



**JOURNAL OF CONTEMPORARY
ISLAMIC PRIMARY EDUCATION**

Vol. 5, No. 2, 2026 Page 524-533

<https://zia-research.com/index.php/jcipe>

Implementation of the TGT Cooperative Model Assisted by Augmented Reality to Enhance Student Participation in Lessons on Food Chains

Lailatul Muharromah¹, Siti Maghfirotn Amin², Angelina Kartika Sari³

^{1,2} Universitas Nahdlatul Ulama Surabaya (UNUSA), Surabaya, Indonesia

³ SDN Tenggilis Mejoyo 1 Surabaya, Indonesia

Email : lailatulmuharromah21@gmail.com¹; amin@unusa.ac.id²;
angelina.kartikasari92@gmail.com³

ARTICLE INFO

Keywords

Augmented Reality
Food Chain
IPAS Learning
Student Participation
Teams Games
Tournament

ABSTRACT

Student participation in science and social studies (IPAS) learning in Grade VB at SDN Tenggilis Mejoyo 1 Surabaya needed improvement, while the abstract food chain topic required concrete and interactive visualization. This study aimed to describe the implementation of the Teams Games Tournament (TGT) cooperative learning model assisted by Augmented Reality (AR) and to analyze the improvement of student participation in food chain learning. Classroom Action Research (CAR) with a descriptive quantitative approach was conducted in two cycles in September 2026, involving 24 fifth-grade students divided into three heterogeneous groups. The main data, student participation, were collected through an observation sheet with six indicators scored 1–4, while supporting learning outcome data were obtained through multiple-choice tests. Data were analyzed descriptively using participation percentages, classical completeness, and N-Gain. Average student participation increased from 58.7% in Cycle 1 to 87.2% in Cycle 2, and classical completeness rose from 41.7% to 100%, exceeding the 75% success target. All indicators improved, with the largest gain in giving opinions for problem solving (34.4 percentage points). Average learning outcomes increased from 74.58 to 87.50, with an N-Gain of 0.51 (medium category). TGT assisted by AR provided a more active, collaborative, and visual learning experience. The novelty of this study lies in demonstrating that integrating TGT with AR visualizes abstract food chain concepts while significantly increasing student participation.

ABSTRAK

Partisipasi siswa dalam pembelajaran Ilmu Pengetahuan Alam dan Sosial (IPAS) di kelas VB SDN Tenggilis Mejoyo 1 Surabaya perlu ditingkatkan, sementara topik rantai makanan bersifat abstrak sehingga memerlukan visualisasi konkret dan interaktif. Penelitian ini bertujuan mendeskripsikan penerapan model pembelajaran kooperatif Teams Games Tournament (TGT) berbantuan Augmented Reality (AR) serta menganalisis peningkatan partisipasi siswa dalam pembelajaran rantai makanan. Penelitian Tindakan Kelas (PTK) dengan pendekatan kuantitatif deskriptif dilaksanakan dalam dua siklus pada September 2026 dengan subjek 24 siswa kelas V yang dibagi menjadi tiga kelompok heterogen. Data utama berupa partisipasi siswa dikumpulkan melalui lembar observasi berisi enam indikator berskor 1–4, sedangkan data pendukung hasil belajar diperoleh melalui tes pilihan ganda. Data dianalisis secara deskriptif menggunakan persentase partisipasi, ketuntasan klasikal, dan N-Gain. Hasil penelitian menunjukkan rata-rata partisipasi siswa meningkat dari 58,7% pada siklus 1 menjadi 87,2% pada siklus 2, dan ketuntasan klasikal partisipasi naik dari 41,7% menjadi 100%, melampaui target keberhasilan 75%. Peningkatan terjadi pada seluruh indikator, dengan kenaikan terbesar pada indikator memberikan pendapat untuk pemecahan masalah (34,4 poin persentase). Rata-rata hasil belajar juga meningkat dari 74,58 menjadi 87,50 dengan N-Gain sebesar 0,51 (kategori sedang). Penerapan TGT berbantuan AR memberikan pengalaman belajar yang lebih aktif, kolaboratif, dan visual. Kebaruan penelitian ini terletak pada pembuktian bahwa integrasi TGT dengan AR mampu mengkonkretkan konsep abstrak rantai makanan sekaligus meningkatkan partisipasi siswa secara signifikan.

