



TGT learning model assisted by puzzle on students' learning outcomes in the excretory system

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ABSTRACT

Biology learning in the schools studied still relies on conventional methods, which result in low student participation and learning outcomes. This provides a crucial foundation for researching to develop a more interactive and effective learning model. This study aims to examine the effect of implementing the Team Games Tournament (TGT) learning model combined with puzzle media on student learning outcomes in the excretory system material in senior high schools (SMA/MA). The research method employed is a quantitative approach with a quasi-experimental design, specifically a pretest-posttest control group design. The study population consisted of all students in grade XI IPA, with sampling conducted using a cluster random sampling technique. The students were divided into an experimental class (receiving implementation of TGT with puzzle media) and a control class (receiving the conventional method). The research instrument was a learning outcome test given before and after the treatment. The results showed a significant difference between the two groups. The average posttest score of the experimental class was higher than that of the control class. An independent t-test revealed that the TGT model, assisted by puzzles, had a positive effect on learning outcomes. Thus, the application of the TGT model with puzzle media has proven effective in increasing active participation, motivation, and student learning outcomes in the excretory system material.

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ABSTRAK

Pembelajaran Biologi pada sekolah yang diteliti masih banyak menggunakan metode konvensional yang menyebabkan rendahnya partisipasi dan hasil belajar peserta didik. Hal ini menjadi dasar penting dilaksanakannya penelitian untuk mencari model pembelajaran yang lebih interaktif dan efektif. Penelitian ini bertujuan untuk mengkaji pengaruh penerapan model pembelajaran Team Games Tournament (TGT) yang dipadukan dengan media puzzle terhadap hasil belajar peserta didik pada materi sistem ekskresi di SMA/MA. Metode penelitian yang digunakan adalah pendekatan kuantitatif dengan desain eksperimen semu tipe pretest-posttest control group design. Populasi penelitian adalah seluruh peserta didik kelas XI IPA, dengan pengambilan sampel menggunakan teknik cluster random sampling yang membagi peserta didik ke dalam kelas eksperimen (penerapan TGT dengan media puzzle) dan kelas kontrol (metode konvensional). Instrumen penelitian berupa tes hasil belajar yang diberikan sebelum dan sesudah perlakuan. Hasil penelitian menunjukkan adanya perbedaan signifikan antara kedua kelompok. Rata-rata nilai posttest kelas eksperimen lebih tinggi dibandingkan kelas kontrol. Uji t independen menunjukkan bahwa model TGT berbantuan puzzle berpengaruh positif terhadap hasil belajar. Dengan demikian, penerapan model TGT dengan media puzzle terbukti efektif dalam meningkatkan partisipasi aktif, motivasi, dan hasil belajar peserta didik pada materi sistem ekskresi.

Kata Kunci: hasil belajar; media puzzle; model team games tournament; sistem ekskresi; TGT

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INTRODUCTION

Education plays a strategic role in the advancement of a country, especially in the era of globalization and increasingly intense international competition. The quality of education is an important element in driving a country's excellence in many sectors (Ratnawati *et al.*, 2024). The success of learning can be measured from the learning outcomes achieved by students, where effective learning enables students to optimize their knowledge and study time in order to achieve national education goals (Herman & Andi, 2023). However, low teaching quality often becomes a major obstacle in achieving learning objectives. An uncondusive learning environment can disrupt students' performance due to internal factors of the teacher, such as a lack of enthusiasm in preparing quality teaching materials and limitations in applying effective teaching methods (Munandar *et al.*, 2025). Therefore, the implementation of the appropriate learning model becomes very important to meet the needs of students and improve cognitive, affective, and psychomotor learning achievements (Agusminarti & Hudi, 2020). The most effective learning is through direct experience with the active participation of students in actions and their impacts, which will positively influence the progress of learning outcomes (Sam & Sulastri, 2024; Sari *et al.*, 2023).

