



Improving Students' Conceptual Understanding and Collaboration Skills in Ecology Learning through Educational Snakes and Ladders Media

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Abstract: This study aims to examine the improvement in students' conceptual understanding and collaboration skills following the implementation of the Snakes and Ladder media in ecology lessons. The material covered ecology and ecosystems, ecosystem components, interactions between living organisms, ecosystem balance, and ecosystem pollution. A quantitative approach with a one-group pretest-posttest pre-experimental design was employed. The research subjects were 28 students from class VII D at SMPN 2 Tuban. Conceptual understanding was measured using essay tests administered as a pretest before instruction and a posttest after instruction. Meanwhile, collaboration skills were assessed via questionnaires administered before and after the lessons involving the Snakes and Ladder media. Data on conceptual understanding were analyzed using descriptive statistics and normalized gain (N-gain) analysis. Collaboration skill data were analyzed descriptively by calculating percentage scores and categorizing them based on established criteria. The results showed that the average conceptual understanding score increased from 35.25 to 58.96, with an N-gain value of 0.37 (indicating a moderate improvement). Students' collaboration skills also improved from 63.00% (fair category) to 77.85% (good category). These findings indicate that implementing the "Snakes and Ladders" educational game in ecology lessons can enhance students' conceptual understanding and collaboration skills.

Keywords: Collaboration skills; Conceptual understanding; Ecology; Educational snakes and ladders media

Introduction

Learning biology, particularly ecology, requires students not only to understand concepts cognitively but also to develop social skills such as collaboration (Santhosh et al., 2024). Collaboration skills are one of the essential competencies that need to be developed in 21st-century learning (M. R. Dewi & Arifin, 2024; Hou & Keng, 2021; Schürmann et al., 2024), as these skills play a role in encouraging students to actively interact, collaborate, and develop problem-solving skills in learning. In reality, classroom learning is often dominated by lectures and individual assignments, which provide little opportunity for student interaction and collaboration. Opportunities to practice these skills

are limited if learning focuses solely on individual activities, which can lead to individualism, low participation in discussions, and underdevelopment of students' collaborative skills (Bahriyatin et al., 2024; Koretsky et al., 2021; Fitri et al., 2023; Wulandari & Rohaeti, 2024). These conditions indicate that students' collaboration skills have not yet developed optimally in the learning process.

Ecology material is actually very relevant to students' daily lives, as it discusses the interactions between living things and their environment, which can be directly observed in real life (Caiman & Kjällander, 2024; Lankers et al., 2023). However, without an engaging and interactive learning approach, concepts such as interactions between living things, the food

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chain, and ecosystem balance are often only understood through rote learning, rather than as a complete system (Bahrudin & Yogihati, 2022; Mulyono et al., 2025; Rahmawati et al., 2022). Conceptual understanding is a crucial aspect of biology learning, particularly in ecology, where concepts are complexly interconnected. Conceptual understanding is demonstrated not only through memorization but also through students' ability to explain, connect, and apply concepts in real-world situations (Abebe et al., 2024; Adipat et al., 2021; Tan, 2022; Yulirismayenti et al., 2025). However, many students still struggle to grasp ecological concepts in depth because learning activities tend to be theoretical and lack active student engagement. As a result, students find it easier to memorize than to understand, leading to quickly forgotten concepts and inaccurate understanding.

One way to address these issues is to utilize innovative and engaging learning media, such as educational snakes and ladders (Kartikaningrum & Mulyani, 2024). This media not only creates a more relaxed and engaging learning environment but also encourages students' conceptual understanding and enhances interaction between students through collaborative play (Aida et al., 2022; Dewi et al., 2024). By integrating ecological material into games, students can learn while playing, making the learning process more meaningful (Ardania et al., 2025; Febrianti et al., 2025; Rosita et al., 2023). Through educational snakes and ladders, students are encouraged to discuss concepts, exchange ideas, and participate actively during classroom activities. Rather than providing direct hands-on experiences, the game facilitates conceptual learning through contextual questions and collaborative discussion. These learning activities are expected to support the development of collaboration skills while strengthening students' conceptual understanding of ecology (Nainggolan & Purwaningsih, 2024; Ren et al., 2024).