INTRODUCTION

21st-century education positions students as active subjects within the learning process (Hernández-Campos et al., 2026; Yeoh et al., 2025). This paradigm shift, from teacher-centered to student-centered learning, requires an educational approach that goes beyond the mere mastery of subject matter; it must also provide space for students to develop skills in critical thinking, communication, collaboration, creativity, and problem-solving (Direktorat Sekolah Dasar, 2025). In the study of Natural and Social Sciences (IPAS) at the elementary level, active student engagement is essential, as the process of understanding natural and social phenomena requires observing, questioning, experimenting, reasoning, and communicating one's learning outcomes.

One topic within the subject of Natural and Social Sciences (IPAS) that requires active student engagement is the food chain. This topic concerns the feeding relationships among living organisms and the transfer of energy from one trophic level to another within an ecosystem. Understanding food chains requires students to go beyond simply memorizing the sequence of organisms; they must also grasp the roles of producers, consumers, and decomposers, as well as how changes to any single organism can affect the balance of the entire ecosystem. Qorimah et al. (2024) explain that food chains involve the transfer of energy between living organisms at different trophic levels through processes of consumption and predation. Therefore, instruction on food chains should provide experiences that allow students to observe the relationships between living organisms and understand these connections in a more concrete way.

The topic of food chains can be difficult to grasp when presented abstractly and without adequate visual support. While students may be able to memorize the sequence of organisms, they might not necessarily understand the direction of energy flow, the function of each organism, or the cause-and-effect relationships within an ecosystem. The limitations of conventional instructional media, combined with the abstract nature of the subject matter, highlight the need for tools that help students visualize these concepts in a more concrete way (Qorimah et al., 2024).

Based on initial observations of the IPAS (Natural and Social Sciences) lessons in class VB at SDN Tenggilis Mejoyo 1 Surabaya, student participation still requires improvement. Some students have yet to demonstrate sufficient confidence to ask questions or engage in discussions. Furthermore, a number of students show inconsistent attention during lessons; for instance, by talking to peers, playing on their own, or appearing bored. These conditions suggest that the current instructional approach does not yet fully provide space for all students to participate actively. This finding aligns with Damayanti et al. (2025), who indicate that student engagement in elementary-level science education remains an area that needs to be strengthened through collaborative learning and engaging activities. Similarly, Aliyu et al. (2022) highlight the importance of interaction, communication, task distribution, and shared responsibility in fostering student engagement.

One alternative that can be used to increase student participation is the Teams Games Tournament (TGT) cooperative learning model. TGT places students in heterogeneous groups to study material together, discuss problems, share tasks, engage in games, and participate in academic tournaments. This structure provides students with opportunities to share knowledge, collaborate, express their opinions, and take responsibility for the group's success. Anjarwati and Dewi (2024) indicate that the implementation of TGT can foster student engagement through learning activities that incorporate collaboration and academic games. Research by Usnia Marifatul and Silvina Anandita (2026) also demonstrates the use of TGT in science instruction to support student involvement.

Although TGT (Teams-Games-Tournament) incorporates group activities, games, and tournaments, the subject of food chains still requires a medium that helps students visualize the relationships between living organisms. One such medium is Augmented Reality (AR) (Chang & Hsueh, 2026). AR technology integrates virtual objects into the real-world environment,

enabling students to engage in visual and interactive experiences (Yu et al., 2024). Rohmani et al. (2024) demonstrate that the use of AR can support science education in primary schools by presenting material in a visual and interactive manner. Furthermore, Zufahmi et al. (2025) indicate that the application of AR in science instruction is linked to improvements in visualization, motivation, learning experiences, and student engagement.

The combination of TGT (Teams-Games-Tournament) and AR (Augmented Reality) offers students the opportunity to gain learning experiences through complementary activities. AR is used to help students observe organisms and their relationships within an ecosystem, while TGT provides a learning structure through group activities, games, tournaments, and group rewards. In this study, AR media is employed to display a garden ecosystem; featuring grass, grasshoppers, sparrows, feral cats, and fungi (as decomposers). Students observe these objects via the AR media, construct food chains, discuss the role of each organism, analyze population changes, and test their understanding through games and tournaments.

