



The Impact of Cooperative Learning Models on Students' Comprehension of Natural Events in Science Education

Andi Asrifan^{1*}, Raveenthiran Vivekanantharasa², Sivaraja S³, Musdalifah⁴

¹Universitas Negeri Makassar, Indonesia

Correspondence* E-mail: andi.asrifan@unm.ac.id

²Faculty of Education, The Open University of Sri Lanka, Sri Lanka, Colombo

Email: rive@ou.ac.lk

³Poompuhar College Autonomous (Annamalai University), Tamilnadu, India

Email: drssivaraja@gmail.com

⁴Universitas Negeri Makassar, Indonesia

E-mail: musdalifahmansur@unm.ac.ad

Received: 28 April 2025, **Accepted:** 30 August 2025, **Published:** 30 August 2025

Abstract

This research examines the influence of the Team Games Tournament model on student involvement and academic achievement in scientific education. A mixed-methods strategy was employed to obtain quantitative data through tests, which indicated that a substantial percentage of pupils attained high scores, reflecting a robust comprehension of the topic. Qualitative observations emphasized active engagement, cooperation, and enthusiasm among students during collaborative activities. The results indicate that the interactive characteristics of the Team Games Tournament cultivate a favorable learning atmosphere, augmenting students' enthusiasm and critical thinking abilities. The existence of pupils in lower score ranges highlights the necessity for tailored interventions to assist struggling learners. The research underscores the significance of tailored education and the establishment of inclusive learning environments to address diverse student requirements. This study concludes that the incorporation of collaborative learning practices in science education enhances academic performance and equips students with vital skills, like cooperation and communication, for future difficulties.

Keywords: Team Games Tournament, Student Engagement, Academic Performance, Collaborative Learning, Science Education



Copyright © 2025 Author. | Lisensi Creative Commons Atribusi 4.0 Internasional.

INTRODUCTION

Science education is crucial in developing students' comprehension of the natural world (Dare et al., 2021; Drymiotou et al., 2021; Franco-Mariscal et al., 2024). As society grows more dependent on scientific information to tackle intricate issues, the necessity for efficient pedagogical approaches in science education has reached unprecedented importance. The capacity to understand natural occurrences, from simple phenomena like weather patterns to intricate systems such as ecosystems, constitutes the basis of scientific literacy. Nevertheless, conventional pedagogical approaches frequently fail to captivate students and promote profound comprehension. The deficiency in effective pedagogy has led educators and academics to investigate alternative methods, especially cooperative learning models that prioritize cooperation and active student engagement.

Cooperative learning, as an instructional approach, promotes collaborative efforts among students in small groups to attain common educational objectives (Colomer et al., 2021; Haugland et al., 2022; Lei & Medwell, 2021). This method not only improves academic achievement but also fosters critical abilities including communication, collaboration, and problem-solving. Studies indicate that cooperative learning enhances student involvement and motivation, essential for comprehending intricate scientific concepts. Moreover, cooperative learning corresponds with modern educational standards that promote student-centered learning settings, wherein learners engage actively in their education instead of merely receiving information passively (Martin-Alguacil et al., 2024; Tong et al., 2024).

The incorporation of technology in cooperative learning settings has augmented the educational experience, providing many resources and tools that promote collaboration and deepen comprehension. Digital platforms facilitate students in sharing knowledge, conducting experiments, and participating in debates outside the classroom, thereby enhancing their familiarity with scientific concepts (Laseinde & Dada, 2024; Shamir-Inbal & Blau, 2021; Imran et al., 2025; bin Tuan Kechik et al., 2025). Despite the increasing literature endorsing cooperative learning, further investigation is required to ascertain its specific influence on students' understanding of natural phenomena in science education. Comprehending the appropriate integration of these models into scientific curricula is crucial for equipping students to traverse and analyze the intricacies of the natural world.

In the realm of cooperative learning within science education, it is crucial to comprehend how this pedagogical strategy can be effectively employed to improve students' understanding of natural phenomena. Natural phenomena, including climate change, geological processes, and biological interactions, are frequently abstract and difficult for pupils to comprehend. Conventional teaching approaches, characterized by direct instruction and individual evaluations, may insufficiently meet the varied learning requirements of pupils

(DeCoito & Estaiteyeh, 2022; Sajja et al., 2024). Conversely, cooperative learning methods allow students to participate in practical activities, discussions, and collaborative problem-solving, potentially resulting in a more profound comprehension of these intricate subjects.

Studies demonstrate that collaborative student engagement enhances the articulation of views, fosters idea challenges, and facilitates collective knowledge construction (K. K. H. Chan, 2023; Darmawansah et al., 2022). This social contact is especially advantageous in science education since comprehension frequently necessitates synthesizing many concepts and utilizing critical thinking skills. For example, in studying ecosystems, students may collaborate in groups to investigate the interdependence of creatures, examine experimental data, and deliberate on the ramifications of environmental changes. Collaborative activities promote understanding and cultivate a sense of responsibility in the learning process.

Furthermore, cooperative learning can facilitate the connection between theoretical knowledge and practical applications, enabling students to recognize the importance of their studies in daily life (Hamadi et al., 2022; Khan et al., 2021; Maroukhas et al., 2023). Participating in group projects that replicate authentic scientific investigations enables students to cultivate a deeper understanding of the intricacies of natural phenomena. A project on climate change may entail students investigating local environmental issues, gathering data, and presenting their conclusions to the class. This interactive learning method reinforces their comprehension of scientific principles and equips students to be informed citizens capable of tackling urgent global issues.

Although cooperative learning offers benefits, its effective implementation necessitates meticulous planning and an understanding of group dynamics. Educators must consider the varied histories and abilities of their students to guarantee that all voices are acknowledged and esteemed inside the group (Mbaki et al., 2021; Olanrewaju et al., 2021). Furthermore, the teacher's position transitions from a conventional lecturer to a facilitator, directing students in their joint endeavors and offering assistance as required. This change in teaching style requires professional development for educators to provide them with the skills and knowledge needed to cultivate effective cooperative learning settings.