Several previous studies have reported that game-based learning media can improve students' conceptual understanding and support collaborative learning during classroom activities (Sari et al., 2026; Wardani & Kiptiyah, 2024). Educational games such as snakes and ladders have been shown to create a fun learning environment and increase student participation in the learning process (Gultom et al., 2023; Rahmah & Risnani, 2023). Meanwhile, Muliyani et al. (2025) reported that game-based learning can also help students understand concepts more contextually. Although previous studies have reported that educational snakes and ladders can improve conceptual understanding, motivation, and classroom participation, most studies have primarily focused on cognitive achievement or general learning outcomes. Studies examining the simultaneous

improvement of conceptual understanding and collaboration skills through educational snakes and ladders in ecology learning at the junior high school level remain limited. Therefore, further research is needed to investigate the potential of this learning media in promoting both competencies simultaneously.

Based on the identified research gap, learning innovations are needed to facilitate both conceptual understanding and collaboration skills simultaneously in ecology learning. Therefore, this study aims to determine the improvement of students' conceptual understanding and collaboration skills after the implementation of educational snakes and ladders media in ecology learning. Therefore, learning innovations are needed that can integrate these two aspects into the learning process. This study aims to determine the improvement in students' conceptual understanding and collaboration skills through the application of educational snakes and ladders media in ecology learning.

Method

This study used a quantitative approach with a pre-experimental method using a one-group pretest-posttest design. The study was conducted in class VII D at SMP Negeri 2 Tuban, involving 28 students as subjects. The sampling technique used purposive sampling, selecting classes with the lower academic performance compared to other classes. The Instruction involved the use of an educational snakes and ladders game, with students working in groups of seven. The learning material focused on ecology, covering five sub-topics: ecology and ecosystems, ecosystem components, interactions among living organisms, food chains, ecosystem balance, and ecosystem pollution. The study aimed to determine improvements in students' conceptual understanding and collaboration skills following the use of the educational Snakes and Ladders game during ecology lessons. To measure conceptual understanding, an essay-based test was administered as both a pretest (before instruction) and a posttest (after instruction). The pretest assessed students' initial knowledge, while the posttest measured gains in conceptual understanding resulting from the use of the educational game. Students completed the tests individually. Table 1 outlines the research design used to assess improvements in conceptual understanding by comparing pretest and posttest results.

Table 1. Research Design

Group	Pre-test	Treatment	Post-test
Experiment	Q1	X	Q2

Description:

X : Implementation of the Educational Snakes and Ladders Game

Q1 : Pre-Test

Q2 : Post-Test

The flowchart of the method can be seen in the Figure 1.

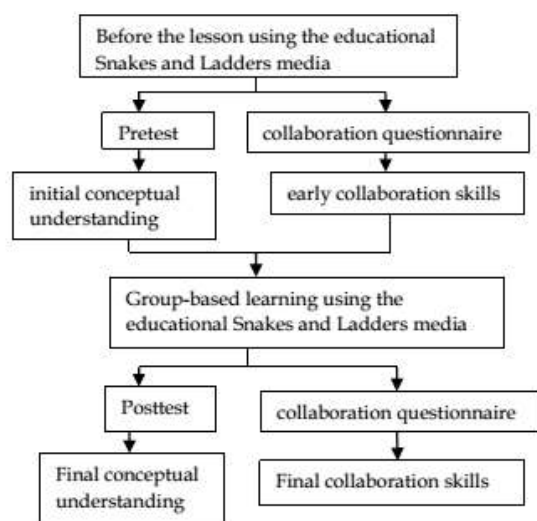


Figure 1. The flowchart of the research steps

The data obtained were then analyzed quantitatively using N-Gain and categorized to indicate students' level of conceptual understanding. The results of the N-gain calculations were then classified based on the N-gain criteria listed in Table 2.

