The Effect of Collaborative Learning Model on Improving Science Concept Understanding among Prospective Elementary School Teachers at Lambung Mangkurat University Student

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ARTICLE INFO	ABSTRACT
	This study aims to describe the implementation of the collaborative learning model toward improving students' conceptual understanding in science courses. This research employed a quasi-experimental design with a pretest–posttest control group. Data were analyzed using gain scores to determine the effectiveness of the model. The results showed that the collaborative learning model had a positive and significant effect on students' conceptual understanding in the Advanced Science course. The average pretest score in the control class was 46.11, while in the experimental class it was 51.81. After the implementation of the collaborative learning model, the posttest scores increased to 68.56 in the control class and 80.11 in the experimental class. The gain score in the control class was 0.01, while in the experimental class it was 0.06, indicating a higher improvement in conceptual understanding among students taught using the collaborative learning model. These findings demonstrate that collaborative learning can effectively enhance students' mastery of scientific concepts through peer interaction, discussion, and shared learning responsibility. The results imply that this model can be an effective alternative for improving science learning outcomes in teacher education programs. *This is an open access article under the <u>CC BY-NC-SA</u> license.*

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1. INTRODUCTION

Human resources owned by a nation play a crucial role in determining its progress and development. The quality, competence, and productivity of human resources directly influence a country's ability to innovate, manage resources effectively, and compete in the global arena. Therefore, investing in education and training is essential to build human capital that can drive sustainable national growth (Abdillah, 2024; Arifin, 2023; Weisbrod, 1962). The initial step that needs to be done is

to improve the quality of prospective educators. Through improving the quality of prospective educators, it is expected to be able to produce quality students too.

Lambung Mangkurat University as one of the institutions that has a big contribution to produce professional education staff from the level of PAUD to high school level. One of the study programs that will produce prospective teachers is the PGSD study program which focuses on providing knowledge, skills, attitudes to students so they can become professional elementary school teacher candidates. Therefore, prospective teachers or lecturers must be equipped with comprehensive competencies that include not only practical teaching skills but also deep and qualified theoretical knowledge. This combination enables them to perform their professional duties effectively, design meaningful learning experiences, and respond adaptively to the diverse needs of students (Rahmah et al., 2024). Adequate preparation during pre-service education is essential to ensure that future educators possess the pedagogical, professional, social, and personal competencies required to uphold the standards of the teaching profession.

As a prospective elementary school teacher, PGSD students are provided with a variety of lecture materials to support their professional competence. As revealed by (Ao & Junsuwan, 2025; Tsabitah & Fitria, 2021), Professional competence refers to a teacher's ability to master learning materials comprehensively, both in breadth and depth, enabling them to effectively guide and facilitate students in achieving the expected competency standards. Efforts to foster professional competence by equipping students about scientific material in elementary schools, one of which is science learning material.

The design of learning should be grounded in the fundamental nature of learning and teaching, as well as an understanding of both learners and educators, rather than being solely focused on outcomes measured through rote memorization(Ardian et al., 2025; Hafizh et al., 2023; Salsabil et al., 2024). Education needs to be aligned with the constructivist paradigm, emphasizing learning as a process in which learners actively construct knowledge and conceptual understanding through cognitive engagement and social interaction (Czarnocha, 2020; Julia et al., 2024; Wildan & Herdiana, 2025.).

Understanding concepts is a mental process of the adaptation and transformation of science (Nurahman et al., 2025; Pebrianti & Irawati, 2024). Based on Gagne's taxonomy, conceptual understanding is at the level of verbal information, according to Bloom's taxonomy at the level of comprehension, according to Anderson's taxonomy at the level of declarative knowledge, based on Merrill's taxonomy at the level of remember paraphrased, and according to Reigeluth's taxonomy at the level of understanding relationships (Reigeluth & Moore, 1999).

Lutfiana & Handayani (2025) Explains that students should have a solid grasp of essential concepts. This conceptual understanding is important so that students are not limited to memorizing facts, but can also comprehend the learning material, expand their knowledge, and relate one concept to another. Saleem et al., (2021) recommend that when teaching science should be taught as a concept, applied in the form of context and associated with science and other concepts, the meaning of knowledge is related to concept knowledge.