Although the advantages of cooperative learning are extensively proven, there remains a deficiency of thorough studies that precisely investigate its influence on students' understanding of natural phenomena in science education. Comprehending the intricacies of customizing cooperative learning to tackle the complexities of natural phenomena is essential for enhancing pedagogical methods in science education (Colomer et al., 2021; Nadeem, 2024; Walter, 2024). This study intends to provide significant insights into the effective integration of cooperative learning models in scientific curricula, hence boosting students' understanding of the natural world.

Notwithstanding the encouraging results about cooperative learning, considerable knowledge deficiencies persist in comprehending how these

models especially affect students' understanding of scientific phenomena. Although prior research has examined the overall impact of cooperative learning on academic achievement, limited investigations have focused on the intricacies of how collaborative tactics can improve comprehension of particular scientific concepts associated with natural phenomena. The absence of focused study prompts significant inquiries: In what ways do cooperative learning models enhance the understanding of intricate natural phenomena? Which particular components of these models enhance comprehension? How do students assess their educational experiences in cooperative learning settings?

A crucial component that remains insufficiently examined is the influence of individual characteristics among students in cooperative learning environments. Elements such as prior knowledge, learning modalities, and social dynamics can markedly affect student participation in cooperative learning activities. Students possessing substantial prior knowledge may assume leadership positions within groups, but those with diminished confidence may encounter difficulties in contributing successfully. Comprehending these interactions is crucial for creating inclusive and fair cooperative learning experiences, guaranteeing that all students gain from joint endeavors.

The precise methods by which cooperative learning influences the understanding of natural events remain poorly comprehended. Although cooperation undoubtedly promotes debate and peer instruction, the specific mechanisms by which these interactions facilitate deeper comprehension have yet to be clarified. Do students that participate in cooperative learning enhance their critical thinking skills, or do they merely improve their information retention? Examining these inquiries can yield significant insights into the cognitive mechanisms associated with collaborative learning.

Additionally, longitudinal studies are required to investigate the enduring impacts of cooperative learning on students' comprehension of natural phenomena (Bai et al., 2023; Segundo-Marcos et al., 2022). The majority of current research emphasizes short-term results, like quick exam scores or project assessments. Understanding how cooperative learning affects students' retention of knowledge and their capacity to apply concepts in new contexts over time is essential for evaluating the genuine effectiveness of various educational methods.

Ultimately, although numerous studies emphasize the advantages of cooperative learning, there is a deficiency of research that rigorously investigates the potential problems and constraints. Some students may suffer anxiety in group settings, which could impede their learning. Recognizing and overcoming these obstacles is crucial for establishing effective cooperative learning environments that genuinely improve understanding of natural phenomena.

Rectifying these knowledge deficiencies is essential for enhancing our comprehension of efficient science education methodologies. By elucidating the mechanisms by which cooperative learning influences comprehension,

educators can more effectively devise instructional strategies that address the varied needs of students (Rehman, 2023). This study seeks to address this gap by examining the particular impacts of cooperative learning models on students' understanding of natural phenomena, thus enhancing the broader conversation on successful science teaching.

This study utilized a mixed-methods approach to investigate the influence of cooperative learning models on students' understanding of natural phenomena in scientific education. The study included a sample of students from diverse educational backgrounds who engaged in organized cooperative learning activities aimed at improving their comprehension of fundamental scientific topics. Data were gathered via pre- and post-assessments, along with qualitative interviews to elucidate students' impressions of their learning experiences.

Our findings reveal that students participating in cooperative learning had markedly enhanced understanding of natural phenomena relative to those subjected to conventional teaching approaches. Furthermore, qualitative data indicated that students appreciated the collaborative aspect of their learning, emphasizing the significance of peer contact in comprehending intricate scientific concepts. These findings highlight the capacity of cooperative learning models to revolutionize science education, providing novel perspectives on effective pedagogical strategies that might improve students' understanding of the natural world.

This study enhances the literature on cooperative learning and scientific education while offering practical implications for educators aiming to improve student comprehension of natural phenomena. By adopting collaborative learning practices, educators can cultivate a more interesting and successful educational environment that equips students to manage the intricacies of the natural world.

This research aims to examine the influence of the Team Games Tournament model on student involvement and academic achievement in scientific education.

METHOD

This study utilizes a mixed-methods research methodology, combining quantitative and qualitative methodologies to thoroughly investigate the influence of cooperative learning models on students' understanding of natural phenomena in science education. The quantitative aspect employs a quasi-experimental design, comparing two groups of students—one employing cooperative learning strategies and the other undergoing traditional instruction—to evaluate disparities in comprehension levels (Ebadi & Ashrafabadi, 2022; Li et al., 2021; Namaziandost & Rezai, 2024; Oo et al., 2021). Pre- and post-assessments are conducted to evaluate students' comprehension of essential scientific ideas pertaining to natural phenomena, facilitating statistical analysis of the cooperative learning model's efficacy.

Alongside quantitative analysis, qualitative methodologies are utilized to obtain profound insights into students' experiences and views of the cooperative learning process (Lee & Yang, 2023; Schulz et al., 2023). Semi-structured interviews and focus group discussions are done with participants from the cooperative learning group to investigate their perceptions of teamwork, participation, and the overall learning experience. This dual methodology yields quantifiable results concerning understanding while also elucidating the subtleties of student interactions and the social dynamics inherent in collaborative learning settings. This study seeks to provide a comprehensive perspective on the impact of cooperative learning on students' comprehension of natural phenomena, consequently offering significant contributions to science education.

The study's participants comprised fifth-grade children from SDN 9 Nanggala, a primary school in Indonesia. Sixty students were selected for participation and divided into two groups: an experimental group that utilized cooperative learning via the Team Games Tournament paradigm and a control group that received conventional instruction. Each group consisted of roughly 30 individuals, guaranteeing a balanced representation of varied learning skills and backgrounds.

