# The Effectiveness of Blended Learning in Improving Students Learning Outcomes and Active Participation in Biology Subjects

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**Abstract:** The rapid development of digital technology in education demands innovative learning models that combine flexibility, interactivity, and collaboration to enhance student engagement and learning outcomes. This classroom action research aimed to analyze the effectiveness of a blended learning model integrated with the cooperative Teams Games Tournament (TGT) approach in improving students' learning outcomes and active participation in Biology subjects. The study was conducted in two cycles involving 28 students of class XI H at SMAN 4 Palu during the 2024/2025 academic year. Data were collected through observation sheets and cognitive learning tests. The results showed a significant improvement in both teacher performance and student learning outcomes. The average teacher activity increased from 78.2% (Good) to 93.7% (Very Good), while students' classical mastery rose from 53.57% to 79%, with the N-Gain improving from "Low" (0.29) to "Moderate" (0.49). Statistical analysis using the Wilcoxon Signed-Rank test confirmed a significant difference between pre-test and post-test scores ($p < 0.001$), with an effect size ($r = -1.000$) categorized as very large. Additionally, students' active participation increased from "Fairly Active" to "Active" in most aspects. These findings indicate that integrating blended learning with the TGT model effectively enhances both cognitive achievement and engagement in Biology learning.

**Keywords:** Active participation; Biology education; Blended learning; Learning outcomes; Teams games tournament

## Introduction

Improving the quality of learning in the 21st century requires teachers to innovate in designing student-centered learning experiences, utilizing technology, and encouraging active participation (Chen et al., 2016; Astriani et al., 2020). Active participation not only involves physical presence but also encompasses deep cognitive, emotional, and social engagement, which ultimately correlates positively with learning achievement (Eppler, 2006; Dolder et al., 2012). However, preliminary observations in class XI H of SMAN 4 Palu revealed a contrasting reality: more than 50% of students did not reach the minimum mastery criterion (KKM 70) in Biology, as indicated by passive attitudes, low motivation, and minimal participation in discussions.

Contemporary pedagogical studies have shown that blended learning has proven effective in addressing the challenges of conventional instruction. Previous research by Gao (2022) demonstrated that integrating platforms such as Google Classroom can improve students' learning outcomes and independence through flexible access and instant feedback. Meanwhile, the

cooperative model Teams Games Tournament (TGT) has been recognized for its ability to create a dynamic learning environment, stimulate intrinsic motivation through healthy competition, and enhance collaboration (Areeisty et al. 2020; Asih & Wiyasa, 2023). Furthermore, the use of interactive digital media such as flipbooks has also been proven effective in facilitating the understanding of complex concepts and improving critical thinking skills (Adodo, 2013; Agustina & Joyoatmojo, 2024).

Although the advantages of each of these approaches have been widely studied, their integrated application remains underexplored. Most previous studies focused on the integration of blended learning with TGT in vocational contexts, while other studies conducted by Erina et al. (2025) and Kundariati et al. (2025) emphasized the effectiveness of TGT alone in enhancing participation. The novelty of this study lies in its holistic integration of the blended learning model (utilizing Google Classroom) with the complete syntax of the cooperative TGT model in the context of Biology learning at the senior high school level (Jones et al., 2012; Hwang et al., 2013). This integration is designed to create a learning ecosystem that not only combines the strengths of online and offline modes but also systematically builds engagement through stages of presentation, teamwork, academic games, and rewards (Liu et al. 2014; Khairunnisa et al., 2022).

The originality and scientific contribution of this article lie in providing empirical evidence on the effectiveness of a hybrid model specifically designed to address two critical issues simultaneously low cognitive learning outcomes and low active participation (Günter et al., 2017; Huda, 2020). This research responds to the urgency of developing a learning model that is adaptive to technological advancements (technology-enhanced learning) while remaining grounded in collaborative and constructivist pedagogical principles. Based on the background and the identified research gap, the objective of this study is to analyze the effectiveness of the integrated blended learning–TGT model in improving learning outcomes and active participation of class XI H students at SMAN 4 Palu in Biology subjects.