The explanation indicates that understanding the concept requires prerequisites for knowledge at a lower level and is a prerequisite for gaining knowledge at a higher level such as the application, analysis, synthesis, evaluation, insight, and wisdom of a person. In Bloom's taxonomic revision, Anderson & Krathwohl divided the concept understanding into 7 aspects, namely: (1) interpreting / interpreting; (2) exemplifying / giving examples; (3) classifying / classifying; (4) summarizing / summarizing; (5) inferring / concluding (6) comparing / (7) explaining / explaining (Wilson & Leslie, 2016)

Raffi (1999) states that there are at least three factors as a major barrier for students in achieving understanding of concepts, namely: (1) the selection of learning methods that tend to tolerate unitary ways of knowing, (2) curriculum substance that tends to be decontextual, and (3) the formulation of learning objectives are rarely oriented towards achieving a deep understanding of concepts.

Based on the statements of (S. Lestari et al., n.d.; Purba et al., 2025) that Learning is interpreted as the construction of information (knowledge) and understanding of concepts through the process of mental operations and social interaction, the lecturer as a facilitator applies a Collaborative Learning model that has the potential to improve students' understanding of concepts.

Learning efforts should be more directing students so that they have a harmony of life that is living together with others, respecting each other's opinions, respecting people's speech, responsibility, being willing to sacrifice, being accommodating, and having a big heart. The ways that are felt to be able to drive the learning process like this, namely through collaborative learning collaboration. Implementation of the Collaborative learning model provides more space for students to be more active in the learning process in the classroom because Collaborative learning emphasizes student discussion and activeness in working with the material that has been provided. Nizar (Yang, 2023) states that Collaborative learning is a group learning process in which each member contributes information, experiences, ideas, attitudes, opinions, abilities, and skills to possess together to increase mutual understanding of the concepts of all members. With the discussion and wider space, it is hoped that it will improve students' understanding of concepts.

Collaborative Learning Model as a means to improve students' understanding of low academic concepts through mutual learning activities in small groups. Not only that, Collaborative Learning can also guarantee students who have high academic ability to better through jumping / jumping material (Bule et al., 2024). As stated by Jasid & Sastromiharjo (2025) that "Much of the peer collaboration research would answer this question in the affirmative; interaction with a more competent peer has been shown to be highly effective in inducing cognitive development". Collaborative learning models are implemented in groups small and facilitating students can have a mutual learning relationship between group members.

Collaborative learning is an instructional approach in which students work together in groups, exchange ideas, and solve problems collectively. This method not only aims to achieve academic goals but also focuses on developing critical thinking skills that are essential for everyday life and the professional world. In today's rapidly advancing information era, critical thinking has become one of the most important skills, considering the complexity of the problems individuals must face when making decisions (Ahmad et al., 2022; Virliana & Fauziah, 2025). So, the collaborative learning model is learning that provides opportunities for students to share knowledge and experiences in small groups. Students have a positive dependency for mutual learning between peers.

Learning that is solely oriented toward cognitive outcomes will certainly have a less positive impact on students' overall development. Such an approach tends to foster individualistic attitudes, reduce tolerance, and distance students from shared values and the spirit of collaboration. As a result, students engage in learning not out of a genuine desire to understand and develop themselves, but merely to achieve high grades. This condition may cultivate selfishness and a lack of appreciation for the importance of cooperation in the learning process. If this continues, such attitudes may persist even after students complete their education. Ultimately, they may face difficulties in interacting, adapting, and collaborating with others, as well as in participating effectively within a community that values cooperation and empathy.

Collaborative learning builds the capacity to tolerate or resolve differences and build opinions in a group. The collaborative model can be described as follows. When collaboration occurs, all students are active. They communicate with each other naturally. In a group of 4 to 6 people, there lecturers have made a plan so that students can collaborate with one another. In groups that have been determined by the lecturer, the existing facilities are sought so that students are able to collaborate. With hope, each student can communicate with each other. With active communication between students, good relations and mutual respect will be established. At the same time have the desire to use it there will be a natural communication with the use of polite language.

According to (Afriadi et al., 2024; Sarifah & Hanif, 2025; Siregar et al., 2024) collaborative learning is a group process in which members support and rely on one another to achieve an agreed goal. This

definition sees the class as a perfect place to develop the skills and team/group building needed for life in the future. It is clearer that collaborative learning is the interaction between team members: (1) developed and shared to achieve a common goal, (2) provides input to better understand the problem at hand, (3) ask questions, understand more deeply and solve solutions, (4) react and work to understand other questions, deep understanding and solutions, (5) each member authorizes other members to talk and give input and to consider their contributions, (6) can be accounted for to other people , and they can be accountable to themselves, and (7) there is interdependence among team members. In collaborative learning, educators or lecturers delegate / transfer all authority to the learning team, collaborative work really authorizes and dares to surrender all the risk of group or class work that might be less approved or in an inconclusive position or produce a solution that is not appropriate with the property of educators or lecturers.