The issue of student engagement in learning has become one of the main obstacles in the education sector today. Based on initial observations at one Madrasah Aliyah in Medan city on February 20, 2025, Biology lessons are still dominated by conventional methods such as lectures and teacher-centered Q&A sessions. This situation causes students to tend to be passive and less participative, with Biology learning outcomes in monthly assessments being <70 or not meeting the Minimum Competency Criteria (KKM). The lack of variety in learning models and the limited availability of learning media facilities worsen this situation, causing students to feel bored and fatigued, which ultimately hinders the achievement of optimal learning outcomes (Risana *et al.*, 2025). The learning concepts that have not been fully mastered by students also reduce problem-solving skills and affect their learning outcomes (Darmayanti *et al.*, 2022). To address the problem of passive learning, an approach that can actively increase student engagement is needed. Students' ability to express their opinions can be enhanced through interactive learning. Teachers not only deliver information, but students also actively share their knowledge (Hafizah *et al.*, 2024). Interesting and creative learning methods need to be well-designed to increase student participation, thereby encouraging greater self-confidence and interest in learning Biology (Nurbaya, 2021). One approach that can be applied is the cooperative learning model of the Team Games Tournament (TGT) type.

The TGT learning model has been widely used as an educational approach that involves all students in the role of peer tutors with elements of games and reinforcement (Mulyasari & Ardiansyah, 2025). The TGT model encourages students to compete skillfully to achieve team victory by incorporating game elements that can improve students' focus and understanding of the material (Mugiyatmi, 2023; Nofriansyah *et al.*, 2024). Collaboration among students in this model allows each member to act as a teacher for their groupmates, which is very suitable for the material on the human excretory system with its high organ complexity (Diah & Siregar, 2023). To improve the effectiveness of the TGT model, appropriate learning media are needed, one of which is puzzle media.

Learning media play a crucial role in enhancing the success of the learning process, especially when combined with innovative learning models. Puzzle media has been proven to support the learning process in concept formation through interactive play (Prasaliani *et al.*, 2021). The advantages of puzzle media are evident from the increased interest and participation of students during learning, as this game can reduce boredom and improve learning concentration. The use of puzzles in learning can train the brain, enhance logical thinking skills, patience, and strengthen students' critical and creative thinking abilities (Kristina *et al.*, 2017). The combination of TGT with puzzle media is expected to be more effective, especially in learning the excretory system material that requires visualization of complex organs (Nurbaya, 2021).

Various studies on the use of the TGT model in learning have been carried out quite extensively. Recent research shows that the TGT learning model significantly improves student learning outcomes, demonstrating a significant effect compared to conventional methods (Nugraha & Subroto, 2020; Unafisah & Febrianti, 2025). Further research indicates that the learning model has a positive effect on learning outcomes (Zulfira *et al.*, 2019). Although various studies have demonstrated the effectiveness of the TGT model in improving learning outcomes across various subjects and materials, there is still a significant research gap. Previous studies have mostly examined the implementation of TGT independently without combining it with specific learning media, particularly puzzle media. Furthermore, no research has specifically explored the integration of TGT with puzzle media on the topic of the human excretory system at the high school level. The human excretory system material, however, has complex conceptual characteristics with various organs that require proper visualization for optimal understanding. The combination of TGT with puzzle media is expected to optimize the learning of this material through a more interactive and enjoyable approach, yet empirical research examining the effectiveness of this combination is still very limited in the context of high school Biology learning.