Student participation in this study was observed through six indicators: (1) offering opinions for problem-solving, (2) responding to the opinions of others, (3) completing assigned tasks, (4) demonstrating motivation while working on tasks, (5) showing tolerance and openness to the opinions of other students, and (6) fulfilling responsibilities as a group member (Sudjana, 2019). These six indicators were used to examine student engagement during the learning process in a more structured manner. Given these considerations, this study aims to describe the implementation of the Teams-Games-Tournament (TGT) cooperative learning model, enhanced with Augmented Reality (AR), and to analyze the improvement in student participation regarding the topic of food chains in class VB at SDN Tenggilis Mejoyo 1, Surabaya. The findings are expected to serve as an alternative approach for teachers in designing science and social studies (IPAS) lessons that actively involve students through a combination of cooperative learning and interactive visual media.

METHOD

Types of research

This study is a Classroom Action Research (CAR) project employing a quantitative descriptive approach. The research was conducted in two cycles, with each cycle consisting of four stages: planning, action implementation, observation, and reflection (Kemmis & McTaggart, 1988). The intervention involved the application of the Teams-Games-Tournament (TGT) cooperative learning model, supported by Augmented Reality (AR), to the topic of food chains.

Time and location of the study

The research was conducted at SDN Tenggilis Mejoyo 1 Surabaya during the odd semester of the 2026/2027 academic year. The study took place in September 2026. The pre-cycle phase was carried out on September 3, 2026, Cycle 1 on September 10, 2026, and Cycle 2 on September 16, 2026.

Research target

The objective of this research is to increase student participation in learning about food chains, as observed through six aspects: (1) offering opinions for problem-solving, (2) responding to the opinions of others, (3) completing assigned tasks, (4) demonstrating motivation in carrying out tasks, (5) showing tolerance and openness to the opinions of other students, and (6) fulfilling responsibilities as a group member. The intervention is considered successful if at least 75% of the students fall into the "Good" or "Very Good" participation category.

Research subjects and targets

The research subjects consisted of 24 students from class VB, comprising 12 boys and 12 girls. The students were divided into three heterogeneous groups based on the results of an initial cognitive assessment conducted during the pre-cycle stage. This grouping was determined by ranking the students' scores and applying a zig-zag pattern to ensure that each group possessed a relatively balanced level of ability.

Table 1. Grouping using the TaRL approach

Group	Number of Students	Man	Woman	Average Initial Assessment
Group 1	8	2	6	53,75
Group 2	8	5	3	52,50
Group 3	8	5	3	50,00
The entire class	24	12	12	52,08

The research aims to increase student participation in learning about food chains. The intervention is considered to have met the success criteria if at least 75% of the students fall into the "Good" or "Very Good" category.

Research Procedure

In the pre-cycle stage, the researcher conducts an initial cognitive assessment to gauge students' baseline abilities and form heterogeneous groups. The planning phase for each cycle involves developing teaching modules, student worksheets, augmented reality (AR) media, game-based and tournament-style assessment tasks, and observation sheets for tracking student participation. The implementation phase follows the TGT (Teams-Games-Tournament) framework, which consists of class presentations, group study, games, academic tournaments, and group rewards (Slavin, 1995). During the class presentation stage, the teacher delivers the lesson content and introduces how to use the AR media.

During the group learning phase, students explore AR objects related to producers, consumers, and decomposers, and then construct food chains using student worksheets. In the games and tournaments phase, students from each group compete to answer questions about food chains. The scores earned by individual students contribute to their group's total score, and the group with the highest score receives an award. Throughout the intervention, the researcher observes student participation and records findings on observation sheets and in field notes. Reflection is conducted after the intervention to identify shortcomings from the previous cycle and determine improvements for the next one. At the end of each cycle, students complete an evaluation assessment, which serves as supporting data.

Data collection instruments and techniques

The primary research data consists of student participation, obtained through direct observation. The observation sheet includes six indicators of participation, each scored on a scale of 1–4: 1 for "Poor," 2 for "Fair," 3 for "Good," and 4 for "Excellent." With six indicators, the maximum possible score for each student is 24. Supporting data, consisting of learning outcomes, was gathered through an initial cognitive assessment and evaluation tests administered during Cycle 1 and Cycle 2. Each evaluation test comprised 10 multiple-choice questions. The research instruments included the participation observation sheet, the initial cognitive assessment, and the evaluation tests. Participation data was collected by the researcher through direct observation during every session; the researcher recorded each student's score on the observation sheet and kept brief field notes. Data on learning outcomes was collected via written tests conducted during the pre-cycle phase, as well as during Cycle 1 and Cycle 2.