Collaborative learning is essentially an instructional method that focuses on the distribution and sharing of tasks within group activities, encouraging students to compare conclusions and group work processes, while also providing them with greater autonomy in completing their group assignments (de Jong et al., 2022; W. P. Lestari et al., 2023). This is of course very contrary to conventional methods, which place more emphasis on lectures and tight group discussions under the supervision of lecturers, which makes students less active in work and opinion. In the conventional learning process, learners provide learning materials in the same direction, namely in the form of one-way communication (teacher oriented), but in an innovative learning process, the direction of communication is two-way (student oriented).

In collaborative learning, it is very much needed the characteristics of cooperation, respect for the opinions of others, self-control, patience, and emotional intelligence that are qualified from students, because by having such traits it is expected that learning will be more meaningful, enjoyable and produce problem solving as is expected. As stated in Ardiansyah & Saqjuddin (2025) and A. H. Susanto et al., (2025) that collaborative learning removes stereotypes that are usually attached to students of certain circles, collaborates in groups, and is accustomed to different people, and produces graduates who are broad-minded and accept diversity, as one of the conditions for success in the era of globalization as it is today.

Collaborative learning is learning where students learn from one another through reflective learning that is active and collaborative. Collaborative learning is a learning relationship, that is learning that starts from the question of students who do not understand "How to do this part"? and students who understand and those who do not understand, both benefit and reciprocal relationships occur (Musfirah et al., 2025). In the collaborative learning model students who have more abilities will help students who have less abilities. And students who feel less able will be assisted by students who are capable, then creating an atmosphere of mutual learning. So, the relationship of mutual learning in collaborative learning will increase students' understanding of concepts so that there will be no students left behind or skyrocketed themselves.

While existing studies emphasize the benefits of collaborative learning in general, limited research specifically explores how collaborative learning enhances conceptual understanding among PGSD students, especially in science learning. The gap lies in contextualizing collaborative learning implementation within PGSD programs in Indonesian universities, such as ULM, with a focus on building deep conceptual understanding rather than surface-level achievement.

The objective of this study is to analyze the effectiveness of collaborative learning models in improving the conceptual understanding of science among PGSD ULM students. This study aims to provide empirical evidence and pedagogical recommendations to enhance professional competence in pre-service elementary teachers through constructivist-based collaborative strategies.

2. METHODS

Type and Design

The methods should be described with sufficient details to allow others to replicate and build on the published results. Please note that the publication of your manuscript implies that you must make all materials, data, computer code, and protocols associated with the publication available to readers. Please disclose any restrictions on the availability of materials or information at the submission stage. New methods and protocols should be described in detail, while well-established methods can be briefly described and appropriately cited.

Research manuscripts reporting large datasets deposited in a publicly available database should specify where the data have been deposited and provide the relevant accession numbers. If the accession numbers have not yet been obtained at the time of submission, please state that they will be provided during review. They must be provided before publication.

Interventional studies involving animals or humans, and other studies that require ethical approval, must list the authority that provided approval and the corresponding ethical approval code.

Data and Data Sources

The population and sample of the study were students in class 2A and students in class 2B. Treatment is given to the experimental class using the Collaborative Learning model in advanced science courses. The total sample is 92 with 79 details of female students and 13 male students. In the experimental class the number of all students was 47 people, 40 women and 7 men, while in the control class there were 45 students, 39 women and 6 men.

Data collection technique

This research was carried out through three stages, namely: (1) the preparatory stage in the form of field studies in the form of observations to campus, (2) the implementation phase was the stage of conducting the research starting with the pretest, and (3) the evaluation stage namely conducting a post test to find out if there were any the effect of collaborative learning. Data collection techniques were carried out in two stages: pre-research and the research process. As for the pre-research stage, namely interviews and observations, while the data collection techniques in the experimental research process: carried out before treatment (pre-test) and after treatment (posttest).

The instrument used in this study was a test. The test is used to measure students' understanding of concepts. The indicators of understanding the measured concepts are interpreting, modeling, classifying, summarizing, concluding, comparing, and explaining the meaning of concepts.

Data analysis

Table 1. Quasi experiment with pretest posttest

Control group	Pretest	No treatment	Posttest
Experiment group	Pretest	Treatment	Posttest

Table 2. List of sample amounts

Group	Sample	Total Student		Total
		W	M	
CC	Class of 2A	40	7	47
EC	Class of 2B	39	6	45
Total number of samples		79	13	92

Table 3. Indicator of concept understanding

Indicator of concept understanding	Definition
Interpretation	Explain, capture or interpret the purpose of words or discourse by expressing their own opinions
For example	Give examples of a concept or principle
Classify	Classify according to type
Summarize	Gather together or summarize
Conclude	Summarize (establish, summarize opinions) based on what is described
Compare	Combining (equating) two things and so on to find out the similarities or the difference
Explain the meaning of the concept	Explain or describe clearly

3. FINDINGS AND DISCUSSION

Findings

The data analyzed in this study are gain scores. The results of this study indicate that the average pretest score in the experimental class is superior to the control class that is 46.11 while the experimental class is 51.81.

