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DEVELOPMENT OF THE SCIENTIFIC DISCOVERY LEARNING MODEL TO ENHANCE STUDENTS CRITICAL THINKING AND COLLABORATION SKILLS IN GEOGRAPHY LEARNING

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ABSTRACT

The needs of education in the 21st century demand an integrated understanding of the 4C competencies, including creativity, critical thinking, communication, and collaboration. Geography learning in schools is still very teacher-centered, which sometimes does not relate the subject matter to real-world events, thus hindering students' critical thinking and collaboration skills. This research was intended to develop a Scientific Discovery Learning learning model to improve students' critical thinking and collaboration skills in geography learning in schools. This research is classified as development research related to the Nieveen model, which consists of the preliminary research phase, prototyping phase, and assessment phase. This research was carried out in the odd semester of the 2025/2026 academic year at Senior High School 1 Jember. The result shows that the Scientific Discovery Learning learning model got a validation score categorized as excellent, and the practicality result from the learning implementation and students' responses was also included in the excellent category. Then the effectiveness of the model is proven by the increase in the N-gain score on students' critical thinking and collaboration skills in geography learning.

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KEYWORDS: Discovery Learning Model, Critical Thinking Skills, Student Collaboration, Geography

1. INTRODUCTION

Technological development in human life has become an essential requirement for fulfilling everyday needs. This technology can act as a platform for entertainment and gaining access to vital information. Technology is also embedded in the education system by offering students access to different learning resources, which can undoubtedly enhance their intellectual capabilities in terms of learning content. The availability of technology can make the learning process more engaging and interactive, hence motivating students to be more proactive in their learning processes (Elfanda et al., 2025).

Learning geography is very important in helping students understand and interact with their surroundings. This understanding includes the potential of the regions of Indonesia, in terms of natural, geographical, and cultural aspects. By learning the potential of natural resources and its effects on life, students are encouraged to explore the natural resources in their surroundings and develop them for their everyday life. The aim of this learning is to encourage students to learn not only by memorizing but also by understanding the wise use of environmental resources, in accordance with the competencies needed in learning in the 21st century (Irawati et al., 2023).

Learning in the 21st century is marked by the fast evolution of information and communication technology, which affects the education sector. The 4Cs, which need to be embedded in students, are creativity, critical thinking, communication, and collaboration, which will help them adjust to the future. The implementation of these skills will make students more competitive, creative problem solvers, team players, and ready to meet the challenges of the workplace in the context of globalization (Lestari & Hindun, 2024).

Critical thinking is an important skill in geography learning as it can enable students to solve different environmental issues raised in the learning content. Critical thinking skills can habituate students to learn information objectively, interpret environmental factors in their surroundings, and make decisions (Ervina et al., 2023). Critical thinking skills encompass the skills to interpret, analyze, conclude, evaluate, explain, and self-regulate the cognitive process to produce effective solutions.

Learning geography in schools may not actively involve students in the learning process because the learning process is likely to be conventional and teacher-centered (Astutik et al., 2023). Students learning in this way are likely to spend most of their time listening to what the teacher is saying, and their learning process is likely to involve memorization. This means that students will not have much time to analyze geospheric phenomena. Learning geography that does not relate to daily life or is contextual is bound to affect students' poor critical thinking skills and participation (Syahidin et al., 2025).

One of the most critical skills in the learning process is collaboration. Collaboration is the process of working together with the division of roles and responsibilities to achieve a common goal. However, this skill is still not optimally utilized in the learning process. This is seen in the fact that there is no active participation in discussions, there is difficulty in solving problems together, and there is a lack of self-confidence in communicating group ideas (Ananta et al., 2023).

From the preliminary study results, it can be seen that the learning process is still dominated by lectures, so many students face difficulties in understanding the subject of Natural Resource Potential and Its Impact on Life. This condition has made the learning process less contextual, students are passive, and scientific skills such as observing, asking questions, reasoning, and collaborating have not developed optimally. With these problems, of course, there is a need for a solution, one of which is to develop a learning model by applying a scientific approach. This is to improve and address the needs of students in practicing critical thinking skills in solving environmental issues and collaboration skills when working together in a team.