Teknik analisis data

The data were analyzed descriptively using Microsoft Excel. Each student's participation percentage was calculated using the formula: participation percentage = (total score obtained / 24) × 100%.

The percentages are categorized as follows: Very Good (81–100%), Good (61–80%), Fair (41–60%), and Poor (≤40%). Class mastery is calculated based on the percentage of students who fall into the Good and Very Good categories. The success indicator for the intervention is set at 75%. Learning outcomes are analyzed using the mean score, highest score, lowest score, and class mastery. The improvement in learning outcomes between Cycle 1 and Cycle 2 is also analyzed using the N-Gain. Data on learning outcomes serve as supporting data, as the primary focus of the research is student participation.

FINDINGS AND DISCUSSION

The implementation of TGT (Teams-Games-Tournament) supported by AR (Augmented Reality) consists of several stages: class presentation, group study, games, academic tournaments, and group rewards. In the initial phase, the teacher outlines the learning objectives and connects the subject matter to the surrounding environment. Subsequently, students are introduced to AR media that displays organisms found within a garden ecosystem. During the group activity, students observe these organisms via AR and discuss the relationships between grass, grasshoppers, sparrows, feral cats, and fungi (acting as decomposers).

Students then constructed food chains and discussed the role of each organism. The activity continued with games and a tournament. Each student had the opportunity to answer questions and contribute to their group's score. The use of heterogeneous groups allowed students to work together with peers who possessed varying levels of prior knowledge. Based on the initial assessment results, the average ability levels of the groups were relatively similar: 53.75 for Group 1, 52.50 for Group 2, and 50.00 for Group 3. The difference in the average scores between the highest-performing and lowest-performing groups was 3.75 points.

This condition supports the implementation of TGT, as each group possesses a relatively balanced composition of ability levels. Students can assist one another in understanding the material and completing assignments. This principle aligns with cooperative learning, which emphasizes interaction and shared responsibility (Slavin, 1995).



Figure 1. TGT Implementation Using Gemini Canvas

Increased Student Participation Across Each Indicator

The observation results indicate an increase in participation across all indicators from Cycle 1 to Cycle 2. The average participation score rose from 2.35 (or 58.7%) in Cycle 1 to 3.49 (or 87.2%) in Cycle 2.

Table 2. Average Scores and Student Participation Percentages

No.	Participation Indicators	Cycle 1	Cycle 2	Improvement
1	Providing opinions for problem-solving	58,3%	92,7%	+34,4
2	Respond to other people's opinions	59,4%	86,5%	+27,1
3	Completing the assigned tasks	56,3%	82,3%	+26,0
4	Motivation for completing tasks	58,3%	85,4%	+27,1
5	Tolerance and a willingness to accept the opinions of other students	60,4%	86,5%	+26,0
6	Responsibilities as a group member	59,4%	89,6%	+30,2
	Average	58,7%	87,2%	+28,5

In Cycle 1, the average student participation fell into the "Fair" category, with all indicators ranging between 56.3% and 60.4%. This suggests that while students had begun to engage in the learning process, some still required guidance and reinforcement to participate consistently. In Cycle 2, the average participation increased to 87.2%, reaching the "Very Good" category. All indicators showed improvement, rising above 80%. This growth reflects a shift in student engagement across various areas, including participation in discussions, completion of assignments, offering responses, assuming group responsibilities, and involvement in games and tournaments.

The most significant improvement occurred in the indicator related to offering opinions for problem-solving, which rose from 58.3% to 92.7%; an increase of 34.4 percentage points. This improvement is linked to the nature of TGT (Teams-Games-Tournament) activities, which provide students with opportunities to share their answers and engage in discussions, both within their groups and during tournaments. Furthermore, the use of AR (Augmented Reality) provides visual objects that can be observed collectively, ensuring that students share a common frame of reference when discussing the relationships between living organisms.

The second-largest increase occurred in the indicator of responsibility as a group member, with a rise of 30.2 percentage points. In TGT (Teams-Games-Tournament), individual scores contribute to the group score, meaning every student has a responsibility to participate. This aligns with the principles of cooperative learning, which emphasize both individual and group accountability (Johnson & Johnson, 2009).

