Gafour, 2020), creating something new, producing many imaginative skills, or making something that already exists into something new. Creative thinking is also the ability to generate original ideas or answers and to understand new and unexpected relationships or unrelated factors (Duff et al., 2013). Hence, creative thinking is very important for a person's success in carrying out life activities because they are one of the determining factors of a nation's excellence (Wijayati et al., 2019).

Students' creative thinking is dominated by the medium and low categories because, to date, lecturers have not made much effort to explore students' understanding of creative thinking skills (Valli et al., 2014). Creative thinking still receives less attention in the learning process at various levels of education (Kairuddin et al., 2020) but in recent years, educational institutions' interest in creative thinking has increased because it is considered important in the world of education (Mullet et al., 2016). Therefore, lecturers as agents of change are expected to develop creative thinking skills (Valli et al., 2014).

Besides creative thinking, solving environmental problems will be successful if it involves various parties by conducting solid collaboration (Ardoin et al., 2020; Avoyan, 2022). Therefore, collaborative skills are needed for policymakers and all components of society to prevent and overcome environmental problems (Collins et al., 2019; Green & Johnson, 2015). Collaborative problem-solving is one of the 21st-century skills or 4Cs essential for successful learning and increased productivity in real work environments (Chiruguru, 2020; Erdoğan, 2019; Partnership for 21st Century Skills, 2015). Collaboration as a partnership/relationship in problem-solving is key to achieving a very effective learning process (Armstrong, 2015; Bryson, 2016; Schmitz & Winskel, 2008). Probe-solving collaboration is one type of social interaction in a specific learning process whereby each group member can be active and constructive in solving all existing problems (Gauvain, 2018; Soller, 2001). The collaboration includes effective communication skills, mutual respect, trust, giving and receiving feedback, decision-making, and conflict management (Grover, 2005; Little, 2007; Sibiya, 2018). One study of biology students at the Islamic University of Riau stated that students' collaborative skills generally showed a sufficient level, which meant they were not able to collaborate well (Hidayati, 2019). Solving environmental problems not only requires the ability to think creatively and collaboration skills but needs the support of individual and community environmental literacy, especially students as potential leaders (Coyle, 2005; McBride et al., 2013).

Environmental science courses are multidisciplinary subjects that are closely related to everyday life (Nugraheni, 2014). Some environmentally unfriendly behaviors in the community are closely related to the understanding and concepts of environmental science, for example, cleanliness ranging from the household environment, schools, markets, and public facilities due to littering. The increase in electronic waste due to the massive use of mobile phones and computers contributes to environmental problems. For example, cleanliness starts in the household environment, schools, markets, and public facilities due to littering (Ferronato & Torretta, 2019; Needhidasan et al., 2014).

The implementation of the environmental science course so far has shown a lack of encouragement to improve students' creative thinking, and collaboration skills. Preliminary research conducted at seven universities in Java and Sumatra of fourteen lecturers and fifty students supported this indication (Nurwidodo et al., 2019). The students tend to memorize concepts because of the application of lecturer-centred learning and the absence of learning models that encourage student creativity both in providing opportunities and creating environmental science products that are beneficial to life (Farwati et al., 2017). In addition, the absence of exploration activities for environmental problems in the field and the opportunity to solve them causes students to lack mastery of environmental problems and