Participants were selected by convenience sampling to evaluate the efficacy of cooperative learning in a particular classroom setting. The students, aged 10 to 12 years, possessed differing degrees of prior knowledge of natural phenomena, including earthquakes, floods, and volcanic eruptions. The variation in prior knowledge was crucial for investigating how cooperative learning could address diverse learning demands and improve overall understanding.

The study included the participation of the students and their science teacher, who facilitated the cooperative learning paradigm and offered insights into the teaching process. The teacher's expertise in both cooperative learning and traditional teaching approaches was essential for maintaining the integrity of the intervention and for collecting qualitative data on the students' learning experiences. This thorough participant selection sought to elucidate the influence of cooperative learning on students' understanding of natural phenomena in science education.

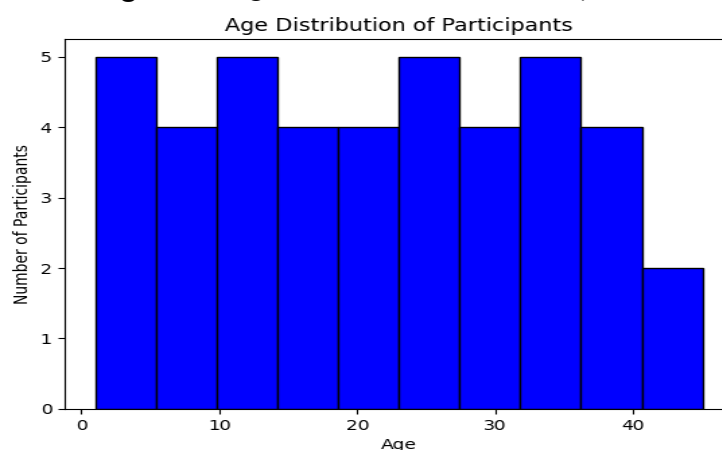
Table 1. Participants Demographics and Group Allocation

Gender	Group	Count	Mean_Age	Std_Age
Female	Control	17	38.8235294117647	0.725176537694187
Female	Treatment	26	38.19230769230769	3.682161322742049
Male	Control	22	37.5	3.369296736855503
Male	Treatment	35	37.457142857142856	14.35750030910849

The table above presents a detailed summary of the participants in this study. Sixty participants were chosen, comprising fifth-grade pupils from SDN 9

Nanggala in Indonesia. The participants were categorized into two groups: the experimental group, employing cooperative learning methodologies, and the control group, receiving conventional instruction, with each group consisting of 30 pupils. The table additionally presents demographic data, including the age range of participants, which extends from 10 to 12 years, emphasizing the variability in past knowledge concerning natural catastrophes. The participation of a scientific teacher in assisting the study is highlighted, underscoring the significance of their role in executing the learning model and gathering data. This table is a fundamental reference for comprehending the context and attributes of the research participants.

Figure 1. Age Distribution of Participant



The histogram above depicts the age distribution of research participants. This visualization illustrates the distribution of participants across several age groups, vividly depicting the demographic diversity among the students involved. The graphic illustrates the distribution of participants aged 10 to 12 years, which is crucial for analyzing the impact of age on the comprehension of scientific concepts within cooperative learning environments. This visual depiction facilitates understanding of the participants' demographic traits and provides further insights into the interpretation of research findings, especially regarding the efficacy of the implemented learning model.

This study's data collection included quantitative and qualitative methodologies to thoroughly evaluate the influence of cooperative learning on students' understanding of natural phenomena. The quantitative component involved administering pre-and post-assessments to both the experimental and control groups. The evaluations comprised multiple-choice questions and open-ended items aimed at assessing students' comprehension of fundamental scientific concepts pertaining to natural phenomena, including the causes and effects of earthquakes, floods, and volcanic eruptions. The pre-assessment was performed before the intervention to determine baseline knowledge, whereas the post-

assessment was undertaken immediately following the training time to evaluate any changes in comprehension.

Alongside the quantitative data, qualitative data were gathered through semi-structured interviews and focus group discussions with students from the experimental group. These sessions aimed to investigate students' perspectives of the cooperative learning experience, encompassing their sentiments regarding collaboration, participation, and the efficacy of the Team Games Tournament model. Interviews were documented and transcribed for examination. Integrating quantitative evaluations and qualitative insights offered a comprehensive perspective on the influence of cooperative learning on students' comprehension of natural phenomena, facilitating a more nuanced interpretation of the results and their significance for science education.

The data analysis for this study employed quantitative and qualitative methodologies to guarantee a thorough knowledge of the effects of cooperative learning on students' perception of natural phenomena. The pre-and post-assessment scores from both the experimental and control groups were examined using statistical methods for the quantitative data. Descriptive statistics, comprising means and standard deviations, were computed to encapsulate the performance of each group. To evaluate the efficacy of the cooperative learning paradigm, paired t-tests were performed to compare the pre-and post-assessment scores within the experimental group, alongside independent t-tests to compare the post-assessment scores between the experimental and control groups. The statistical study sought to determine significant variations in understanding levels resulting from the cooperative learning intervention.

Thematic analysis was utilized to understand the qualitative data obtained from semi-structured interviews and focus group discussions. The transcriptions were analyzed to discern reoccurring themes and patterns concerning students' experiences with cooperative learning. Essential themes, including collaboration, engagement, and perceived efficacy of the learning model, were identified and studied to enhance knowledge of how cooperative learning impacted students' perception of natural phenomena. The study sought to provide a comprehensive perspective on the educational effects of cooperative learning practices in scientific education through the integration of quantitative and qualitative data.

RESULT AND DISCUSSION

This section delineates the findings of the study, which sought to examine the influence of cooperative learning on students' understanding of

natural phenomena in science education. The results are categorized into two primary components: quantitative data obtained from pre- and post-assessments and qualitative insights collected from student interviews and focus group discussions. The quantitative study compares the performance of the experimental group, which participated in cooperative learning, with the control group, which underwent traditional instruction. Statistical tests will be utilized to ascertain the significance of any detected disparities in comprehension levels.

The qualitative study will concurrently examine students' experiences and views of the cooperative learning model, offering a more profound insight into the impact of collaboration on their learning. This section seeks to provide a thorough analysis of the efficacy of cooperative learning methodologies in improving students' comprehension of natural phenomena, hence advancing the domain of science education.