Several studies have found that the discovery and scientific methods can enhance critical thinking and collaboration skills among students. Based on the research conducted by Armawati & Susetyo (2025), the scientific method has been found to be very effective in enhancing critical thinking skills among students, particularly in analyzing, evaluating, and concluding information. Moreover, the research conducted by Purba & Jailani (2023) reveals that the application of scientific methods also promotes collaboration and digital literacy among students through cooperative learning. The combination of both methods can definitely produce an active and meaningful learning process.

From the above description, the Scientific Discovery Learning model is required to enhance the critical thinking and collaboration skills of students. The Scientific Discovery Learning model integrates scientific and collaboration approaches and is intended to overcome the low critical thinking and collaboration skills in geography learning. Thus, this research was carried out, and the title of this research is "Development a Scientific Discovery Learning Model to Improve Students Critical Thinking and Collaboration Skills in Geography Learning."

2. RESEARCH METHOD

The method of research used in this study is Research & Development with the focus on learning development using a design-based research approach. One of the solutions to complex educational issues could be using a design research approach, which aims to design, develop, and improve learning interventions such as strategies, teaching materials, and systems. The Plomp & Nieveen model is a development model that is used as a reference in this study, which consists of several stages, namely preliminary research, then the prototyping phase, and finally the assessment phase. The research was conducted at Senior High School 1 Jember with the research subjects being grade XI students in the odd semester of the 2025/2026 academic year.

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This research employs qualitative and quantitative data, which are collected using a number of data collection techniques. The data collection was carried out to evaluate the application of the Scientific Discovery Learning model and to analyze the critical thinking skills and collaboration of students. A number of techniques that have been modified to suit the aims of the research and employed in the data collection process in this study include: 1) instrument validity, which is carried out to ensure that the research instrument is capable of measuring the variables accurately and as it is in reality. The validation process involves expert validators, and users by filling out a validation sheet that contains criteria for assessment that relate to the validity and feasibility of the instrument including ATP, teaching modules, LKPD, critical thinking skills test questions, and learning model books. The assessment of the instrument employs a four-level scale, which includes less valid, quite valid, valid, and very valid; 2) questionnaire, which is a sheet of a number of questions that are answered by the respondents; 3) Observation, which is carried out to observe directly the relationship between teachers and students in the process of applying the learning model. The observers record a number of important aspects such as cooperation, activeness in group discussions, and the role of the teacher in facilitating learning; 4) Tests, which are employed as a means to evaluate the learning outcomes of students in the process of learning. In this research, a test was employed to measure the critical thinking skills of students after they had undergone learning using the scientific discovery learning model.

The first technique of data analysis is the validity of the learning model, which was measured using a validation sheet to determine the validity of the learning device, followed by a score using a percentage. Second, the practicality of the learning device was measured based on the implementation of the learning model in the classroom learning activities. This was measured by the statement of practitioners that the model could be implemented based on a good level of implementation at each stage. The practicality of the learning device was also measured by the responses of the students in the form of a questionnaire using a Likert scale at the end of the learning activity. Third, the effectiveness of the learning model is the extent to which the product developed is able to achieve research objectives and provide a positive impact on students. In this study, effectiveness was shown by the increase in the critical thinking and collaboration skills of students after the implementation of the Scientific Discovery Learning model with a minimum N-gain score in the moderate category.

3. RESULTS AND DISCUSSION

This research will produce a learning model that can enhance critical thinking skills for problem-solving with appropriate solutions and also collaboration skills with their study group mates. The data of this research is the result of product validity, practicality, and effectiveness tests, which have been carried out in small class trials, large class trials, and dissemination. The development of the Scientific Discovery Learning learning model will be able to show results that have met the criteria, including validity, practicality, and effectiveness, which will be explained in detail in the following explanation.