minimally contribute is to solving environmental problems (Torkar, 2014).
Several learning models have been applied to separately develop aspects of creative thinking and collaboration skills of candidate teachers. The OIDDE learning model (Husamah et al., 2018), project-based blended learning (Sumarni et al., 2021), RANDAI learning model (Arsih et al., 2023), and 'Moving the Kaleidoscope' model (Ayyildiz & Yilmaz, 2021) have been applied to develop aspects of creative thinking. Of the four models, only the OIDDE learning model has been used for candidate biology teachers. candidate, namely t (Husamah et al., 2018). Remap Jigsaw learning (Indriwati et al., 2019), ASICC model learning (Santoso et al., 2021), inquiry and project-based learning (Hairida et al., 2021), and Predict-Observe-Explain-based Project (POEP) learning (Ilma et al., 2022a) have been applied to develop aspects of collaboration skills. However, it is still rare that learning models oriented towards the development of creative thinking and collaboration skills, especially in environmental science courses, are implemented for biology teacher candidates. Therefore, we developed the EMKONTAN learning model to involve students in observing environmental problems, identifying, and analyzing environmental problems, preparing action plans and possible integration into natural resource conservation, implementing actions to solve environmental problems, monitoring and evaluation, and follow-up plans. This learning model is used in Environmental Science courses to improve students' creative thinking and collaboration skills, providing opportunities for students to participate in learning through appropriate steps in solving environmental problems that can provide unity of creative thinking skills, collaborative skills, and environmental literacy. The model syntax includes socialisation and environmental observation, identification and analysis of environmental problems, action planning and integration into natural resource conservation, actions to solve environmental problems and integrate into natural resource conservation, monitoring and evaluation, and follow-up plans. The syntax is structured considering the characteristics of creative thinking and collaborative skills (Nurwidodo, Hadi, et al., 2021; Nurwidodo, Romdaniyah, et al., 2021). If the syntax of the EMKONTAN model is applied properly, the opportunities for creative thinking and collaborative skills of students will increase. According to Nurwidodo et al (2023), the EMKONTAN learning model has a positive effect on students' environmental literacy and could be applied to improve environmental literacy outcomes. The EMKONTAN learning model must be implemented to improve various student abilities, in this case, creative thinking and collaborative skills.
It is hypothesised that the EMKONTAN learning model in Environmental Science courses will improve creative, collaborative thinking skills and environmental literacy contributing to better and sustainable environmental problem-solving. Therefore, the study objectives are as follows: (a) to analyse the differences in the creative thinking of students taught by the EMKONTAN learning model, problem-based learning, and conventional learning, and (b) to analyse differences in collaborative skills of students taught by learning EMKONTAN, problem-based learning, and conventional. The study results are expected to contribute alternative learning models that can be used by teachers and lecturers to develop their prospective teachers' creative thinking and collaborative skills.

Method

This research was conducted at IKIP Budi Utomo-Malang and Universitas Muhammadiyah Malang and involved a saturated sample of 50 second-semester students. Hypothesis testing was conducted on student learning outcomes in the form of description test scores on creative thinking and collaborative skills. Meanwhile, environmental literacy scores on the aspects of knowledge and cognitive skills were obtained through multiple-choice tests and the normality of the residual data was assessed using Kolmogorov Smirnov (alpha = 5%) and the data homogeneity using the Levene Test (alpha = 5%). The hypothesis was tested using ANACOVA with the test criteria stating that if the probability level of significance (alpha = 5%) then H0 is rejected. The study design was a non-equivalent pre/post-test control group design, with tests conducted at the beginning (pretest) and the end (posttest) of learning in the control and experimental groups (Table 1).

Table 1. Research design

Group	Pretest	Treatment	Posttest
EMKONTAN learning model (Experiment)	O1	X1	O2
Positive control (Problem-based learning/PBL)	O3	X2	O4
Negative control (conventional learning model)	O5	X3	O6

Where O1, O3, and O5= pretest score; O2, O4, and O6= post-test score; X1= EMKONTAN learning model; X2= PBL model; and X3= conventional learning model.
The independent variables were the EMKONTAN learning model, the PBL, and conventional (direct) learning models. The dependent variable was creative thinking and collaborative skills. The creative thinking was assessed in the form of an essay test sheet developed based on a rubric adapted from Treffinger et al. (2002) regarding the following indicators: originality, fluency, flexibility, and elaboration.