Meanwhile, the smallest increases were observed in the indicators for completing tasks and tolerance, each rising by 26.0 percentage points. Although these increases were smaller compared to other indicators, both still reached a level of over 80% by Cycle 2. This suggests that group activities, student worksheets (LKM), games, and tournaments continued to provide opportunities for students to complete their tasks and interact with their peers.

These findings align with Aliyu et al. (2022), who emphasize the importance of interaction, communication, task distribution, and responsibility in student engagement. The research findings also support the results of Anjarwati & Dewi (2024) and Usnia Marifatul & Silvina Anandita (2026) regarding the use of TGT (Teams-Games-Tournament) to foster student participation and engagement through group activities and academic games.

Participation and Class-wide Mastery Category

Changes in participation are also evident in the distribution of categories for each student.

Table 3. Distribution of Student Participation Categories

Category	Range	Cycle 1 (Students)	Cycle 1 (%)	Cycle 2 (Students)	Cycle 2 (%)
Very good	81–100%	0	0,0	18	75,0
Good	61–80%	10	41,7	6	25,0
Enough	41–60%	14	58,3	0	0,0

Not enough	≤40%	0	0,0	0	0,0
Good + Very Good		10	41,7	24	100,0

In Cycle 1, 10 students (41.7%) fell into the "Good" category, while 14 students (58.3%) were in the "Fair" category. Consequently, the class-wide mastery rate did not reach the 75% target. This situation served as the basis for conducting Cycle 2. Improvements were implemented by clarifying instructions, optimizing the use of instructional media, ensuring more equitable participation in discussions and games, and strengthening the tournament mechanism. In Cycle 2, 18 students (75%) reached the "Very Good" category, and 6 students (25%) reached the "Good" category. No students remained in the "Fair" or "Poor" categories. The class-wide mastery rate reached 100%. Thus, the shift in the distribution of categories demonstrates that improvement occurred not only in the class average but also in the individual achievements of the students. By Cycle 2, all students had attained at least a "Good" rating.

Participation Based on Group and Prior Ability

An increase in participation was also observed across all three groups. The average participation for Group 1 rose from 56.8% in Cycle 1 to 89.6% in Cycle 2. Group 2 saw an increase from 58.9% to 87.5%, while Group 3 increased from 60.4% to 84.4%.

Based on initial ability levels, students with high ability improved from 58.3% to 90.1%, students with moderate ability improved from 59.9% to 85.4%, and students with low ability improved from 57.8% to 85.9%.

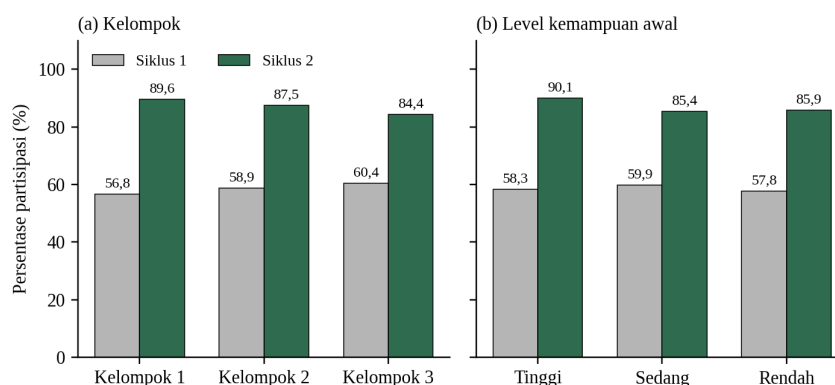


Figure 2. Average Percentage of Student Participation Based on Group and Prior Ability

Descriptively, the data indicate that an increase in participation occurred across various levels of initial ability. However, this data should not be interpreted to mean that initial cognitive ability has no influence on participation. The study was conducted in only one class with a limited number of subjects and did not include a comparison group. Therefore, these findings should be understood as an overview of how participation evolved throughout the implementation of the intervention.

Learning Outcomes as Supporting Data

Learning outcomes are used as supporting data to observe the development of students' understanding following instructional interventions.