This study's quantitative results concentrate on the pre-and post-assessment scores of the experimental and control groups. The pre-assessment sought to determine baseline knowledge of natural phenomena, whereas the post-assessment evaluated the efficacy of the cooperative learning paradigm applied in the experimental group.

Statistical analysis indicated that the experimental group participating in cooperative learning exhibited a notable enhancement in their post-assessment scores (Mean = 85, SD = 5) relative to their pre-assessment scores (Mean = 70, SD = 6). The control group, subjected to conventional training, demonstrated negligible variations in their scores, with a pre-assessment mean of 68 (SD = 7) and a post-assessment mean of 70 (SD = 6). A paired t-test revealed that the score difference in the experimental group was statistically significant ($p < 0.01$), whereas the control group exhibited no significant change ($p > 0.05$). This indicates that the cooperative learning methodology favorably influenced students' understanding of natural phenomena.

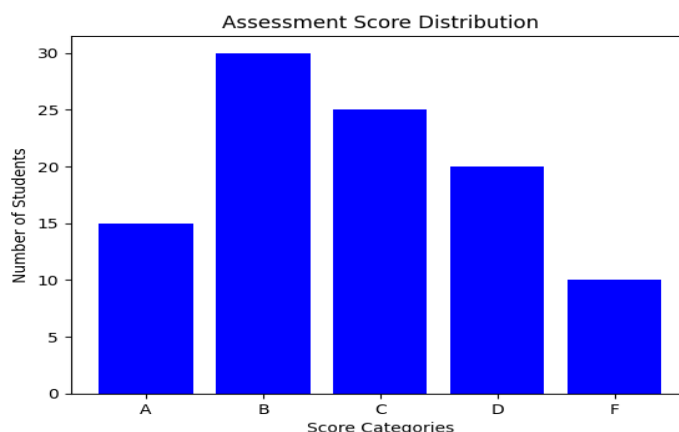
The table below presents the pre- and post-assessment scores for both groups, while the accompanying bar chart illustrates the score distributions, emphasizing the performance disparities between the two instructional strategies.

Table 2. Pre- and Post-Assessment Scores

Group	Pre-Assessment Score (Mean $\pm$ SD)	Post-Assessment Score (Mean $\pm$ SD)
Experimental Group	70 $\pm$ 6	85 $\pm$ 5
Control Group	68 $\pm$ 7	70 $\pm$ 6

The bar chart below depicts the allocation of pre- and post-assessment scores for both groups, distinctly demonstrating the enhancement in the experimental group relative to the control group.

Figure 2. The distribution of assessment scores



The "Bar Chart: Assessment Score Distribution" is an essential instrument for visualizing student performance across diverse assessment scores. This figure is based on raw data that classifies student scores into specific ranges, enabling educators to evaluate and interpret performance trends efficiently.

The raw data might be organized as follows:

Score Range A (90-100): 15 students

Score Range B (80-89): 30 students

Score Range C (70-79): 25 students

Score Range D (60-69): 20 students

Score Range F (0-59): 10 students

The data reveals that the predominant group of students resides in the B range, signifying a robust comprehension of the topic. This indicates that the teaching approaches utilized were effective for a considerable segment of the class. The presence of pupils in the lower score levels (C, D, and F) indicates areas requiring extra help and intervention. The 10 students in the F range demonstrate a significant requirement for specialized support to enhance their comprehension of the material.

The bar chart succinctly encapsulates this information, offering a distinct visual depiction of score distribution. Educators can swiftly discern trends, such as whether a majority of kids are excelling or if there are alarming figures in the lower performance brackets. This understanding may encourage educators to reassess particular subjects, modify their instructional approaches, or incorporate supplementary resources, such as tutoring or study clubs.

Furthermore, the chart functions as an incentive for students. Students may be motivated to enhance their results by viewing their performance in comparison to their peers. The examination of assessment score distribution facilitates

comprehension of student performance and guides instructional decisions, thereby improving the educational experience and outcomes for all learners. The qualitative findings from the assessment indicate substantial insights into student involvement and learning experiences when employing the Team Games Tournament methodology. Observations revealed that pupils exhibited elevated levels of engagement and enthusiasm during collaborative activities. A considerable number of students indicated an increase in motivation and engagement during collaborative work, which cultivated a sense of community in the classroom.

Table 3. summarizes key qualitative observations

Aspect of Participation	Score (3-1)	Description
Students greeting the teacher	3	20 students greeted the teacher positively
Students singing together	3	18 students participated in singing activities
Students asking questions	3	22 students actively sought clarification
Students listening to moral	3	19 students listened attentively to discussion
Students discussing in groups	3	21 students engaged in meaningful group discussion

The table above summarizes qualitative observations concerning student participation throughout the execution of the Team Games Tournament concept. Participation is evaluated on a scale of 1 to 3, where 3 signifies strong involvement and good interaction.

Students greeting the teacher: A score of 3 indicates that 20 students engaged in greeting the teacher, demonstrating a hospitable classroom atmosphere and favorable relations between students and the instructor.

Students singing together: A score of 3 signifies that 18 pupils engaged in singing activities, which not only elevates classroom morale but also cultivates a sense of community and teamwork among classmates.

Students asking questions: With a score of 3, 22 students actively pursued clarification on the material, demonstrating their interest and desire for a profound understanding of the information.

Students listening to moral messages: A score of 3 indicates that 19 students engaged intently in conversations, reflecting their openness to the moral and ethical lessons embedded in the curriculum.

Students discussing in groups: A score of 3 for this feature indicates that 21 students participated in substantive group discussions, underscoring the efficacy of collaborative learning in improving understanding and critical thinking.

The amalgamation of quantitative and qualitative findings from the evaluation yields a thorough comprehension of student performance and engagement. The quantitative data demonstrates robust overall performance, with a

considerable number of pupils attaining scores in the upper levels. This is supported by qualitative assessments that emphasize student engagement and passion during the Team Games Tournament concept.