Table 2. N-gain Criterion

N-gain	Criteria
$g \geq 0.70$	High
$0.30 \leq g < 0.70$	Medium
$g < 0.30$	Low

The data on students' collaboration skills were obtained using a questionnaire instrument, which was given before and after the implementation of the snakes and ladders media in the learning process. The questionnaire used a Likert scale with 4 answer choices, namely; strongly disagree (1), Disagree (2), Agree (3), and Strongly Agree (4). The final score was obtained by comparing the score obtained with the maximum score, then converted into a percentage.

$$\% = \frac{n}{N} \times 100 \quad (1)$$

Description:

% = Percentage of collaboration skills

n = Score obtained

N = Total score

To facilitate the interpretation of student collaboration skills data, grouping criteria are needed based on the percentage values obtained (table 3).

Table 3. Criteria for Students' Collaboration Skills

Percentage	Category
86% - 100%	Very Good
76% - 85%	Good
60% - 75%	Enough
55% - 59%	Less
<54%	Very Less

Result and Discussion

Research data on students' conceptual understanding was obtained through pretest and posttest. The results of the study revealed an overall mean pretest score of 35.25 and an overall mean posttest score of 58.96. The highest pretest score was only 50, while the posttest score increased to 85. These data indicate an increase in students' conceptual understanding after the implementation of educational snakes and ladders media in learning. To clarify the comparison of pretest and posttest scores, the data are presented in Figure 2.

To further assess the improvement in students' conceptual understanding, we analyzed the difference between pretest and posttest scores using the N-gain calculation. The N-gain calculation yielded 0.37 (Table 5), which falls into the moderate category.



Figure 2. Students' conceptual understanding before and after learning using snakes and ladders media

From figure 2 and table 5, it can be seen that there was an increase in students' conceptual understanding of ecology material after learning using educational snakes and ladders media. This occurs because learning with educational snakes and ladders media provides a more active and meaningful learning experience. Students not only passively receive material, but also engage in play activities, discussions, and group collaboration, thus enabling them to build a better understanding. Snakes and ladders media also presents learning in an interesting and contextual format, thus

encouraging students to think, answer questions, and connect concepts during the game.

In addition to showing an overall improvement, an analysis was also conducted on each sub-material to determine the improvement in students' conceptual understanding in greater detail. Analyzing each sub-

material is important for identifying the material that showed the greatest and least improvement following the implementation of the educational Snakes and Ladders game. The average pretest and posttest scores for each sub-topic are presented in figure 3.