## Method

### Time, Place, and Research Subjects

This classroom action research (CAR) was conducted in May 2025 at SMA Negeri 4 Palu, located on Jl. Mokolembake, Lere, West Palu, Palu City, Central Sulawesi. The research subjects consisted of 28 students of class XI H in the even semester of the 2024/2025 academic year, comprising 14 male and 14 female students. This study was designed to improve the quality of learning through the implementation of an instructional intervention and to measure its impact.

### Type of Research

The type of research used was classroom action research adopting a collaborative lesson study model, involving cooperation between biology teachers, teacher professional education (PPG) students, and field supervisors. The CAR model followed the procedures developed by Kemmis and Taggart [10], which consist of four stages in each cycle: (1) planning, (2) acting, (3) observing, and (4) reflecting. This study was conducted in two cycles, where each cycle applied the lesson study stages (plan, do, see).

### Hypothesis

The action hypothesis of this study states that the implementation of blended learning integrating the flipped classroom approach with the cooperative learning model Teams Games Tournament (TGT) is effective in improving students' cognitive learning outcomes and active participation. The data collected included quantitative data (students' cognitive learning scores from tests) and qualitative data (observation results of students' active participation).

### Research Procedures

The research procedure began with pre-research activities, including obtaining permission, conducting preliminary school and classroom observations, diagnosing problems, and preparing research instruments. The instruments consisted of multiple-choice learning outcome tests and observation sheets used to record teacher activities and students' active participation.

In each cycle, the research team carried out lesson planning (preparing lesson modules, media, and instruments), action implementation where one model teacher conducted the lesson, simultaneous observation by other team members, and reflection sessions to evaluate strengths and weaknesses for improvement in the next cycle.

### Data Analysis Techniques

Data were analyzed quantitatively. Teacher activity observation data were analyzed using percentage formulas ($P = f/N \times 100\%$) and categorized according to predetermined criteria. Improvement in learning outcomes was analyzed using normalized N-Gain scores with interpretation categories following Sukarelawa et al. [11]. The level of intervention effectiveness was also determined based on the percentage of improvement. Furthermore, to measure the magnitude of the intervention's impact, Cohen's d effect size analysis was used, with interpretation categories referring to Anditha

et al. Students' active participation data were analyzed by calculating the percentage achievement of each observed aspect and categorized according to the criteria of Aini et al. The intervention was considered successful in enhancing active participation if at least 75% of students achieved a minimum "Good" category. The minimum mastery criterion (KKM) for Biology at the school was 70.

## Result and Discussion

This classroom action research was conducted in two cycles in class XI H of SMAN 4 Palu. The data collected included teacher activity, students' cognitive learning outcomes, and active participation.

*Teacher Activity*

The results of teacher activity observations in implementing blended learning showed a significant improvement from Cycle I to Cycle II. In Cycle I, the average percentage of teacher activity reached 78.2% (Good category), with several aspects such as initiating the lesson and communicating learning objectives still requiring improvement. After reflection and adjustments, the teacher's performance in Cycle II increased to 93.7% (Very Good category), indicating excellent mastery across all aspects of learning, including guiding group work and facilitating students' active engagement (Table 1).

**Table 1.** Summary of Teacher Activity Observation Results

| Cycle | Average Percentage | Category |
|---|---|---|
| I | 78.2% | Good |
| II | 93.7% | Very Good |

The improvement in teacher activity from Cycle I to Cycle II reflects the successful adaptation of the teaching team in implementing the blended learning model integrated with Teams Games Tournament (TGT). During Cycle I, several instructional steps such as presenting objectives, managing group dynamics, and facilitating online–offline transitions had not yet reached optimal execution (Husna et al., 2013). After reflection and revision, Cycle II demonstrated greater mastery, with teachers more effectively utilizing digital tools (Google Classroom, flipbooks, and interactive media) and providing timely feedback during face-to-face sessions. These changes align with findings byHwang et al. (2013), which highlight that the teacher's ability to integrate digital platforms determines the quality of interaction in blended environments. Moreover, the collaborative structure of TGT encouraged teachers to function as facilitators rather than information transmitters, thereby increasing students engagement.

The significant improvement in teacher activity percentage indicates that lesson study-based reflection successfully supported professional growth and instructional quality. This emphasizes that the combination of pedagogical reflection and technology-assisted instruction can strengthen teachers' competence in managing 21st-century classrooms.