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3.1 Validity Data of the Scientific Discovery Learning Model

Validation was carried out as an initial stage before trials in small classes, large classes, and dissemination. The validation instruments used the scientific discovery learning model, ATP, Teaching Modules, Student Worksheets (LKPD), and critical thinking skills test questions. The validators were lecturers who had a Master of Social Studies Education degree and at least a doctorate, and the user validators were geography teachers. The result of the learning model validation is described in the following table.

Table 1. Validation Results

Validation Instrument	Average Validation Results (%)			Category
	Expert	Users	Average	
Scientific Discovery Learning Model	85,31	100	92,67	Very Valid
ATP	91,67	87,5	89,58	Very Valid
Teaching Module	93,73	96,87	95,3	Very Valid
LKPD	95	100	97,5	Very Valid
Critical Thinking Skills Test Questions	96,86	96,63	97,75	Very Valid

From the table, it can be seen that the average validation results from the development of the scientific discovery learning model were 92.67%, which is categorized as very valid. The average from the ATP validation results was 89.58%, which is categorized as very valid. Next, the average validation results for the Teaching Module obtained a value of 95.3%, which is categorized as very valid. In addition, the average results from the LKPD validation obtained a value of 97.5%, which is categorized as very valid. The average validation obtained for the critical thinking test questions was 97.75%, which is categorized as very valid.

3.2 Practical Data of the Scientific Discovery Learning Model

3.2.1 Data on the Implementation of the Scientific Discovery Learning Model

Data learning implementation was obtained by assessing the implementation of the Scientific Discovery Learning learning model during the learning process conducted in 2 classes of XI IPS at Senior High School 1 Jember. The data obtained were used to measure the practicality of the Scientific Discovery Learning learning model. The implementation was conducted in a small class test in class XI IPS 2 involving 10 students, then a large class test was conducted in class XI IPS 2 involving 35

students, then a dissemination class test was conducted in class XI IPS 1 involving 36 students. The observer was an assessor of the implementation of the Scientific Discovery Learning learning model during the learning process by using an observation sheet. The result of the implementation of the Scientific Discovery Learning model will be explained as follows.

Table 2. Learning Implementation Results

Type of application	Average (%)			Category
	Meeting 1	Meeting 2	Implementation	
Small Class Trial	88,72	91,2	89,93	Very Good
Large Class Trial	89,12	91,82	90,47	Very Good
Dissemination class test	91,9	94,69	93,29	Very Good

The implementation of the Scientific Discovery Learning model obtained results in the small class meeting 1 obtained an average of 88.72%, and meeting 2 was 91.2%. The average implementation of the small class test was 89.93% with a very good category. The results of the implementation in the large class meeting 1 obtained an average of 89.42%, and meeting 2 was 91.82%. The average implementation of the large class test was 90.47% with a very good category. The results of the implementation in the dissemination class meeting 1 obtained an average of 91.9%, and meeting 2 was 94.69%. The average implementation of the dissemination class test was 93.29%% with a very good category.

3.2.2 Student Response Data to the Scientific Discovery Learning Model

In the final stage after completing the whole series of learning, the result of student responses to the application of the Scientific Discovery Learning model can be obtained. The result of student responses was obtained by conducting small class trials in class XI IPS 2 involving 10 students, then large class trials in class XI IPS 2 involving 35 students, then dissemination class trials were applied to class XI IPS 1 involving 36 students.

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Table 3. Student Response Results

Type of application	Average Student Response (%)	Criteria
Small Class Trial	85,68	Strongly agree
Large Class Trial	86,68	Strongly agree
Dissemination class test	82,7	Strongly agree