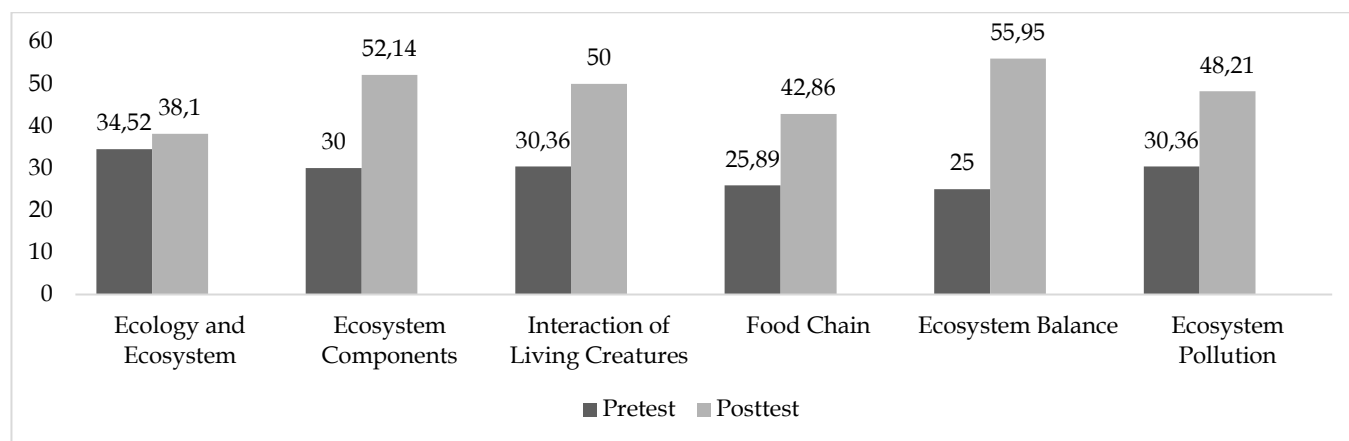


Figure 3. Average pretest and posttest scores for each ecology sub-topic

Based on Figure 3, all sub-topics showed an increase in average scores from the pretest to the posttest. The greatest increase occurred in the Ecosystem Balance sub-material, rising from 25.00 to 55.95. Meanwhile, the smallest increase was observed in the Ecology and Ecosystems sub-material, rising from 34.52 to 38.10. Nevertheless, all sub-topics demonstrated improved learning outcomes following the implementation of the educational Snakes and Ladders game. This indicates that the educational snakes and ladders media helped students develop a better understanding of various ecosystem concepts.

To determine the level of improvement in conceptual understanding for each sub-topic in greater detail, N-gain calculations were performed for each sub-topic. This analysis aimed to examine the improvement in students' conceptual understanding across each sub-topic after the implementation of the educational Snakes and Ladders media. The N-gain calculation results for each sub-topic are presented in Figure 3.

Table 4. N-gain for Each Sub-Material

Sub-material	N-gain	Category
Ecology and Ecosystem	0.05	Low
Ecosystem Components	0.32	Medium
Interaction of Living Creatures	0.28	Low
Food Chain	0.23	Low
Ecosystem Balance	0.41	Medium
Ecosystem Pollution	0.26	Low

Based on Table 4, the N-gain values for each sub-topic fall into varying categories. The Ecosystem Balance sub-material achieved the highest N-gain value of 0.41

medium category, followed by the Ecosystem Components sub-material with an N-gain of 0.32 also in the medium category. Meanwhile, the Ecology and Ecosystems sub-material recorded the lowest N-gain value of 0.05 low category. The sub-material of Interactions Among Living Things, Food Chains, and Ecosystem Pollution obtained N-gain values of 0.28, 0.23, and 0.26, respectively, all of which fall into the low category.

The variation in N-gain values across the sub-topics indicates that the improvement in students' conceptual understanding was not uniform. Nevertheless, all sub-materials showed score improvements following instruction that utilized the educational Snakes and Ladders game, indicating that the implementation of the educational Snakes and Ladders media was associated with improvements in students' conceptual understanding of ecosystem topics.

Although the N-gain analysis for each sub-material shows varying levels of improvement, the overall improvement in students' conceptual understanding was further examined using the total N-gain. The results of the overall N-gain calculation are presented in Table 5.

Table 5. Results of overall N-gain Calculation for Students' Concept Understanding

Group	Pretest average	Posttest average	N-gain
Experiment	35.25	58.96	0.37

These findings are consistent with previous studies reporting that educational snakes and ladders media can support improvements in students' conceptual

understanding and encourage active participation during the learning process (Ellyati, 2023; Sa'adah, 2025; Septiyanto & Nuroh, 2021; Wulandary et al., 2025). This active student engagement allows students to build conceptual understanding through interaction and information exchange with their group mates. This aligns with research showing that the use of game media in learning can contribute to student engagement during the learning process, thus impacting better conceptual understanding (Chen & Liang, 2022; Hartati et al., 2025; Yulirismayenti et al., 2025; Zhong, 2023).

The use of engaging learning media can also increase student motivation, making them more enthusiastic about participating in learning. This has an impact on improving students' conceptual

understanding, as the learning process becomes more enjoyable and less monotonous (Laswadi et al., 2024; Mardiah & Jasrial, 2026; Safitri et al., 2022; Hartati et al., 2025). The moderate N-gain value (Table 5) indicates that several obstacles remain, such as differences in students' initial abilities and levels of active participation during learning activities. Although students' conceptual understanding improved after the implementation of the educational Snakes and Ladders media, the average posttest score remained relatively low. Therefore, additional instructional strategies may be needed to further strengthen students' conceptual understanding. Furthermore, because this study employed a pre-experimental design without a control group, the findings should be interpreted with caution.