Based on the problems that have been outlined, namely the low biology learning outcomes of students due to passive conventional learning, as well as the great potential of the TGT model that has not been optimized with the appropriate learning media, the research question arises: "Apakah penerapan model pembelajaran Team Games Tournament (TGT) yang dikombinasikan dengan media puzzle dapat meningkatkan hasil belajar peserta didik kelas XI IPA pada materi sistem ekskresi di Madrasah Aliyah kota Medan? (Can the implementation of the Team Games Tournament (TGT) learning model combined with puzzle media improve the learning outcomes of 11th-grade science students on the excretory system material at Madrasah Aliyah in Medan?)." Based on the theoretical and empirical studies that have been presented, the hypothesis of this research is that there is a positive and significant effect of implementing the TGT learning model combined with puzzle media on improving the biology learning outcomes of 11th-grade science students on the excretory system material compared to the conventional learning methods currently in use.

Therefore, this study aims to analyze the effect of the TGT learning model combined with puzzle media on the learning outcomes of 11th-grade science students on the excretory system material at Madrasah Aliyah in Medan. This research is expected to provide concrete solutions to the problems of conventional learning, which still dominate the Biology education process, while also contributing to the development of more effective, interactive, and innovative learning strategies to improve the quality of Biology learning at the Madrasah Aliyah level.

LITERATURE REVIEW

Team Games Tournament (TGT) Learning Model

A learning model is a systematic framework for carrying out learning so that the objectives are achieved (Dewi & Kristiantari, 2020). Learning models play an important role in educational activities because they provide guidance for teachers to design an effective learning process. One relevant learning model is the cooperative model, which is a strategy that emphasizes collaboration and interaction among students to achieve shared learning goals (Kardiyanto *et al.*, 2024). One popular type of cooperative learning is the Teams Games Tournament (TGT). TGT is a group-based teaching method that combines game activities with healthy competition between teams. This model was developed by Robert Slavin to deepen understanding of the material through teamwork and enjoyable game elements (Agusminarti & Hudi, 2020). In its implementation, the students are divided into groups of 4-5 members. They then participate

in a game in the form of a quiz related to the lesson material, allowing each student the opportunity to actively participate and act as a peer tutor (Mulyasari & Ardiansyah, 2025).

In addition to enhancing student engagement, the TGT model also emphasizes targeted competition to motivate students in mastering the material (Sari, 2025). Engaging game elements can help improve focus and concentration (Mugiyatmi, 2023). This model is also in line with the constructivist approach, where knowledge is not only transferred by the teacher but constructed through the activities and interactions of the students (Sari *et al.*, 2025). With a varied and enjoyable learning environment, TGT is able to enhance classroom activity, critical thinking skills, and self-confidence, as well as students' learning outcomes (Nilasari *et al.*, 2024). Theoretically, the TGT model is relevant to the concepts of active learning and student-centered learning promoted by the Kurikulum Merdeka, where students become the main subjects in the learning process. (Amalia *et al.*, 2025). Through educational games, students can construct knowledge independently while collaborating with their groupmates (Zeng *et al.*, 2020). TGT also provides opportunities for the development of social skills, such as communication, cooperation, and sportsmanship, all of which are part of 21st-century competencies (Wulandari & Rosdiana, 2024). In addition, with the tournament, students are motivated to study more seriously because there is a challenge that sparks a healthy competitive spirit. This makes TGT not only effective in improving conceptual understanding but also instills character values that support educational success (Nofriansyah *et al.*, 2024).

Puzzle Media

Media serves as a bridge for messages between teachers and students so that the material is easily understood (Samarinda *et al.*, 2022). Puzzles media are a type of concrete media that can be used in Biology learning, especially for material that is abstract in nature. A puzzle is an image divided into several parts that must be reassembled to form a complete picture. (Widodo *et al.*, 2024). The use of puzzles provides many benefits, such as training thinking skills, patience, improving memory, and encouraging active participation from students (Afra *et al.*, 2020; Hafidah *et al.*, 2020). In addition, puzzles create a fun learning atmosphere, reduce boredom, and make students more enthusiastic (Hasyim, 2020). This media can also help students visualize difficult Biology concepts, making understanding better (Septiyani & Yulianto, 2025). Thus, puzzle activities not only support concept understanding but also develop social skills through group cooperation.