The collaborative skills instrument is based on the formulation by Greenstein (2012) which states that collaboration skills consist of working productively, showing respect, compromise, and responsibility.
The data collected were the test score data obtained through pre-test and post-tests. Before collecting post-test data, learning was carried out as a class experimental activity using the EMKONTAN learning model, the positive control class with the PBL learning model, and the negative control class with the conventional learning model. Each meeting was observed to assess the dependent variable.
The data were analyzed using descriptive statistics to determine the validity and implementation of EMKONTAN and the effectiveness of the EMKONTAN model in improving students' creative thinking and collaborative skills were analysed using inferential statistics. Hypothesis testing was performed using one-way ANCOVA.

Results and Discussion

The effectiveness of the EMKONTAN model on students' creative thinking

The results of the variance of the effectiveness of the EMKONTAN, PBL, and conventional learning models on student creativity are shown in Table 2.

Table 2. The average percentage of students' creativity pretest and posttest

No	Creativity Aspect	Category			
		Advanced (%)	Proficient (%)	Basic (%)	Beginner (5)
		Pre-test			
1	Curiosity	20.00	20.00	26.70	33.00
2	Fluency	10.00	33.33	50.00	6.67
3	Originality	13.00	16.70	43.30	26.70
4	Elaboration	16.70	13.30	26.70	43.30
5	Flexibility	13.30	16.67	30.00	40.00
6	Divergent	3.33	30.00	30.00	36.67
		Post-test			
1	Curiosity	56.70	30.00	10.00	3.30
2	Fluency	20.00	46.67	30.00	6.67
3	Originality	23.00	23.30	33.30	20.00
4	Elaboration	63.30	13.30	10.00	13.30
5	Flexibility	40.00	23.33	23.30	13.33
6	Divergent	6.67	33.33	30.00	30.00

The results show that the average percentage of student creativity in the field trials increased after being taught via the EMKONTAN learning model, with more students being advanced in all aspects of creativity in the post-test compared to the pre-test.
The ANCOVA of creativity results is provided in Table 3 showing that there are differences in learning model variance [F count = 146.83 with p-value = 0.00. P-value < (α = 0.05)], indicating that the learning model affects student creativity.

Table 3. ANCOVA results of creativity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	36435.09a	4	9108.77	122.69	0.00
Intercept	10747.61	1	10747.61	144.77	0.00
X creativity	33.04	1	33.04	0.44	0.50
Class	32701.78	3	10900.59	146.83	0.00
Error	10318.90	139	74.23		
Total	169254.00	144			
Corrected Total	46754.00	143			

a. R Squared = 0.779 (Adjusted R Squared = 0.773)

The creativity LSD test results are presented in Table 4 showing that the learning models are significantly different with the EMKONTAN model having the highest post-test mean value. The detailed scores for each aspect are presented in Figure 1 showing that the EMKONTAN-taught class has the highest creativity scores.

Table 4. Creativity LSD test results

Class	Mean	LSD	Notation
Conventional	10.81	14.18	A
PBL	31.39	34.75	B
EMKONTAN	53.66	57.02	C