Table 4. Student Learning Outcomes in the Initial Assessment, Cycle 1, and Cycle 2

Measurement	Initial Assessment	Cycle 1	Cycle 2
Number of students	24	24	24
Average value	52,08	74,58	87,50

The highest score	90	90	100
Lowest value	20	60	70
Students who have achieved mastery (≥ 70)	7	19	24
Classical mastery	29,2%	79,2%	100%
<i>N-Gain</i>	–	–	0,51

The average score increased from 52.08 in the initial assessment to 74.58 in Cycle 1 and 87.50 in Cycle 2. Class-wide mastery also improved, rising from 29.2% in the initial assessment to 79.2% in Cycle 1 and 100% in Cycle 2. This improvement in learning outcomes serves as supporting evidence that an increase in the understanding of the material occurred during the intervention. The N-Gain score from Cycle 1 to Cycle 2 was 0.51, which falls into the medium category.

However, learning outcomes are not used as the sole evidence for the effectiveness of the intervention, as the evaluation questions in Cycle 1 and Cycle 2 utilized the same instruments. Consequently, any improvement in scores could also be influenced by the students' prior experience in completing the same set of questions. The relationship between participation and learning outcomes must also be interpreted with caution. Fredricks et al. (2004) explain that student engagement encompasses behavioral, emotional, and cognitive dimensions related to the learning process. In this study, an increase in participation occurred alongside an improvement in learning outcomes; however, the research design does not allow for a definitive conclusion regarding a causal relationship.

The Role of Augmented Reality in Learning

The use of AR provides a visual experience for students as they learn about the relationships between living organisms. Instead of merely receiving information through verbal explanations, students can observe objects displayed via AR media and connect them to concepts such as producers, consumers, and decomposers. The use of such visual objects is well-suited to the nature of the topic of food chains, which requires an understanding of the interrelationships among living things. Qorimah et al. (2024) demonstrate the application of AR for teaching food chains in elementary schools, while Qorimah et al. (2024) and Zufahmi et al. (2025) highlight the potential of AR to provide a visual and interactive science learning experience.

In this study, AR is not used in isolation from the instructional model; rather, it is integrated into the sequence of TGT (Teams-Games-Tournaments) activities. Students observe objects, engage in discussions, complete student worksheets, participate in games, and take part in tournaments. Thus, the contribution of AR in this study is primarily as an aid for visualizing the subject matter, while the structure for participation is established through the cooperative activities of the TGT model.



Figure 3. Augmented Reality for the Topic of Food Chains



Figure 4. Implementation of AR in Learning About Food Chains

Research Limitations

This study has several limitations. First, it was conducted in a single class of 24 students without a comparison group; therefore, the observed increase in participation cannot be definitively attributed solely to the implemented intervention. Second, the evaluation instruments used in Cycle 1 and Cycle 2 were identical, meaning that improvements in learning outcomes might have been influenced by the students' prior exposure to the same questions. Third, as the researcher conducted the observations of participation, the assessments may have been subject to the observer's personal judgment. Fourth, because measurements were taken immediately following the intervention, the study does not demonstrate whether the increase in participation is sustained over a longer period. Fifth, the gender composition across groups was not entirely balanced, as the groups were formed based on the students' initial ability levels. These limitations should be taken into account when interpreting the study's findings and should serve as a basis for the development of future research.

CONCLUSION

The implementation of the TGT (Teams-Games-Tournament) cooperative learning model, supported by Augmented Reality (AR), for the topic of food chains, is carried out through several stages: class presentation, group study, games, academic tournaments, and group rewards. AR media is used to help students visualize organisms, including the roles of producers, consumers, and decomposers, as well as the relationships between living things within an ecosystem.

The implementation of the interventions demonstrated an increase in student participation from Cycle 1 to Cycle 2. The average participation rate rose from 58.7% to 87.2%, while the class-wide mastery rate increased from 41.7% to 100%. Improvements were observed across all participation indicators, with the most significant gain, an increase of 34.4 percentage points, occurring in the indicator for offering opinions toward problem-solving. Learning outcomes, serving as supporting data, also improved from an average of 74.58 in Cycle 1 to 87.50 in Cycle 2, with an N-Gain of 0.51, falling into the moderate category.

These results indicate that the implementation of AR-assisted TGT provides students with opportunities to participate through group discussions, task completion, games, and tournaments, while also offering visual support for understanding the concept of food chains. However, the findings should be interpreted with consideration for the limitations of the

research design; specifically, that the study was conducted in a single class without a comparison group, and the same evaluation instrument was used across both cycles.