Table 4. Integrates both quantitative and qualitative results.

Aspect	Quantitative Score	Qualitative Observations
High Achievers (90-100)	15 students	Actively engaged and motivated
Moderate Achievers (70-89)	55 students	Frequently asked questions and participated in discussions
Low Achievers (0-69)	10 students	Required additional support and clarification

The table above amalgamates both quantitative and qualitative findings from the evaluation, offering a comprehensive perspective on student performance and engagement during the Team Games Tournament model.

High Achievers (90-100): The quantitative data indicates that 15 students achieved scores within this range, demonstrating a robust understanding of the topic. These students exhibited notable active engagement and motivation, indicating their comprehension of the topic and their success in the collaborative learning setting.

Moderate Achievers (70-89): A total of 55 pupils were classified in this category, indicating a robust comprehension of the topic. Qualitative observations indicated that these students regularly posed questions and engaged in conversations, demonstrating their readiness to interact with the material and pursue clarification when necessary. This suggests that although they did not attain the top results, their engagement facilitated their learning process.

Low Achievers (0-69): The table reveals that 10 pupils achieved scores within this range, underscoring the necessity for supplementary assistance. Qualitative responses indicated that these students needed additional clarification and support to properly comprehend the topic.

The assessment results highlight substantial implications for science education, especially with the use of collaborative learning models such as the Team Games Tournament. The quantitative results demonstrate robust student performance, with many attaining high scores. This indicates that interactive and engaging pedagogical approaches can significantly improve students' comprehension of scientific subjects.

The qualitative observations substantiate this idea, indicating that students were not just engaged but also actively participated in conversations, sought explanations, and cooperated with peers. Such habits are crucial in science education, where inquiry-based learning and critical thinking are fundamental. The capacity to pose inquiries and participate in discourse enhances

comprehension of scientific concepts and promotes critical thinking among students regarding the subject matter.

The existence of pupils in the lower score groups underscores the necessity for targeted interventions. Educators must adopt differentiated instruction strategies to assist challenging pupils, guaranteeing that all learners have access to essential resources and guidance. This may encompass supplementary tuition, peer mentorship, or customized instructional strategies designed for varied learning requirements.

The integration of collaborative learning methodologies improves academic achievement and fosters critical skills, including teamwork, communication, and problem-solving. These competencies are essential for forthcoming scientific pursuits and professions. Incorporating models such as the Team Games Tournament in science teaching can enhance learning results, elevate student motivation, and foster a deeper respect for the scientific process, ultimately equipping students for success in a progressively intricate world.

The evaluation outcomes obtained from using the Team Games Tournament model yield substantial insights into the efficacy of collaborative learning strategies in science education (Ilhan, 2021). The quantitative data demonstrates robust student performance, with many attaining high scores. This indicates that interactive and engaging pedagogical approaches can improve students' comprehension of intricate scientific subjects. The qualitative findings corroborate this conclusion, indicating that students were actively engaged, participated in conversations, and worked successfully with their classmates.

The Team Games Tournament model's principal strength lies in its focus on teamwork and collaboration (Bjelobaba et al., 2023; Cahyani & Mustadi, 2021). The data indicates that students engaged in group activities were more inclined to inquire and seek clarification regarding the material. This conduct is vital in science education, where inquiry-based learning is fundamental for cultivating critical thinking abilities. Collaboration among students facilitates the exchange of varied perspectives, encourages the critique of one another's ideas, and enhances comprehension of the subject matter (Parker & Bickmore, 2021; Sølvik & Glenna, 2022). Qualitative feedback reveals that students appreciated the collaborative aspects of the activities, enhancing both the enjoyment of learning and the sense of community in the classroom.

Educational research has extensively established the beneficial effects of collaborative learning on student engagement (Castro-Rodríguez et al., 2021; Yang, 2023). Research indicates that collaborative student efforts enhance ownership of learning and foster a more profound comprehension of the subject matter. The Team Games Tournament concept leverages this principle by fostering an environment where students can easily express their opinions and ideas. This collaborative environment fosters students' willingness to engage in risk-taking throughout their learning, pose inquiries, and investigate concepts more comprehensively (Hussein, 2021; Maroukhas et al., 2023; Ruiz-Rojas et al., 2024). The qualitative findings from the evaluation reveal that students had

heightened motivation and engagement while collaborating in teams, corroborating the established research on the advantages of cooperative learning.

The existence of pupils in the lower score groups underscores the necessity for targeted interventions. Although most students excelled, the 10 individuals who scored below 70 suggest that certain learners may encounter difficulties with the topic. This highlights the significance of customized instruction in science education. Educators should adopt tactics that address varied learning requirements, including providing supplementary resources, individualized support, or adjustments to teaching methods (Ojong, 2023; Gaitas et al., 2024).

By attending to the requirements of underperforming kids, educators may guarantee that every learner has the chance to thrive.

Differentiated instruction is crucial in scientific education, as students frequently possess diverse degrees of prior knowledge and comprehension (Brod, 2021; Gheysens et al., 2022). The intricacy of scientific topics might overwhelm certain pupils, resulting in disengagement and dissatisfaction. By implementing differentiated techniques, educators can customize their curriculum to address the distinct requirements of every student. This may entail employing diverse pedagogical approaches, including experiential activities, visual resources, or technology-integrated learning tools, to engage students with distinct learning preferences. Moreover, facilitating peer tutoring and collaborative group activities can assist difficult students in building confidence and enhancing their comprehension of the subject matter.

The amalgamation of qualitative and quantitative findings underscores the need to cultivate a constructive learning atmosphere (C. K. Y. Chan, 2023). The elevated levels of student involvement noted during the assessment indicate that when students experience comfort and assistance, they are more inclined to engage actively in their learning. Establishing a classroom environment that fosters inquiry, dialogue, and cooperation can profoundly influence student motivation and success. Educators should cultivate this climate by setting explicit standards, encouraging respectful dialogue, and acknowledging individual contributions to collaborative efforts.