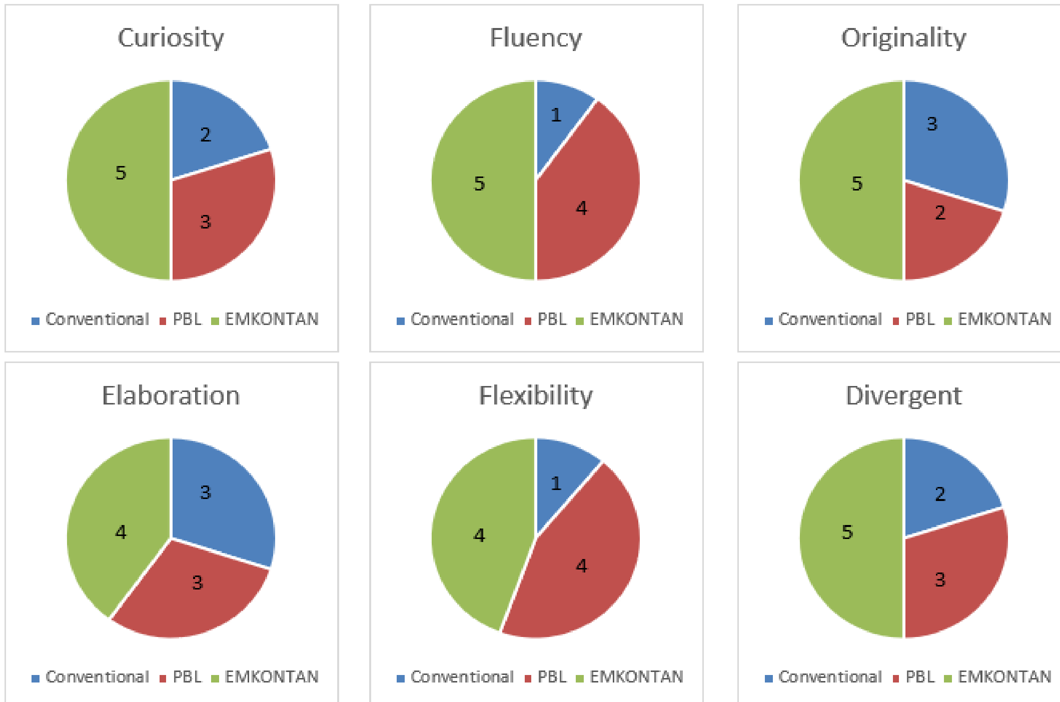

Figure 1. Average Student Creativity Score

These results indicate that the learning model affected student creativity, with the EMKONTAN learning model contributing most to student creativity compared to the PBL and conventional learning models. EMKONTAN involves students exploring curiosity, and fluency in thinking, generating new ideas, providing detailed explanations, bringing up several possibilities, and adapting, combining, or modifying ideas to solve a problem. This is following other studies which 'state that creativity in all its aspects can be increased through learning that challenges the problems that exist around students (Coman et al., 2020; Craft, 2003; Häkkinen & Mäkelä, 1996; Lodge et al., 2018).

EMKONTAN is significantly different from PBL because it provides opportunities for students to directly orientate towards environmental problems through the observation of environmental problems around them, thereby developing their curiosity. Students' curiosity is empowered through observation, identification, and analysis of environmental problems. Gulacar et al. explained that the activities of observation, identification, and problem analysis increase students' curiosity before students identified and analysed the problem (Gulacar et al., 2013). Likewise, Greenstein (2012) explains that curiosity is the originator of creativity. Student curiosity will encourage students to elaborate in depth about the material following the study by Pluck and Johnson (2011) which reported that students with high curiosity were able to provide analysis. For example, for students to identify and analyse the impact of environmental damage if no adjustments are made and the consequences, they must explore their curiosity about the possible impacts of environmental damage, and compile an action plan to solve environmental problems. In this case, students are directed to elaborate on the impact of environmental damage and realise actions (behaviours) to solve environmental problems.

In addition, through the identification and analysis of environmental problems, students are directed to think flexibly. Greenstein (2012) explains flexible thinking as thinking by suggesting possibilities that will occur. For example, students make predictions about the decline in biodiversity in Indonesia such as extinction, flooding, drought, landslides, and reduced oxygen supply, then find solutions to environmental problems with the conservation of natural resources which need to be realised in action plans to prevent the decline in biodiversity. Integration with natural resources is provided through reforestation, selective logging, and in-situ and ex-situ conservation. Fluency in thinking in finding solutions is achieved through group discussions, reading references, and good cooperation. Fleming et al. (2019) explained that students' fluency in thinking is influenced by the learning environment, such as the references and media used.

Students' fluency in thinking can also be trained through the preparation of action plans to solve environmental problems and integrate them into natural resource conservation, training students to think systematically in solving problems (Dunlosky et al., 2013; Martinich et al., 2006). In practice, each group reports on the project's progress and identifies obstacles, then the other groups give suggestions to solve these problems. For example, a group that has difficulty designing posters using an application, another group can give suggestions to make posters manually.