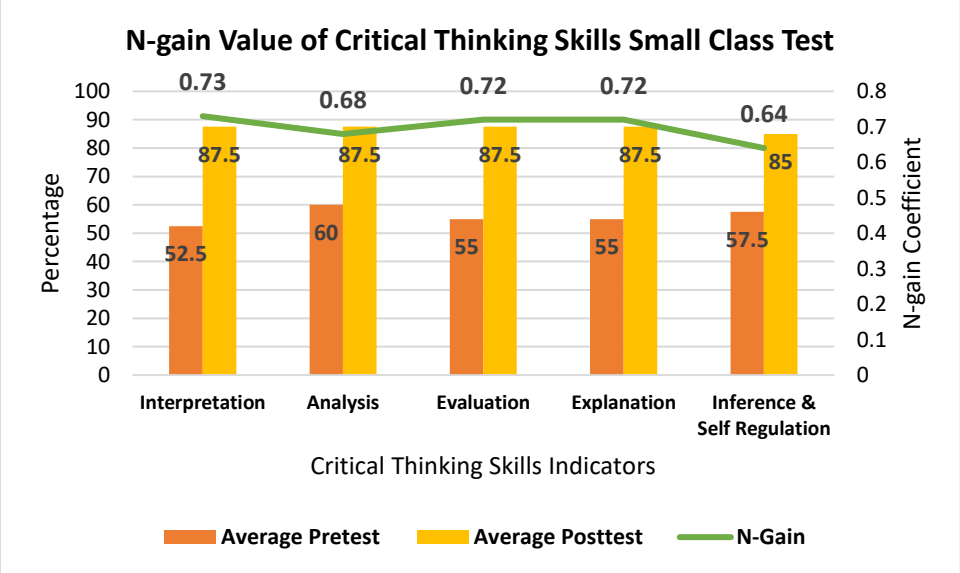
The average student response in the small-class trial was 85.68%, with a strongly agreed category. The result in the large-class trial was 86,68%, with a strongly agreed category. The result in the dissemination class trial was 82,7%, with a strongly agreed category.

3.3 Data on the Effectiveness of the Scientific Discovery Learning Model

3.3.1 Critical Thinking Skills

The effectiveness of the Scientific Discovery Learning model in enhancing students' critical thinking skills was evaluated through small-class, large-class, and dissemination-class trials. In the small-class trial conducted at Senior High School 1 Jember, ten students from class XI IPS 2 participated. The results of the N-gain analysis for each critical thinking indicator revealed a significant improvement, with the interpretation indicator achieving an N-gain value of 0.73, which falls into the high category. This indicator demonstrated the greatest increase among all measured aspects, indicating that the Scientific Discovery Learning model effectively supports students in interpreting information and understanding problems critically.

Figure 1. N-gain Values of Critical Thinking Skills Small Class Test



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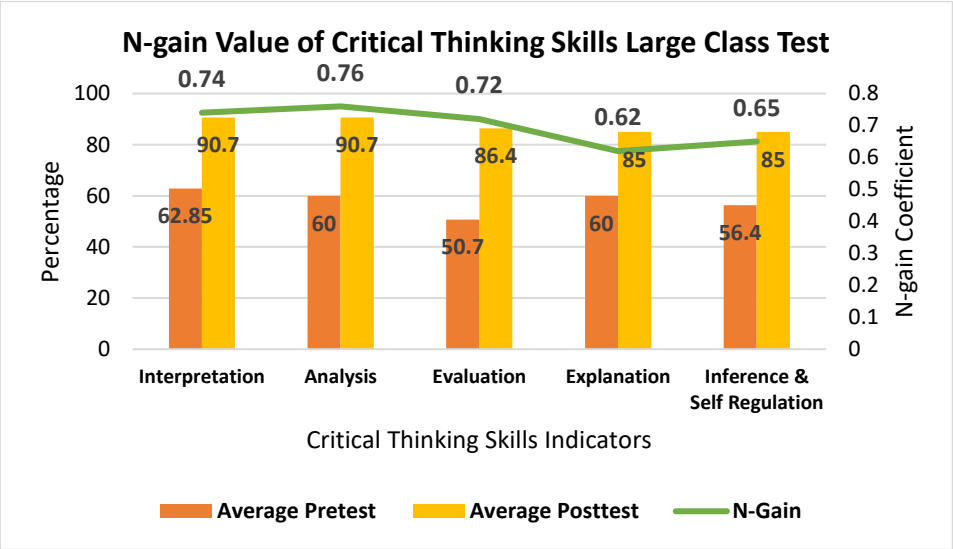
Subsequently, a large-class trial involving 35 students from class XI IPS 2 was carried out. The N-gain analysis showed that the analysis indicator reached the highest improvement with a score of 0.76, categorized as high. These findings suggest that the application of the Scientific Discovery Learning model enables students to analyze geographical phenomena more deeply and systematically. The structured learning stages encourage students to explore problems, process information critically, and draw logical conclusions.