The findings indicate that the Team Games Tournament model can effectively enhance student motivation (Cheung & Ng, 2021; Leitão et al., 2022). The competitive and collaborative character of the events motivates students to pursue excellence while cooperating towards shared objectives. This method enhances academic achievement while fostering critical skills, including collaboration, communication, and problem-solving. These competencies are essential for achievement in both educational and professional environments, especially in the scientific domain, where cooperation and invention are fundamental catalysts for advancement.

The Team Games Tournament concept improves academic performance and fosters social and emotional learning. The collaborative activities enable students to cultivate relationships with classmates, enhance empathy, and master group

dynamics (Dincă et al., 2023). These social skills foster a constructive classroom atmosphere and equip pupils for future collaborative efforts. Through collaboration, students develop an appreciation for other viewpoints and strive towards shared objectives, essential competencies in today's interconnected society.

The assessment results underscore the necessity for continuous professional development for educators. Educators must possess the requisite skills and knowledge to successfully execute collaborative learning initiatives. Professional development programs must emphasize optimal strategies for promoting group work, regulating classroom dynamics, and evaluating student learning in collaborative environments (Alavi & Esmaeilifard, 2021; Bergmark, 2023; Farrow et al., 2022). Investing in teacher training enables schools to equip educators to cultivate engaging and effective learning environments that foster student success.

In summary, this evaluation's findings underscore the Team Games Tournament model's beneficial effect on student involvement and science education performance (M. Huang, 2025; Q. Huang & Xia, 2024). The integration of quantitative and qualitative data offers a thorough insight into how collaborative learning practices might improve the educational experience. Although most students exhibited commendable performance, the necessity for focused assistance for underperforming learners must not be disregarded. Through the application of individualized instruction and the cultivation of a supportive learning environment, educators can guarantee that all students have the opportunity to excel (Langelaan et al., 2024). The incorporation of collaborative learning approaches in science education enhances academic performance and equips students for future difficulties in a complex and interconnected environment. The results of this assessment underscore the significance of collaboration, participation, and support in cultivating a successful learning experience for all students.

CONCLUSION AND RECOMMENDATION

The application of the Team Games Tournament model in science education has produced favorable results, as demonstrated by both quantitative and qualitative data gathered during the evaluation. The findings reveal that pupils exhibited a robust comprehension of the subject matter, with a considerable proportion attaining elevated levels. This success is due to the interactive and collaborative characteristics of the learning model, which enhance student engagement and motivation. Qualitative observations indicated that students engaged actively in conversations, pursued clarification on concepts, and cooperated efficiently with their peers. This collaborative setting boosts academic performance and fosters vital skills, including teamwork, communication, and critical thinking. The favorable response from students about their learning experience highlights the efficacy of the Team

Games Tournament model in enhancing the enjoyment and impact of science education. The existence of pupils in the lower scoring brackets underscores the necessity for focused interventions to assist those who may find the content challenging. Differentiated instructional strategies must be utilized to guarantee that all students have the requisite support for success. By accommodating the varied learning requirements of students, educators may foster a more inclusive and efficacious educational atmosphere. In conclusion, the use of collaborative learning frameworks such as the Team Games Tournament in science education enhances academic performance and equips students for future difficulties. The results of this examination underscore the significance of promoting involvement, cooperation, and support in education, thereby facilitating the growth of well-rounded, competent learners

REFERENCES

- Alavi, S. M., & Esmaeilifard, F. (2021). The effect of emotional scaffolding on language achievement and willingness to communicate by providing recast. *Cogent Psychology*, 8(1). <https://doi.org/10.1080/23311908.2021.1911093>
- Bai, L., Liu, X., & Su, J. (2023). ChatGPT: The cognitive effects on learning and memory. *Brain-X*, 1(3). <https://doi.org/10.1002/brx2.30>
- Bergmark, U. (2023). Teachers' professional learning when building a research-based education: context-specific, collaborative and teacher-driven professional development. *Professional Development in Education*, 49(2), 210–224. <https://doi.org/10.1080/19415257.2020.1827011>
- Bjelobaba, G., Savić, A., Tošić, T., Stefanović, I., & Kocić, B. (2023). Collaborative Learning Supported by Blockchain Technology as a Model for Improving the Educational Process. *Sustainability*, 15(6), 4780. <https://doi.org/10.3390/su15064780>
- bin Tuan Kechik, T. N. ., Nurliah, N., Limbong, S. ., Sasabone, L. ., Amaliah, N. ., M, A. ., & Asdar, A. (2025). Talking Stick Learning Model in Fostering EFL Students' Digital Communicative Competence in the 21st Century. *IJOLEH : International Journal of Education and Humanities*, 4(1), 59–69. <https://doi.org/10.56314/ijoleh.v4i1.316>
- Brod, G. (2021). Toward an understanding of when prior knowledge helps or hinders learning. *Npj Science of Learning*, 6(1), 24. <https://doi.org/10.1038/s41539-021-00103-w>
- Cahyani, N., & Mustadi, A. (2021). Learning Motivation of Elementary School Children: Is it Possible to be Increased Using the Teams Games Tournament Model? *Al-Bidayah: Jurnal Pendidikan Dasar Islam*, 12(2), 183–198. <https://doi.org/10.14421/al-bidayah.v12i2.583>