The advantages of puzzle media in Biology learning are not only found in the aspect of visualization, but also in their contribution to creating meaningful learning experiences. Puzzles can facilitate collaborative learning, where students help each other assemble pieces of images until they form a specific organ or system. This activity encourages students to think analytically, train hand-eye coordination, and improve focus in completing challenges (Adam *et al.*, 2023). Puzzles also align with the principle of learning by doing, which has been proven to enhance memory retention and problem-solving skills. In the context of the excretory system material, puzzles provide students with the opportunity to understand the interconnection between organs through an enjoyable and challenging activity. (Maulidah *et al.*, 2025).

Learning Outcomes

Learning outcomes are a measure of students' success in achieving competencies after participating in the learning process (Yuwanita *et al.*, 2020). Learning outcomes include the knowledge, attitudes, and skills acquired after students go through a series of learning activities (Paratiwi & Ramadhan, 2023). Learning outcomes can also be understood as changes in an individual's behavior in accordance with learning objectives (Sari *et al.*, 2023). Learning outcomes are influenced by the interaction of students with

the learning environment, including the models and media used in learning (Lubis *et al.*, 2024). The use of the TGT model, which emphasizes collaboration, along with concrete puzzle media, can improve learning outcomes because both create active, enjoyable, and meaningful learning experiences. With a more engaging atmosphere, students will be more focused, motivated, and able to remember the material better (Septiarani & Rif'iyati, 2025).

Furthermore, learning outcomes not only reflect mastery of cognitive concepts, but also social skills and attitudes developed during the learning process. When students learn through the TGT model, they not only understand the material, but also hone their collaboration, critical thinking, and problem-solving skills (Darmansyah *et al.*, 2025). Similarly, puzzle media help learners develop visual-spatial abilities, attention to detail, and consistency in completing tasks. The combination of both will support the achievement of learning outcomes holistically, covering cognitive, affective, and psychomotor aspects, in accordance with the objectives of Biology learning that emphasize mastery of concepts and scientific thinking skills (Nairo *et al.*, 2025).

Excretory System

The excretory system is a collection of organs that function to eliminate metabolic waste substances such as carbon dioxide, urea, ammonia, water, and bile pigments from the body (Helendra & Sari, 2021). The organs involved in this system include the kidneys, skin, lungs, and liver. The kidneys function in filtering the blood and producing urine, the skin releases sweat containing water and salts, the lungs expel CO₂ and water vapor, while the liver produces bile pigments from the breakdown of red blood cells (Pratama *et al.*, 2024).

This material has complex characteristics and is full of scientific terms, making it often difficult for students to understand if it is taught only verbally (Yosefia *et al.*, 2025). To overcome this difficulty, an interactive and engaging learning approach is needed (Samosir & Manalu, 2025). The TGT model can create an enjoyable competitive atmosphere through team-based quizzes, while puzzle media allows visualization of the organs of the excretory system. The combination of both makes learning more interesting, reduces boredom, and helps students understand the relationships between organs as well as the excretion process (Handini & Budiyanto, 2023). This strategy has the potential to improve both students' conceptual understanding and learning outcomes.

In addition to the complexity of the concepts, the excretory system requires an understanding of the relationships between organs and the physiological processes that occur simultaneously. If presented solely through lectures, students tend to develop misconceptions or memorize without understanding (Ristante *et al.*, 2021). Therefore, combining the TGT model with puzzle media becomes the right strategy to create meaningful learning. Students can actively engage through team discussions and quiz tournaments that stimulate competitiveness, while puzzles provide a concrete experience in arranging the structure of the excretory organs. This approach not only clarifies concepts but also supports the mastery of higher-order thinking skills, such as analysis and synthesis, which are highly needed in science learning (Handini & Budiyanto, 2023).