Figure 2. N-gain Values of Critical Thinking Skills Large Class Test



Furthermore, the dissemination-class trial was conducted with 36 students from class XI IPS 1. The results indicated that the inference and self-regulation indicator achieved the highest N-gain score of 0.78, which is also classified as high. This improvement reflects students' ability to evaluate information, draw accurate conclusions, and regulate their own thinking processes. Overall, the results from all trial stages confirm that the Scientific Discovery Learning model is effective in significantly improving students' critical thinking skills in geography learning.

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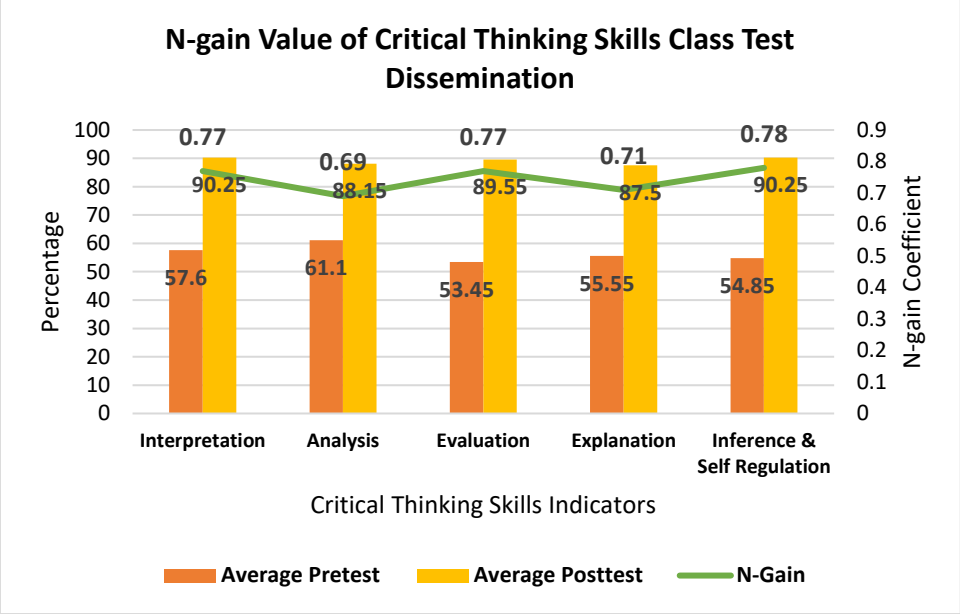
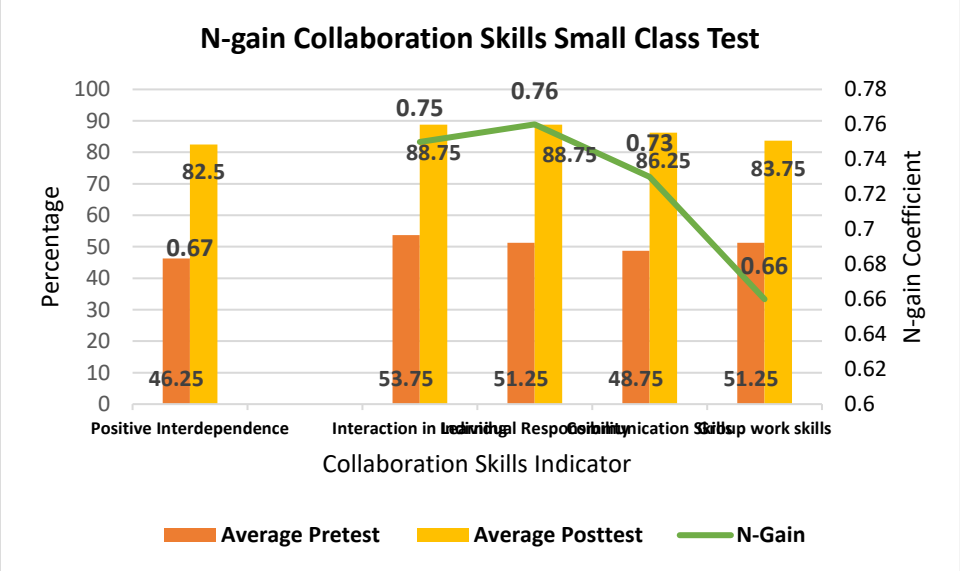
Figure 3. N-gain Values of Critical Thinking Skills Class Test Dissemination