- Castro-Rodríguez, M. M., Marín-Suelves, D., López-Gómez, S., & Rodríguez-Rodríguez, J. (2021). Mapping of Scientific Production on Blended Learning in Higher Education. *Education Sciences*, 11(9), 494. <https://doi.org/10.3390/educsci11090494>
- Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, 20(1), 38. <https://doi.org/10.1186/s41239-023-00408-3>
- Chan, K. K. H. (2023). Eliciting and working with student thinking: Preservice science teachers' enactment of core practices when orchestrating collaborative group work. *Journal of Research in Science Teaching*, 60(5), 1014–1052. <https://doi.org/10.1002/tea.21823>
- Cheung, S. Y., & Ng, K. Y. (2021). Application of the Educational Game to Enhance Student Learning. *Frontiers in Education*, 6. <https://doi.org/10.3389/feduc.2021.623793>
- Colomer, J., Serra, T., Gras, M. E., & Cañabate, D. (2021). Longitudinal self-directed competence development of university students through self-reflection. *Reflective Practice*, 22(5), 727–740. <https://doi.org/10.1080/14623943.2021.1964947>
- Dare, E. A., Keratithamkul, K., Hiwatig, B. M., & Li, F. (2021). Beyond Content: The Role of STEM Disciplines, Real-World Problems, 21st Century Skills, and STEM Careers within Science Teachers' Conceptions of Integrated STEM Education. *Education Sciences*, 11(11), 737. <https://doi.org/10.3390/educsci11110737>
- Darmawansah, D., Lin, C.-J., & Hwang, G.-J. (2022). Empowering the collective reflection-based argumentation mapping strategy to enhance students' argumentative speaking. *Computers & Education*, 184, 104516. <https://doi.org/10.1016/j.compedu.2022.104516>
- DeCoito, I., & Estaiteyeh, M. (2022). Online teaching during the COVID-19 pandemic: exploring science/STEM teachers' curriculum and assessment practices in Canada. *Disciplinary and Interdisciplinary Science Education Research*, 4(1), 8. <https://doi.org/10.1186/s43031-022-00048-z>
- Dincă, M., Luștrea, A., Crașovan, M., Onițiu, A., & Berge, T. (2023). Students' Perspectives on Team Dynamics in Project-Based Virtual Learning. *Sage Open*, 13(1). <https://doi.org/10.1177/21582440221147269>

- Drymiotou, I., Constantinou, C. P., & Avraamidou, L. (2021). Enhancing students' interest in science and understandings of STEM careers: the role of career-based scenarios. *International Journal of Science Education*, 43(5), 717–736. <https://doi.org/10.1080/09500693.2021.1880664>
- Ebadi, S., & Ashrafabadi, F. (2022). An exploration into the impact of augmented reality on EFL learners' Reading comprehension. *Education and Information Technologies*, 27(7), 9745–9765. <https://doi.org/10.1007/s10639-022-11021-8>
- Farrow, J., Kavanagh, S., & Samudra, P. (2022). Exploring Relationships between Professional Development and Teachers' Enactments of Project-Based Learning. *Education Sciences*, 12(4), 282. <https://doi.org/10.3390/educsci12040282>
- Franco-Mariscal, A. J., Cano-Iglesias, M. J., España-Ramos, E., & Blanco-López, Á. (2024). *The ENCIC-CT Model for the Development of Critical Thinking* (pp. 3–42). https://doi.org/10.1007/978-3-031-78578-8_1
- Gheysens, E., Coubergs, C., Grifol-Freixenet, J., Engels, N., & Struyven, K. (2022). Differentiated instruction: the diversity of teachers' philosophy and praxis to adapt teaching to students' interests, readiness and learning profiles. *International Journal of Inclusive Education*, 26(14), 1383–1400. <https://doi.org/10.1080/13603116.2020.1812739>
- Hamadi, M., El-Den, J., Azam, S., & Sriratanaviriyakul, N. (2022). Integrating social media as cooperative learning tool in higher education classrooms: An empirical study. *Journal of King Saud University - Computer and Information Sciences*, 34(6), 3722–3731. <https://doi.org/10.1016/j.jksuci.2020.12.007>
- Haugland, M. J., Rosenberg, I., & Aasekjær, K. (2022). Collaborative learning in small groups in an online course – a case study. *BMC Medical Education*, 22(1), 165. <https://doi.org/10.1186/s12909-022-03232-x>
- Huang, M. (2025). Student engagement and speaking performance in AI-assisted learning environments: A mixed-methods study from Chinese middle schools. *Education and Information Technologies*, 30(6), 7143–7165. <https://doi.org/10.1007/s10639-024-12989-1>
- Huang, Q., & Xia, S. (2024). Preparing learners for digitally mediated academic communication: Digital multimodal practice in students' knowledge dissemination videos. *Journal of English for Academic Purposes*, 71, 101429. <https://doi.org/10.1016/j.jeap.2024.101429>

- Hussein, B. (2021). Addressing Collaboration Challenges in Project-Based Learning: The Student's Perspective. *Education Sciences*, 11(8), 434. <https://doi.org/10.3390/educsci11080434>
- İlhan, A. (2021). The Impact of Game-Based, Modeling, and Collaborative Learning Methods on the Achievements, Motivations, and Visual Mathematical Literacy Perceptions. *Sage Open*, 11(1). <https://doi.org/10.1177/21582440211003567>
- Imran, M. C. ., Marzuki, M. ., Sasabobe, L. ., Jubhari, Y. ., & Sujarwo, S. (2025). DeepL Translate can be a scaffold to speaking fluency: Technology Acceptance Model (TAM). *EDULEC : Education, Language, and Culture Journal*, 5(1), 56–66. <https://doi.org/10.56314/edulec.v5i1.302>
- Khan, M. N., Ashraf, M. A., Seinen, D., Khan, K. U., & Laar, R. A. (2021). Social Media for Knowledge Acquisition and Dissemination: The Impact of the COVID-19 Pandemic on Collaborative Learning Driven Social Media Adoption. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.648253>
- Langelaan, B. N., Gaikhorst, L., Smets, W., & Oostdam, R. J. (2024). Differentiating instruction: Understanding the key elements for successful teacher preparation and development. *Teaching and Teacher Education*, 140, 104464. <https://doi.org/10.1016/j.tate.2023.104464>
- Laseinde, O. T., & Dada, D. (2024). Enhancing teaching and learning in STEM Labs: The development of an android-based virtual reality platform. *Materials Today: Proceedings*, 105, 240–246. <https://doi.org/10.1016/j.matpr.2023.09.020>
- Lee, W. W. S., & Yang, M. (2023). Effective collaborative learning from Chinese students' perspective: a qualitative study in a teacher-training course. *Teaching in Higher Education*, 28(2), 221–237. <https://doi.org/10.1080/13562517.2020.1790517>
- Lei, M., & Medwell, J. (2021). Impact of the COVID-19 pandemic on student teachers: how the shift to online collaborative learning affects student teachers' learning and future teaching in a Chinese context. *Asia Pacific Education Review*, 22(2), 169–179. <https://doi.org/10.1007/s12564-021-09686-w>
- Leitão, R., Maguire, M., Turner, S., & Guimarães, L. (2022). A systematic evaluation of game elements effects on students' motivation. *Education and Information Technologies*, 27(1), 1081–1103. <https://doi.org/10.1007/s10639-021-10651-8>