Conventional learning is significantly different from PBL and EMKONTAN in empowering student creativity, as indicated by the low scores of all aspects of student creativity. In conventional classes, learning relies on textbooks and student worksheets containing multiple-choice questions and descriptions. Students are not taught contextually, so it is difficult for them to think creatively and apply it in everyday life.

The effectiveness of the learning model on collaboration skills

The results of the variance of the effectiveness of the EMKONTAN, PBL, and conventional learning models on collaboration skills are presented in Table 5, showing that the EMKONTAN learning model improved all collaboration skills.

Table 5. The average percentage of pretest and posttest students' collaboration skills in field trials

No	Collaboration skills	Category			
		Very good (%)	Good (%)	Enough (%)	Not enough (%)
		Pre-test			
1	Productive work	17.00	43.30	23.00	17.00
2	Show respect	23.30	20.00	50.00	6.67
3	Compromise	20.00	16.67	46.70	16.67
4	Responsibility	33.30	10.00	23.30	33.33
		Post-test			
1	Productive work	50.00	43.30	3.30%	3.30
2	Show respect	63.30	20.00	13.33%	3.33
3	Compromise	46.70	16.67	30.00	6.66
4	Responsibility	66.70	16.67	6.67	10.00

Table 6 shows the differences in learning models [Fcount = 254.00 with p-value = 0.00. P-value < (α = 0.05)], therefore, the hypothesis that the learning model affects students' collaboration skills are accepted. The LSD test results in Table 7 show significant differences in the learning model, with the highest average post-test scores in the EMKONTAN-taught class. The highest average score and the average value per aspect are presented in Figure 2 showing that the students taught via the EMKONTAN learning model had the highest collaboration skill scores.

Table 6. ANCOVA results of the collaboration skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1772.85a	4	443.21	190.51	0.00
Intercept	508.65	1	508.65	218.64	0.00
X Collaboration	1.35	1	1.35	0.58	0.44
Class	1772.73	3	590.90	254.00	0.00
Error	323.36	139	2.32		
Total	19170.00	144			
Corrected Total	2096.22	143			

R Squared = 0.84 (Adjusted R Squared = 0.84)

Table 7. LSD test results for collaboration skills

Class	Mean	LSD	Notation
Conventional	6.72	7.31	A
PBL	13.08	13.67	B
EMKONTAN	15.40	16.00	C