METHODS

This study uses a quantitative research method with a quasi-experimental research type. The learning approach (Quasi Experiment) used is the Team Games Tournament (TGT) to determine the effect of the

TGT approach on students' learning outcomes. The experimental design used is the Pretest-Posttest Control Group Design. This research was conducted at Madrasah Aliyah Persiapan Negeri 4 Martubung. The research was carried out during the even semester of the 2024/2025 academic year, from February to June 2025. The population in this study consisted of all eleventh-grade science students (Class XI IPA) of MAPN 4 Martubung who were enrolled in the even semester of the 2024/2025 academic year, totaling 160 students from five classes. The sampling was conducted using the cluster random sampling technique, which involved randomly selecting two classes out of the five available. Based on the draw results, Class XI IPA 3 was chosen as the experimental group and Class XI IPA 4 as the control group, each consisting of 32-33 students.

The research design implemented was a controlled group with a pretest and a posttest. In this study, two groups were used as control groups and one group as the experimental group. Next, each group carried out a pretest to identify differences between the control group and the experimental group. In this study, both groups received different treatments. The experimental group applied the TGT method to the excretory system material. On the other hand, the control group conducted the learning process only using traditional methods with the same material, namely the excretory system. In addition, each group also carried out a posttest on the excretory system material to measure the differences in student learning outcomes between the control groups and the experimental group. **Table 1** related to the research design is illustrated as follows.

Table 1. Pretest and Posttest Design

Group	Pretest	Treatment	Posttest
Experiment	Y ₁	X	Y ₂
Control	Y ₁	-	Y ₂

Source: Research, 2025

Description

Y₁: Initial test results (pretest) of both groups (experimental and control)

Y₂: Final test results (posttest) of the two groups (experimental and control)

X₁: Using the Team Games Tournament model

The research procedure was carried out in several stages. The first stage was observation and initial interviews to identify learning problems and determine the focus of the research. The second stage was the preparation of learning outcome test instruments, which were validated by experts before use. The third stage was the implementation of a pretest on both groups to measure initial abilities. The fourth stage was the administration of treatment, where the experimental group was taught using the TGT model assisted by puzzle media. The modification made to this model was the use of puzzle media to increase students' engagement in understanding the material. The syntax of the TGT model refers to Rusman in his book titled "Model-Model Pembelajaran Mengembangkan Profesionalisme Guru (Learning Models to Develop Teacher Professionalism)," which is presented in **Table 2**. In contrast, the control group used conventional learning methods. The treatment was conducted in four sessions with a duration of two lesson hours each (2 x 45 minutes). After the treatment was completed, a posttest was conducted to measure the students' final learning outcomes.

Table 2. Syntax of the Team Games Tournament (TGT) Learning Model

Stages	Teacher Activities
Stage 1 Class Presentation	The teacher provides the information needed for learning, explains the learning objectives, and encourages students to be more motivated in their studies.
Stage 2 Forming a Team	The teacher divided the class into several study groups made up of students with different abilities.
Stage 3 Games	The teacher helps students answer questions in the provided game.
Stage 4 Tournament	The teacher holds a competition between groups and provides assessments to determine the extent of the students' understanding.
Stage 5 Group Recognition	The teacher gives rewards to groups that have made an effort and achieved good learning outcomes.

Source: Rusman in his book "Model-model pembelajaran : Mengembangkan Profesionalisme Guru (Learning Models: Developing Teacher Professionalism)"

The instrument used in this study was a learning outcome test administered twice, namely before learning (pretest) and after learning (posttest). This test was used to measure students' learning outcomes on the excretory system material in accordance with the research objective, which is to determine the effect of implementing the TGT model assisted by puzzle media on students' learning outcomes. The scores from this test serve as the basis for statistical analysis calculations, such as tests for normality, homogeneity, and t-test.