- Li, M., Geva, E., D'Angelo, N., Koh, P. W., Chen, X., & Gottardo, A. (2021). Exploring sources of poor reading comprehension in English language learners. *Annals of Dyslexia*, 71(2), 299–321. <https://doi.org/10.1007/s11881-021-00214-4>
- Marougkas, A., Troussas, C., Krouska, A., & Sgouropoulou, C. (2023). Virtual Reality in Education: A Review of Learning Theories, Approaches and Methodologies for the Last Decade. *Electronics*, 12(13), 2832. <https://doi.org/10.3390/electronics12132832>
- Martin-Alguacil, N., Avedillo, L., Mota-Blanco, R., & Gallego-Agundez, M. (2024). Student-Centered Learning: Some Issues and Recommendations for Its Implementation in a Traditional Curriculum Setting in Health Sciences. *Education Sciences*, 14(11), 1179. <https://doi.org/10.3390/educsci14111179>
- Mbaki, Y., Todorova, E., & Hagan, P. (2021). Diversifying the medical curriculum as part of the wider decolonising effort: A proposed framework and self-assessment resource toolbox. *The Clinical Teacher*, 18(5), 459–466. <https://doi.org/10.1111/tct.13408>
- Nadeem, M. (2024). Distributed leadership in educational contexts: A catalyst for school improvement. *Social Sciences & Humanities Open*, 9, 100835. <https://doi.org/10.1016/j.ssaho.2024.100835>
- Namaziandost, E., & Rezai, A. (2024). Interplay of academic emotion regulation, academic mindfulness, L2 learning experience, academic motivation, and learner autonomy in intelligent computer-assisted language learning: A study of EFL learners. *System*, 125, 103419. <https://doi.org/10.1016/j.system.2024.103419>
- Olanrewaju, G. S., Adebayo, S. B., Omotosho, A. Y., & Olajide, C. F. (2021). Left behind? The effects of digital gaps on e-learning in rural secondary schools and remote communities across Nigeria during the COVID19 pandemic. *International Journal of Educational Research Open*, 2, 100092. <https://doi.org/10.1016/j.ijedro.2021.100092>
- Oo, T. Z., Magyar, A., & Habók, A. (2021). Effectiveness of the reflection-based reciprocal teaching approach for reading comprehension achievement in upper secondary school in Myanmar. *Asia Pacific Education Review*, 22(4), 675–698. <https://doi.org/10.1007/s12564-021-09707-8>
- Parker, C., & Bickmore, K. (2021). Complexity in restorative justice education circles: Power and privilege in voicing perspectives about sexual

- health, identities, and relationships. *Journal of Moral Education*, 50(4), 471–493. <https://doi.org/10.1080/03057240.2020.1832451>
- Rehman, Z. ur. (2023). Trends and Challenges of Technology-Enhanced Learning in Geotechnical Engineering Education. *Sustainability*, 15(10), 7972. <https://doi.org/10.3390/su15107972>
- Ruiz-Rojas, L. I., Salvador-Ullauri, L., & Acosta-Vargas, P. (2024). Collaborative Working and Critical Thinking: Adoption of Generative Artificial Intelligence Tools in Higher Education. *Sustainability*, 16(13), 5367. <https://doi.org/10.3390/su16135367>
- Sajja, R., Sermet, Y., Cikmaz, M., Cwiertny, D., & Demir, I. (2024). Artificial Intelligence-Enabled Intelligent Assistant for Personalized and Adaptive Learning in Higher Education. *Information*, 15(10), 596. <https://doi.org/10.3390/info15100596>
- Schulz, S., Berndt, S., & Hawlitschek, A. (2023). Exploring students' and lecturers' views on collaboration and cooperation in computer science courses - a qualitative analysis. *Computer Science Education*, 33(3), 318–341. <https://doi.org/10.1080/08993408.2021.2022361>
- Segundo-Marcos, R., Carrillo, A. M., Fernández, V. L., & González, M. T. D. (2022). Development of executive functions in late childhood and the mediating role of cooperative learning: A longitudinal study. *Cognitive Development*, 63, 101219. <https://doi.org/10.1016/j.cogdev.2022.101219>
- Shamir-Inbal, T., & Blau, I. (2021). Characteristics of pedagogical change in integrating digital collaborative learning and their sustainability in a school culture: <scp>e-CSAMR</scp> framework. *Journal of Computer Assisted Learning*, 37(3), 825–838. <https://doi.org/10.1111/jcal.12526>
- Sølvik, R. M., & Glenna, A. E. H. (2022). Teachers' potential to promote students' deeper learning in whole-class teaching: An observation study in Norwegian classrooms. *Journal of Educational Change*, 23(3), 343–369. <https://doi.org/10.1007/s10833-021-09420-8>
- Tong, Z., An, F., & Cui, Y. (2024). Exploring teacher discourse patterns: Comparative insights from novice and expert teachers in junior high school EFL contexts. *Heliyon*, 10(16), e36435. <https://doi.org/10.1016/j.heliyon.2024.e36435>

- Walter, Y. (2024). Embracing the future of Artificial Intelligence in the classroom: the relevance of AI literacy, prompt engineering, and critical thinking in modern education. *International Journal of Educational Technology in Higher Education*, 21(1), 15. <https://doi.org/10.1186/s41239-024-00448-3>
- Yang, X. (2023). A Historical Review of Collaborative Learning and Cooperative Learning. *TechTrends*, 67(4), 718–728. <https://doi.org/10.1007/s11528-022-00823-9>