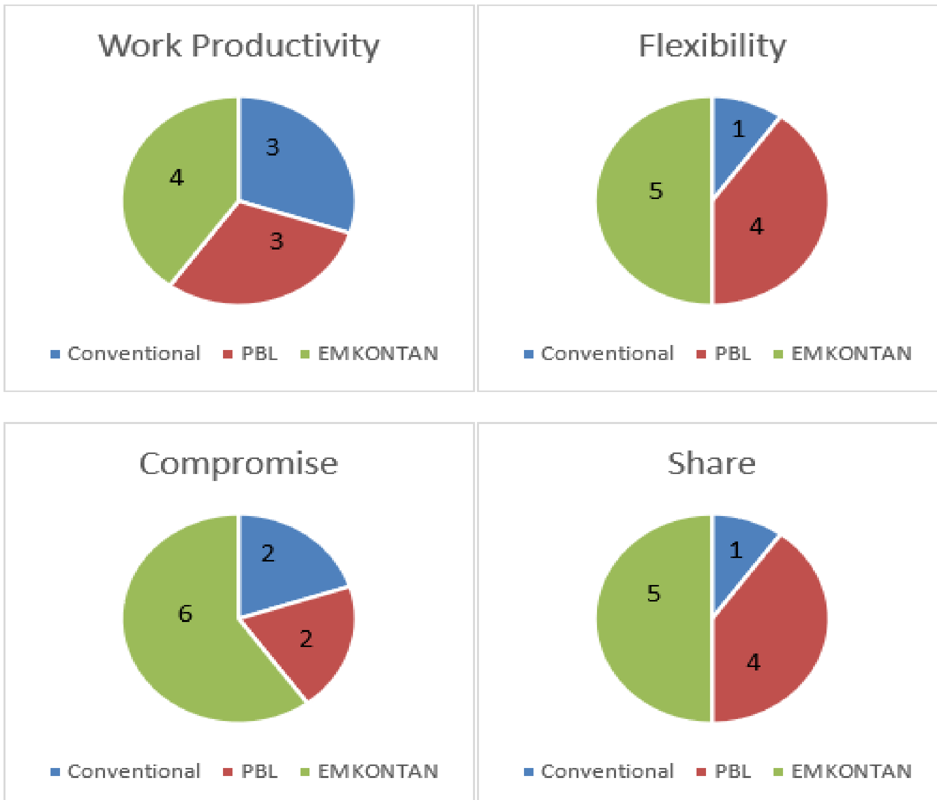

Figure 2. Average score of collaboration skills for the classes taught via the conventional, PBL, and EMKONTAN learning models

These results indicate that the learning model affected students' collaboration skills. The EMKONTAN learning model contributes more to students' collaboration skills compared to PBL as this model involves students in productive work, mutual respect, compromise, and responsibility in completing group assignments. Students must express their respective opinions and discuss together to determine an appropriate solution to prevent the Coronavirus through posters. Students who can express opinions are those who already have prior knowledge of the material. This is in accordance with the study results of Ilma et al. (2022) which stated that students who are active in a group have at least some knowledge.

Collaborative skills in the aspect of productive work are evident when students identify and analyse problems, take action planning steps and implement actions. The identification and analysis of environmental problems are performed when students have succeeded in determining the factors that influence the emergence of environmental problems. Productive work involves the students designing action-planning activities regarding solving environmental problems. Each group has a leader who helps the lecturer to divide the tasks into groups to prepare tools and materials, compile work procedures, and make a schedule of activities. Cheruvelil et al. (2020) explain that productive work can be achieved through the division of tasks into groups, thus training the students to be responsible. Greenstein (2012) explains that responsibility is not only about punctuality in collecting assignments but more about achieving the best work.

Collaborative skills in the aspect of mutual respect occur when students have discussions with fellow group members and when presenting results outside the group. Students carefully listen to suggestions or ideas given by other groups. This is in accordance with Greenstein (2012) who states that mutual respect is achieved through group learning activities. In addition, O'Leary et al. (2012)

reported that mutual respect can give positive energy to others. Similarly, when students reported the group's progress, they conveyed the obstacles they faced and then the other groups provided solutions.

There was a significant difference between EMKONTAN and PBL in improving student collaboration skills, with EMKONTAN's steps making a major contribution to the development of student collaboration skills through the process of observation, identification and analysis, action plans, implementation of monitoring and evaluation actions and follow-up plans. This is following previous research which explains that student collaboration can be improved through making identification, preparing an action plan, carrying out the action, analysing, and conducting monitoring and evaluation (Le et al., 2018).

EMKONTAN and PBL significantly differ from conventional learning because conventional classroom learning cannot facilitate the development of student collaboration skills. Learning in conventional classrooms only involves knowledge transfer activities which are conducted individually without actively involving students in learning. Learning in conventional classrooms only provides assignments in the form of questions with lower levels of cognition. Hasan and Pardjono (2019) reported that student collaboration skills are difficult to develop in learning that only emphasises memory, understanding, and analysis.

Conclusion

The EMKONTAN learning model significantly improves students' creativity and collaboration skills, therefore this learning model can be applied to improve students' creative thinking and collaborative skills outcomes in environmental learning.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding of this paper.

Author Contributions

N. Nurwidodo: Data curation; Writing ─ original draft. **I. Ibrohim:** Writing an original draft; Writing ─ review and editing; Formal analysis. **S. Sueb:** Writing ─ review and editing. **F. M. Abrori:** Conceptualization. **T. A. Darojat:** Writing ─ review and editing.

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