3.3.2 Collaboration Skills

The effectiveness of the Scientific Discovery Learning model in fostering students' collaboration skills was also examined through small-class, large-class, and dissemination-class trials. In the small-class trial involving ten students from class XI IPS 2, the N-gain analysis showed that the individual responsibility indicator obtained the highest score of 0.76, categorized as high. This result indicates that students became more accountable for their roles and contributions during group learning activities.

Figure 4. N-gain Collaboration Skills Small Class Test



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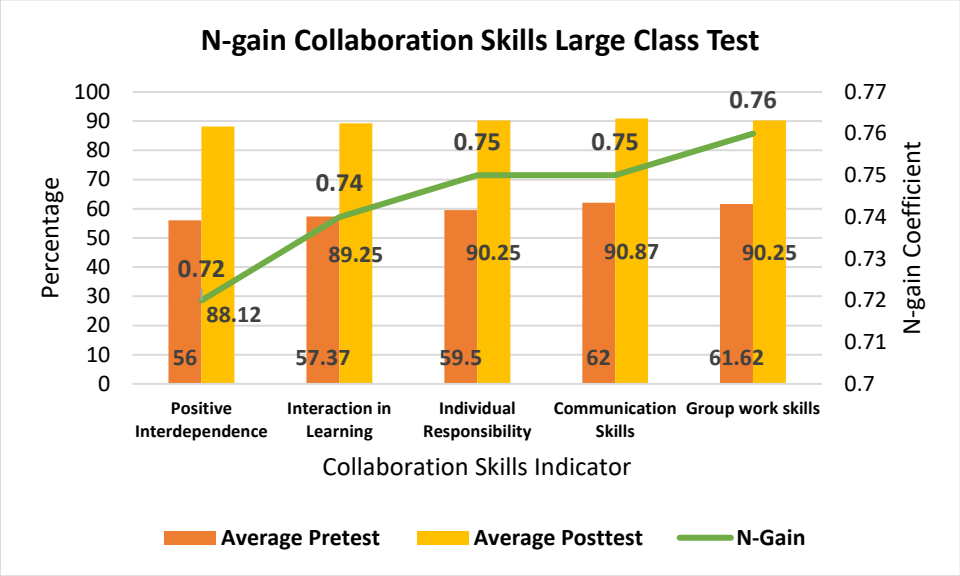
In the large-class trial with 35 students from class XI IPS 2, the indicator related to group work skills achieved an N-gain value of 0.76, which is also classified as high. This finding demonstrates that the Scientific Discovery Learning model effectively promotes cooperative interaction, mutual support, and shared responsibility among group members during the learning process.

Figure 5. N-gain Collaboration Skills Small Class Test



Meanwhile, the dissemination-class trial conducted with 36 students from class XI IPS 1 revealed that the communication skills indicator showed the highest improvement, with an N-gain score of 0.75 in the high category. This result suggests that students were increasingly able to express ideas, engage in meaningful discussions, and exchange information effectively. Based on these findings, it can be concluded that the Scientific Discovery Learning model is effective in enhancing students' collaboration skills across various learning contexts.