The data analysis technique used is inferential statistics with the help of SPSS version 25 software. Before testing the hypothesis, prerequisite tests were conducted, namely normality testing using Shapiro-Wilk and homogeneity of variance testing using Levene's Test. After both assumptions were met, hypothesis testing was conducted using an Independent Samples t-Test at a significance level of 0.05 to determine the difference in learning outcomes between the experimental group and the control group.

RESULTS AND DISCUSSION

Based on the research that has been conducted, the students' learning outcome data is divided into two categories, namely data before the treatment and data after the treatment. Data before the treatment was obtained from the pretest conducted on the control group and the experimental group before the learning process began. Meanwhile, data after the treatment was obtained from the posttest of the control group, which did not receive any special treatment, and the experimental group, which was given treatment through the TGT model assisted by puzzle media.

The results of the data processing were used to examine the effect of the TGT model assisted by puzzle media on the learning outcomes of 11th grade science students in classes XI IPA 3 and XI IPA 4 on the excretory system material. The pretest and posttest scores from both groups are presented in **Table 3**. The table shows a comparison of scores between the control group and the experimental group before and after the learning process took place.

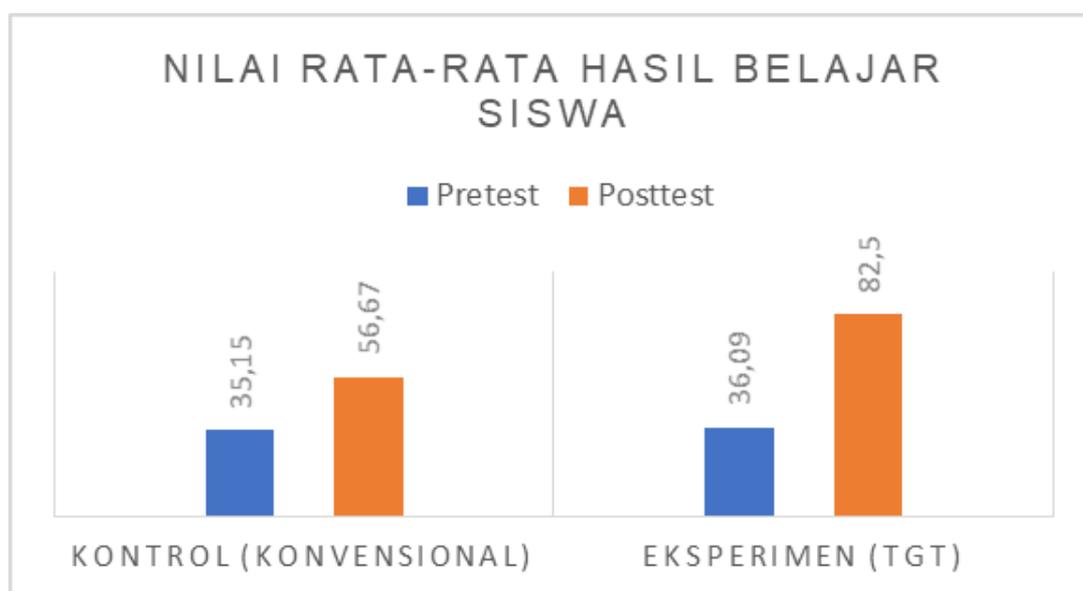
Table 3. Descriptive Statistics Test Results

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Control Pretest	33	30	20	50	35.15	8.52
Control Posttest	33	30	40	70	56.67	8.98
Experimental Pretest	32	35	20	55	36.09	10.37
Experimental Posttest	32	35	70	100	82.50	6.48
Valid N (listwise)	65					

Source: Resource, 2025

Table 3 shows that the average pretest score in the control group was 35.15 with a standard deviation of 8.52, while the posttest score increased to 56.67 with a standard deviation of 8.98. This increase indicates an improvement in learning outcomes, although the variation in scores among students remained relatively high. In contrast, the experimental group had an average pretest score of 36.09 with a standard deviation of 10.37, which then increased significantly to 82.50 on the posttest with a smaller standard deviation of 6.48. These findings indicate that the implementation of the TGT model assisted by puzzle media can improve student learning outcomes more effectively and produce a more even distribution of scores compared to the control group. A clearer comparison can be seen in **Figure 1**.