Figure 4. Some documentation of the research implementation

This study examines not only students' conceptual understanding but also their collaboration skills. Figure 4. illustrates the implementation of the educational Snakes and Ladders game during ecology learning. During the learning activities, students worked collaboratively in small groups to answer question cards, discuss ecological concepts, and make decisions together while playing the game. These activities encouraged active participation, communication, and the exchange of ideas among group members, allowing students to construct their conceptual understanding through collaborative learning. This learning process is consistent with the improvement in students' conceptual understanding shown by the moderate N-gain score and also supports the development of students' collaboration skills. Data collected via student questionnaires revealed an average pre-treatment collaboration skill score of 63.00%, placing it in the "sufficient" category. These

results indicate that, prior to instruction using the educational Snakes and Ladders game, students' collaboration skills had not developed optimally. This was evident in the low levels of student participation in group activities, contribution of ideas, and involvement in decision-making. A detailed breakdown of collaboration skill percentages for each indicator prior to the treatment is presented in Table 6.

Following the initial assessment of students' collaboration skills, a follow-up measurement was conducted after the implementation of educational Snakes and Ladders media in the learning process. The results indicate an improvement in students' collaboration skills across all observed indicators. This improvement suggests that the use of educational Snakes and Ladders media encouraged students to engage more actively in teamwork, take responsibility for tasks, and respect the opinions of group members

during the learning process. Details regarding the percentages of students' collaboration skills following the intervention are presented in Table 7.

Table 6. Percentage of Students' Collaboration Skills before Learning

Indicator	Score (%)	Category
Mutual respect	66	Enough
Responsibility	64	Enough
Cooperation	65	Enough
Coordination with the group	63	Enough
Active participation	60	Enough
Involvement in decision-making	62	Enough
Contribution of ideas	59	Less
Problem solving	61	Enough
Adaptation to the group	64	Enough
Respecting the opinions of peers	66	Enough
Average	63	Enough

Table 7. Percentage of Students' Collaboration Skills after Learning

Indicator	Score (%)	Category
Mutual respect	80	Good
Responsibility	78	Good
Cooperation	79	Good
Coordination with the group	77	Good
Active participation	75	Enough
Involvement in decision-making	78	Good
Contribution of ideas	74	Enough
Problem solving	76	Good
Adaptation to the group	77	Good
Respecting the opinions of peers	79	Good
Average	77.85	Good

Based on Table 7, it can be seen that all indicators of collaboration skills are in the good category, except for the contribution of ideas and active participation which are in the medium category. Mutual respect has the highest score of 80%, this indicates that students already have an attitude of mutual respect for one another, this attitude is very important in group collaboration. As stated by Cooney et al. (2020), mutual respect and responsibility within the group are also important factors in the success of collaboration. Other indicators, namely responsibility, group cooperation, coordination within the group, involvement in decision-making, problem solving, group adaptation, and respect for the opinions of friends, all also fall in the good category although the score is slightly below mutual respect. These findings indicate that most collaboration skill indicators reached the good category, reflecting positive interaction among students during the learning activities.

Two indicators remained in the sufficient category: active participation at 75% and idea contribution at 74% (Table 7). This indicates that some students were not fully active in expressing their opinions or were not

optimally involved during group discussions. This could be due to a lack of self-confidence or a lack of familiarity with collaborative learning activities. Therefore, ongoing efforts are needed to improve students' collaboration skills by familiarizing them with learning activities involving group work.

Conclusion

Based on the results of this study, it can be concluded that the implementation of the "Snakes and Ladders" educational game is associated with improvements in conceptual understanding and collaboration skills regarding ecology topics among Grade VII D students at SMP Negeri 2 Tuban. Students' conceptual understanding improved from 35.25 to 58.96, with an N-gain score of 0.37, indicating a moderate level of improvement. Meanwhile, students' collaboration skills increased from 63.00% (fair category) to 77.85% (good category) following the learning activities.

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Author Contributions

Conceptualization, Y.A.P., D. N., ; methodology, Y.A.P., validation, D. N.; investigation, Y.A.P., D. N., data curation, Y.A.P., D. N.; writing original draft preparation, Y.A.P., D. N., ; writing review and editing, D. N. All authors have read and agreed to the published version of the manuscript

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Conflicts of Interest

All authors declare that they have no conflict of interest.

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