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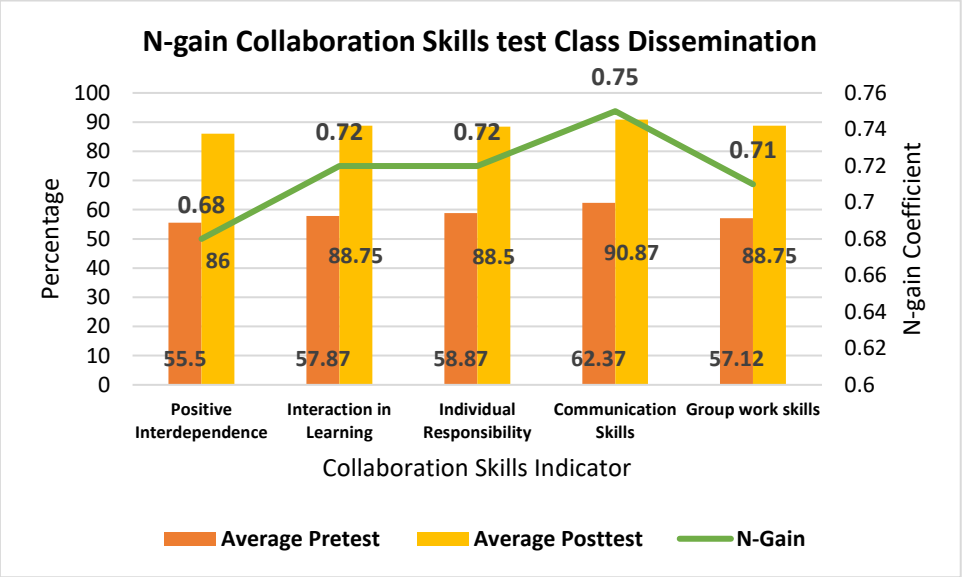
Figure 6. N-gain Collaboration Skills test Class Dissemination



The validated Scientific Discovery Learning Model demonstrated a very high level of validity, indicating that it is appropriate for implementation in the learning process. This high validity is attributed to the structured application of five systematic learning syntaxes. The first stage, Observation and Problem Orientation, focuses on engaging students in identifying facts or problems through activities such as observing, listening, reading, and interpreting information. This stage is essential because a clear understanding of the problem forms the foundation for identifying appropriate solutions (Nurwidodo et al., 2025). The second stage, Question Formulation and Group Organization, encourages students to generate questions based on the observed issues while the teacher organizes students into small working groups. This phase supports the development of social interaction, effective communication, and collaborative problem-solving skills (Sumarno & Peni, 2025). The third stage, Exploration and Investigation, involves students in collecting information from multiple sources or conducting guided investigations. Through direct engagement with data, objects, and phenomena, students develop a more active and in-depth understanding of the learning material (Magfiroh et al., 2025). The fourth stage, Discussion and Association, emphasizes the exchange and analysis of information obtained during previous stages, which is then synthesized into conclusions. Group discussions facilitate peer support and scaffolding, enabling students to construct knowledge collaboratively and draw more comprehensive conclusions. The final stage, Presenting and Evaluating, provides students with opportunities to present their findings orally in front of the class. Feedback from peers and teachers during this stage allows students to reflect on their understanding, refine arguments, and strengthen collective knowledge construction, thereby supporting optimal cognitive development (Xu & Wang, 2023).

In terms of practicality, the Scientific Discovery Learning model demonstrated strong feasibility following its implementation across multiple learning stages. Practicality data were collected through

observation sheets completed by observers during classroom implementation and through student response questionnaires filled out individually after the learning activities. The implementation was conducted through a sequence of trials, including small-class, large-class, and dissemination-class tests, all of which indicated that the model could be applied effectively in classroom settings. However, the findings also revealed that the Question Formulation and Group Organization stage required further refinement. Some students needed additional practice, guidance, and confidence-building support to actively ask questions and express ideas, particularly those who tended to be passive. To address this limitation, teachers provided scaffolding through examples of scientific questions and guiding question prompts, as appropriate instructional support is essential to ensure that learning objectives are achieved effectively (Astutik et al., 2025). Student responses collected through questionnaires further supported the practicality of the model. In the small-class trial, the average student response reached 85.68%, categorized as strongly agree, which was influenced by collaborative activities during the question formulation stage. The large-class trial yielded a student response of 82.7%, also classified as strongly agree, reflecting effective implementation of the Discussion and Association stage, where students actively exchanged ideas and linked findings to develop problem solutions. Similarly, the dissemination-class trial achieved an average response of 82.7% with a strongly agree category, indicating that the Scientific Discovery Learning model is practical and well received by students.