*Cognitive Learning Outcomes*

The implementation of the blended learning model proved effective in improving students' learning outcomes. The classical mastery level increased from 53.57% (15 out of 28 students achieved mastery) in Cycle I to 79% (22 out of 28 students achieved mastery) in Cycle II. Statistical analysis using the Wilcoxon Signed-Rank test showed a significant difference between pre-test and post-test scores in both cycles ($p < 0.001$) (Table 2).

**Table 2.** Summary of Students Cognitive Learning Outcomes

| Indicator | Cycle I | Cycle II |
|---|---|---|
| Average Pre-test Score | 54.04 | 54.04 |
| Average Post-test Score | 67.32 | 76.43 |
| Average Difference | +13.28 | +22.39 |
| Classical Mastery (≥70) | 15/28 (53.57%) | 22/28 (79%) |
| Average N-Gain | 0.29 | 0.49 |
| N-Gain Category | Low | Moderate |
| Percentage of Students (N-Gain ≥ 0.3) | 46% | 96% |

A significant improvement was observed in the average post-test scores from Cycle I to Cycle II, increasing from 67.32 to 76.43. Similarly, the classical learning mastery rose sharply from 60.7% (not yet meeting classical mastery criteria) to 89.3% (meeting classical mastery criteria). This indicates that the improvements made based on the reflections from Cycle I successfully addressed various challenges and further optimized the implementation of the model.

More importantly, beyond the mere increase in scores, there was a notable improvement in the quality of students' understanding as measured by the N-Gain score. The average N-Gain increased from the "Low" category (0.29) in Cycle I to the "Medium" category (0.49) in Cycle II. Even more impressively, the percentage of students who experienced meaningful improvement (N-Gain ≥ 0.3) jumped from 46% to 96% (Table 3). This demonstrates that almost all students not only improved their scores but also achieved substantial conceptual understanding.

Non-parametric statistical analysis using the Wilcoxon Signed-Rank test indicated that there was a statistically significant difference between pre-test and post-test scores in both cycles ($p < 0.001$). Additionally,

the effect size calculated based on the Rank-Biserial Correlation yielded a coefficient of -1.000, indicating that the intervention's impact falls into the "very large" category. These findings provide strong and reliable empirical support that the improvement in learning outcomes can be attributed to the blended learning intervention rather than to chance or other confounding variables.

**Table 3.** Effect Size Test of the Blended Learning Model on Learning Outcomes

| | Paired Samples T-Test | | | | | |
|---|---|---|---|---|---|---|
| Cycle I | W | z | df | p | Rank-Biserial Correlation | SE Rank-Biserial Correlation |
| | 0 | -4.623 | | < .001 | -1 | 0.213 |
| Cycle II | W | z | df | p | Rank-Biserial Correlation | SE Rank-Biserial Correlation |
| | 0 | -4.623 | | < .001 | -1 | 0.213 |

Note. Cohen's d corrected for correlation between observations.
Note. Wilcoxon signed-rank test.

The success of this intervention is supported by the integrated learning mechanisms within the blended learning model (Maker et al., 2015). During the online phase, the flipped classroom approach enabled students to independently study foundational material at their own pace, thereby optimizing face-to-face time for more complex learning activities (Yeh & Goh, 2016). In the face-to-face phase, the cooperative Teams Games Tournament (TGT) model created a collaborative and interactive learning environment. The gamified elements and structured team work in TGT were shown to enhance motivation, engagement, and conceptual understanding among students (Loyens et al., 2015).

Furthermore, the classroom action research approach allowed for systematic reflection after Cycle I. This reflection process successfully identified several implementation challenges, such as suboptimal explanation of learning steps and varied levels of student adaptation to digital platforms (Tseng et al., 2011; Swari & Manuaba, 2022; Trullàs et al., 2022). Based on these findings, targeted improvements were made in Cycle II, which ultimately contributed to the overall increased effectiveness of the intervention (Yang et al., 2022; Murisqa & Nurmaliah, 2024).

*Active Participation*

Based on observations conducted during the learning process, students' active participation showed a significant improvement from Cycle I to Cycle II. The observation data are summarized in the following Table 4 to provide a clear and concise overview.