The post test value in the control class was 68.56 and the experimental class was 80.11. This proves that after being treated using a collaborative learning model the posttest value of the experimental class is superior to the control class.

The experimental class experienced more improvement in terms of understanding the concept compared to the control class. The experimental class increased by 28.3 while the control class increased by 22.45.

Indicator analysis of understanding concepts in the experimental class for interpreting indicators increased by 25.4%. On the copying indicator there was an increase of 11.7%, the indicator classifying had an increase of 30.3%, on the summarizing indicator it had increased by 16.5%, on the conclusion indicator had an increase of 19.1%, the comparing indicator had an increase of 20, 5%, and the indicator explained an increase of 22.7%.

Whereas the control class for the interpreting indicator experienced an increase of 14.3%, the copying indicator experienced an increase of 4.4%, the classification indicator experienced an increase of 10.8%, the summarizing indicator experienced an increase of 18.5%, the indicator concluded experienced an increase of 14.1%, the compare indicator experienced an increase of 6%, and the indicator explained an increase of 18.8%.

Discussions

Based on the description it appears that the increase in each indicator is more in the experimental class compared to the control class. There is a significant difference in students' understanding of the concept between using a collaborative learning model and those using conventional methods. Judging from the average value of the gain score of students' concept understanding in class using collaborative learning models is higher than the value of students in conventional classes.

The gain score in the control class is 0.01 while the experimental class is 0.06. Whereas based on the independent t-test sample table the significance level of the data is 0.636. The level of this score is considered correlation, because the test score has a significance score above 0.5. So, Ha is accepted and Ho is rejected. The findings of this research on the collaborative learning model of understanding the concept of class IIA students of PGSD Lambung Mangkurat University in the academic year 2024/2025.

Table 4. Average score of concept understanding

Average Score	Pre test	Post test
Control Class	46,11	68,56
Experimental Class	51,81	80,11

Diagram 1. Pretest and posttest charts in the control class and experimental class
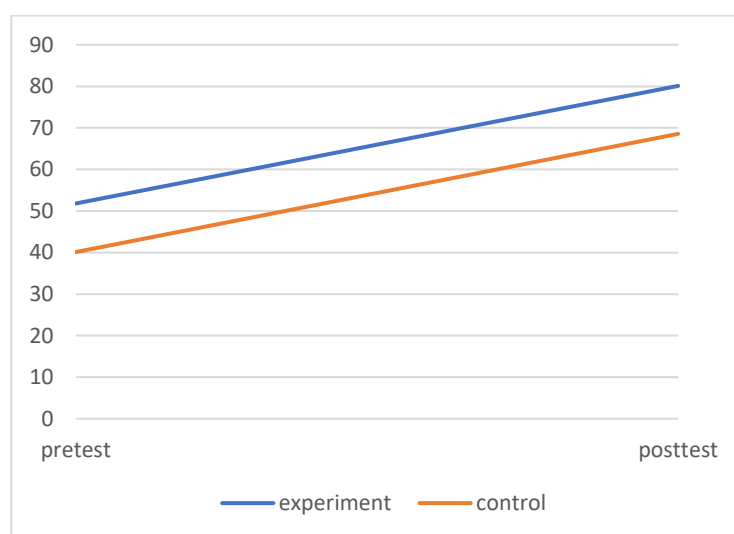
Table 5. The results of understanding the concepts of each indicator

Indicator	Percentation					
	Experiment			Control		
	pretest	Post test	Difference	pretest	Post test	Difference
Interpretation	40,3	65,7	25,4	41,7	56,0	14,3
For example	81,4	93,1	11,7	64,4	68,8	4,4
Classify	56,9	87,2	30,3	35,0	45,8	10,8
Summarize	65,4	81,9	16,5	50,5	69,0	18,5
Conclude	43,1	62,2	19,1	40,2	54,3	14,1
Compare	55,6	76,1	20,5	49,5	55,5	60
Explain the meaning of concept	38,2	60,9	22,7	39,4	58,2	18,8

Table 6. Independent sample t-test

		Levene's Tes for Equality of Variance		t-test for Equality of Means						
		F	Sig	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the difference	
									Lower	Upper
Postest	Equal Variances Assumed	,225	,636	3,055	74	,003	2,236	,732	,777	3,694
	Equal Variances Not Assumed			3,068	73,169	,003	2,236	,729	,783	3,688

Learning that uses collaborative learning can improve students' understanding of concepts because when collaborative learning is learned there is a relationship of student learning so that students who do not understand the learning understand and students who already understand will become more understanding. In learning collaborative learning models provide opportunities for students who do not understand to ask for the help of their own friends so that students will understand. The purpose of this group activity is as a means of exchanging thoughts, opinions and different interpretations of learning materials and assignments given to them.