The effectiveness of the Scientific Discovery Learning model was clearly reflected in the N-gain scores obtained after classroom implementation, which reached at least the moderate category and predominantly the high category. These results demonstrate improvements in students' critical thinking abilities, particularly in problem-solving contexts, as well as enhanced collaboration skills during group-based tasks. In the small-class trial, the average N-gain score reached 0.70, categorized as high. This improvement was most evident in the interpretation indicator, which was strongly influenced by the Question Formulation and Group Organization stage. Through structured question development, students were trained to interpret information critically by transforming observations into analytical questions and reasoned opinions (Priswati et al., 2024). Similarly, the large-class trial also achieved an average N-gain score of 0.70, indicating high effectiveness. This improvement was associated with the Exploration and Investigation stage, where students were able to investigate and respond to problems by analyzing geographical phenomena in their surrounding environment. Critical thinking skills played a key role in supporting students' ability to examine data and draw logical conclusions (Kamur et al., 2025). The highest level of effectiveness was observed in the dissemination-class trial, which achieved an N-gain score of 0.78. This improvement indicates that students were increasingly capable of drawing accurate conclusions and revising their understanding based on new information. This outcome was influenced by the Discussion and Association stage, in which students shared and evaluated information collaboratively until reaching well-supported conclusions. Such learning activities promote active engagement, knowledge sharing, teamwork, and positive social interaction, ultimately contributing to improved learning outcomes (Sulastri et al., 2024).

Students collaboration skills were assessed using a ten-item questionnaire. The N-gain analysis for the small-class trial showed an average score of 0.71, classified as high. The most significant improvement was found in the individual responsibility indicator, which was influenced by the Exploration and Investigation stage. This stage encouraged students to become more active, reflective, and responsible learners when considering multiple perspectives and making reasoned decisions (Jannah & Miftah, 2025). In the large-class trial, collaboration skills also improved significantly, with an N-gain score of 0.74. The greatest improvement was observed in group work skills, influenced by the Question Formulation and Group Organization stage. This stage enabled students to engage more actively in questioning, discussion, leadership development, and collaborative knowledge construction (Barus, 2023). Likewise, the dissemination-class trial achieved an N-gain score of 0.74, with the highest increase found in communication skills. This improvement was driven by the Discussion and Association stage, where students demonstrated enhanced abilities to analyze problems, exchange ideas, and communicate solutions effectively. These collaborative interactions also supported cognitive development, particularly in strengthening critical thinking skills (Suleman, 2024).

4. CONCLUSION

Based on the results of this development research, the Scientific Discovery Learning model can be concluded to meet the criteria of validity, practicality, and effectiveness. The model demonstrated a high level of validity as confirmed by expert and practitioner evaluations. Its practicality was evident from the successful implementation of learning activities, supported by positive observer assessments and favorable student responses across all trial stages.

The effectiveness of the Scientific Discovery Learning model was shown through significant improvements in students' critical thinking and collaboration skills, as indicated by increased N-gain scores. Students were able to apply critical thinking skills effectively in solving problems, draw accurate conclusions, and regulate their thinking processes. In addition, students demonstrated improved collaboration skills by working responsibly in groups, communicating ideas clearly, and engaging actively in discussions.

The feasibility of the Scientific Discovery Learning model as a learning framework is supported by its strong theoretical foundation, clear instructional objectives, and alignment with students' learning characteristics. The implementation of this model contributes positively to the quality of geography learning by fostering active participation, meaningful interaction, and higher-order thinking skills. Therefore, the Scientific Discovery Learning model can be recommended as an effective instructional approach to improve learning outcomes and support the development of critical thinking and collaboration skills in geography education.

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