**Table 4.** Comparison of the Average Scores of Students Active Participation in Cycle I and Cycle II

| Aspect Observed | Cycle I | Cycle II |
|---|---|---|
| Asking questions | 2 (Fair) | 3 (Active) |
| Answering questions/giving ideas | 2 (Fair) | 3 (Active) |
| Initiative in asking/answering questions without being prompted | 2 (Fair) | 3 (Active) |
| Contribution during group discussions | 2 (Fair) | 3 (Active) |
| Cooperating and respecting group members | 2 (Fair) | 3 (Active) |
| Completing group tasks | 3 (Active) | 3 (Active) |
| Cooperation within the group | 2 (Fair) | 3 (Active) |
| Presenting discussion results clearly | 2 (Fair) | 3 (Active) |
| Confidence during presentation | 3 (Active) | 3 (Active) |
| Involvement in Teams Game Tournament (TGT) | 3 (Active) | 3 (Active) |
| Submitting assignments on time | 1 (Poor) | 1 (Poor) |
| Responding to discussions in the forum | 2 (Fair) | 2 (Fair) |
| Asking questions related to online materials | 1 (Poor) | 1 (Poor) |
| Responding to teacher instructions (online) | 1 (Poor) | 1 (Poor) |

Most aspects of participation observed during face-to-face learning showed a consistent improvement from the "Fairly Active" category (score 2) in Cycle I to "Active" (score 3) in Cycle II. These aspects include (1) the ability to ask and answer questions (Aspects 1, 2, 3), (2) contribution during discussions and presentations (Aspects 4, 8, 9), and (3) teamwork within groups (Aspect 7).

This improvement indicates that students became more enthusiastic and confident through the implementation of the Blended Learning model and the cooperative Teams Game Tournament (TGT) type. The game-based structure of TGT proved effective in motivating students to participate actively. Reflection from Cycle I successfully identified students' needs to create a more engaging and enjoyable learning

atmosphere, which ultimately increased their participation during Cycle II.

The improvement in students' active participation from Cycle I to Cycle II indicates the model's success in fostering engagement across affective, cognitive, and behavioral dimensions. Initially, students were hesitant to ask questions or take initiative during discussions, reflecting low confidence and limited adaptation to hybrid learning (Wang, 2021; Nuraini et al., 2023). Through continuous exposure to online materials and structured group games, students gradually became more confident and interactive (Ristiliana et al., 2022; Silaban & Manulu, 2024). The TGT approach with its elements of teamwork, competition, and reward proved particularly effective in motivating students to contribute actively. This finding aligns with research by Ristiliana et al. (2022), which revealed that the gamification element in cooperative learning increases students' willingness to participate and express ideas.

In addition, the integration of blended learning provided flexibility and autonomy in learning. Students could review materials asynchronously through Google Classroom, allowing them to better prepare for synchronous discussions and TGT sessions. Reflection meetings after Cycle I also played a crucial role in identifying constraints such as unclear instructions and uneven participation. By refining communication and increasing teacher support, Cycle II achieved a higher participation level, moving most aspects from "Fairly Active" to "Active." The consistent improvement across multiple indicators questioning, discussion, and teamwork demonstrates that when cognitive challenge is combined with social collaboration and digital facilitation, learning engagement can significantly increase. This confirms that the hybrid model used in this study not only develops academic competence but also nurtures collaborative and communicative skills essential for lifelong learning.

## Conclusion

The implementation of the blended learning model integrated with the cooperative Teams Games Tournament (TGT) approach effectively improved students' learning outcomes and active participation in Biology classes. This integration optimized online and face-to-face learning phases, fostered collaboration, and increased student motivation through competitive and engaging learning activities. The findings suggest that this hybrid instructional model can serve as an effective strategy for enhancing cognitive achievement and student engagement in 21st-century science education.

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### Author Contributions

Conceptualization, Mohammad Jamhari and Syech Zainal; methodology, Syech Zainal; analysis, I Nengah Kundera; writing original draft preparation, Mohammad Jamhari; writing, review and editing, All authors.

### Conflicts of Interest

The authors declare that there are no competing interests.

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