This activity group not only aims to foster communication that emphasizes relationships with other students, but also learn from one another. As stated by Susanto & Yohana (2025) that explain that in the learning relationship, students engage with and encounter perspectives different from their own, allowing mutual influence that broadens and deepens their way of thinking. Moreover, collaborative learning fosters a sense of positive interdependence among learners.

Research by Houghton et al., (2022) on collaborative learning has shown that when students are given the opportunity to work together, they are able to do better. This proves that collaborative learning is beneficial and has a positive effect on the development of learning. Learning like this allows students to be actively involved in the process and when they do, they can better understand certain concepts or retain knowledge in their long-term memory. In addition, with students learning together, they will experience a complex and successful learning process and the teacher can produce students with good academic results.

(Lisyalama & Puspita,(2024); Wulandari et al., (2022) In their study, it was revealed that the ability to solve scientific problems and the level of confidence in learning science among prospective science teacher students who participated in lectures using problem-based collaborative learning strategies were higher compared to those who took conventional lectures. A research on peer influence also proves that collaborative learning can improve conceptual understanding and learning outcomes. peer influence plays a significant role in enhancing students' conceptual understanding within collaborative learning environments. Interaction with peers allows students to exchange ideas, clarify misunderstandings, and construct knowledge together through meaningful discussion. Consequently, peer involvement in collaborative learning not only strengthens comprehension but also fosters active participation, motivation, and deeper engagement in the overall learning process (Girsang et al., 2024; Mu'arifah et al., 2023).

4. CONCLUSION

Based on the research data, it was concluded that learning using collaborative learning learning models has an effect on increasing students' understanding of concepts. Using the collaborative learning model will create a climate of mutual learning, students who lack understanding will become understood and students who already understand will become more understanding because of exchanges and interactions between peers. In applying the collaborative learning model we must ensure that students really work together to solve a problem so that the benefits of collaborative learning can really be felt.

The novelty of this research lies in its specific focus on the implementation of the Collaborative Learning model to enhance conceptual understanding in science among PGSD (Elementary School Teacher Education) students at Lambung Mangkurat University, which has been relatively underexplored in the Indonesian context. While previous studies have highlighted the general benefits of collaborative learning, this study provides empirical evidence on its effectiveness in improving concept mastery based on multiple cognitive indicators—such as interpreting, classifying, concluding, and explaining concepts.

The main contribution of the study is its demonstration that collaborative learning significantly enhances conceptual understanding more effectively than conventional methods, especially in the context of teacher training programs. It also contributes pedagogical insights by providing a constructivist-based strategy that promotes deeper learning, peer interdependence, and inclusive participation in science education.

One limitation of this study is its restricted sample size and scope, involving only second-year students from a single university, which may limit the generalizability of the findings. Additionally, the research focuses solely on science learning without integrating other subject areas, which could provide broader insight into the model's applicability across the curriculum.

Future studies are recommended to:
1. Expand the research sample across multiple teacher education institutions to validate the findings in diverse educational settings.
2. Investigate longitudinal effects of collaborative learning on students' academic development and teaching performance in real classroom environments.
3. Explore the integration of digital collaborative tools to examine how technology-enhanced collaboration might further improve concept understanding.
4. Examine the impact of collaborative learning on other aspects of professional competence, such as pedagogical content knowledge and classroom management skills.

The findings of this study have important implications for teacher education programs and instructional practices. The significant improvement in conceptual understanding suggests that collaborative learning should be integrated systematically into science pedagogy for prospective elementary teachers. Educators are encouraged to:
1. Redesign learning activities to support peer interaction, mutual responsibility, and reflection, which are core elements of collaborative learning.
2. Train lecturers and instructors to adopt a facilitative role, guiding students through meaningful dialogue and teamwork rather than one-way instruction.
3. Promote student-centered learning environments that value cooperation, communication, and critical thinking.

In light of these findings, it is suggested that curriculum developers and education policymakers consider adopting collaborative learning models more widely to foster 21st-century skills and ensure deeper learning outcomes in teacher training programs.

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