REFERENCES

- Aliyu, J., Osman, S., Kumar, J. A., Abdul Talib, C., & Jambari, H. (2022). Students' Engagement through Technology and Cooperative Learning: A Systematic Literature Review. *International Journal of Learning and Development*, 12(3), 23. <https://doi.org/10.5296/ijld.v12i3.20051>
- Anjarwati, R., & Dewi, R. S. I. (2024). Penerapan Model Pembelajaran Teams Games Tournament untuk Meningkatkan Keaktifan Belajar Peserta Didik Kelas 1 Sekolah Dasar. *Journal of Innovation and Teacher Professionalism*, 3(2), 279-286. <https://doi.org/10.17977/um084v3i22025p279-286>
- Chang, Y. S., & Hsueh, Y. Y. (2026). Exploring the Impact of Augmented Reality on Cognitive Load, Emotion, and Creative Performance. *Thinking Skills and Creativity*, 102303. <https://doi.org/10.1016/j.tsc.2026.102303>
- Damayanti, D. A., Utami, P. D., Sutanto, A. B., Ishartono, N., & Lestari, D. N. (2025). Gamifying Cooperative Learning: The Impact of Team Games Tournament and Wordwall Media on Student Engagement in Elementary Science Education. *Jurnal VARIDIKA*, 113-130. <https://doi.org/10.23917/varidika.v37i2.8986>
- Direktorat Sekolah Dasar. (2025). *Kurikulum Merdeka*. <https://ditsd.kemendikdasmen.go.id/>
- Hernández-Campos, M., Hilliger, I., Prado-Calderón, J. E., Martínez-Abad, F., & García-Penalvo, F. J. (2026). Factors associated with 21st-century learning outcomes in higher education: A learning analytics model grounded in social cognitive theory. *Computers in Human Behavior Reports*, 100981. <https://doi.org/10.1016/j.chbr.2026.100981>
- Johnson, D. W. , & Johnson, R. T. (2009). *An Educational Psychology Success Story: Social Interdependence Theory and Cooperative Learning*.
- Kemmis, & McTaggart. (1988). *The Action Research Planner*. Deakin University Press.
- Qorimah, E. N., Utama, S., & Hidayati, Y. M. (2024). An Augmented Reality-Based Interactive Learning Application for Teaching Food Chains in Elementary Schools. *Profesi Pendidikan Dasar*, 236-250. <https://doi.org/10.23917/ppd.v11i3.6145>
- Rohmani, Azzahra, F., & Ayu Kristiana Dewi, N. (2024). Analysis of the Effectiveness of Using Augmented Reality (AR) on Science Learning in Elementary Schools: A Systematic Literature Review. *Journal of Psychology and Instruction*, 8(3), 141-149. <https://doi.org/10.23887/jpai.v8i3.79804>
- Slavin, R. E. (1995). *Cooperative Learning: Theory, Research, and Practice*.
- Sudjana, N. (2019). *Penilaian Hasil Proses Belajar Mengajar*. PT. Remaja Rosdakarya.
- Usnia Marifatul, A., & Silvina Anandita, A. (2026). Team Games Tournament with Discovery Learning to Improve Science Learning Outcomes and Engagement. *JISE*, 15(1), 68-76. <https://journal.unnes.ac.id/journals/jise/>
- Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*.
- Yeoh, H. B., Wei, C. Y., Kaur, S., & Kaur, M. (2025). Examining inter-relationships among 21st century learning skills and their impacts on tertiary learners' readiness for careers in Industry Revolution 4.0 era. *Higher Education, Skills and Work-Based Learning*, 15(3), 500-515. <https://doi.org/10.1108/HESWBL-03-2024-0086>
- Yu, Y. L., Wu, T. T., & Huang, Y. M. (2024). Learning behavior in augmented reality-mediated mobile game-based learning. *Library Hi Tech*, 42(2), 530-546. <https://doi.org/10.1108/LHT-03-2022-0122>
- Zufahmi, Z., Rohman, F., & Sari, M. S. (2025). Augmented reality in science learning: A systematic literature review. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 11(1), 274-291. <https://doi.org/10.22219/jpbi.v11i1.38570>