Figure 1. Comparison of Average Learning Outcomes



Source: Research, 2025

Figure 1 shows a comparison of the average learning outcomes of students between the control class (conventional learning) and the experimental class (learning using the TGT model) during the pretest and posttest. In the control class, the average pretest score of 35.15 increased to 56.67 in the posttest. Meanwhile, in the experimental class, the average pretest score of 36.09 increased more significantly to 82.5 in the posttest. This indicates that the application of the TGT learning model provides a greater improvement in learning outcomes compared to conventional learning. This difference demonstrates the effectiveness of the TGT model in enhancing students' understanding of the material taught.

Normality Test

Normality testing is conducted to determine whether the test data follow a normal distribution. This test uses the Shapiro-Wilk test because the sample size is less than 50. The results of the normality test are presented in **Table 4**.

Table 4. Normality Test Results

Class		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	sig.	Statistic	df	sig.
Result	Control Pretest	.178	32	.011	.937	32	.063
	Control Posttest	.134	32	.155	.947	32	.120
	Experimental Pretest	.146	32	.083	.940	32	.075
	Experimental Posttest	.182	32	.009	.934	32	.052

Source: Research, 2025

Based on **Table 4**, it can be seen that all data in both the control and experimental groups, for both the pretest and posttest, have significance values above 0.05. The control group obtained a significance value of 0.063 for the pretest and 0.120 for the posttest, while the experimental group obtained 0.075 for the pretest and 0.052 for the posttest. Although the posttest significance value of the experimental group is close to the 0.05 threshold, it still statistically meets the normality assumption. Therefore, it can be concluded that the data from both groups are normally distributed and thus suitable to proceed to the next stage of analysis.

Homogeneity Test

Next, a homogeneity test was conducted to determine whether the data variances of the two groups are similar. In this study, the homogeneity test was carried out using Levene's Test. This test is performed as a prerequisite before conducting a t-test. The criteria for the homogeneity test are that if the probability value is greater than 0.05 (>0.05), the data is considered normally distributed, whereas if the significance value is less than 0.05 (<0.05), the data is not normally distributed. The results of the homogeneity test can be seen in **Table 5**.

Table 5. Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Result	Base Bon Mean	3.805	1	62	.056
	Base Bon Median	3.171	1	62	.080
	Based on Median and with adjusted df	3.171	1	61.741	.080
	Based on trimmed mean	3.858	1	62	.054

Source: Research, 2025

Based on **Table 5**, the significance value based on the mean is 0.056, while based on the median it is 0.080, and based on the trimmed mean it is 0.054. All these values are above 0.05, so it can be concluded that the variance between the two groups is homogeneous. This homogeneity meets one of the prerequisites for proceeding with the hypothesis test using an independent samples t-test.

Hypothesis Testing

Hypothesis testing was conducted using an independent samples t-test to determine the difference in average learning outcomes between the control group and the experimental group. This test uses the assumption that the data are normally distributed and homogeneous, as proven by the previous test. The results of the analysis are presented in **Table 6**.

Table 6. Independent Sample t-test Results

		Levene's test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Result	Equal Variances Assumed	3.805	.056	-13.592	62	.000	-26.250	1.931	-30.111	-22.389
	Equal Variances Not Assumed			-13.592	56.965	.000	-26.250	1.931	-30.117	-22.383

Source: Research, 2025

Based on **Table 6**, the t-test results show a significance value of 0.000 ($p < 0.05$), which means there is a significant difference between the two groups. The calculated t-value is -13.592 with a mean difference of -26.250 and a 95% confidence interval ranging from -30.111 to -22.389. These results indicate that learning using the TGT model assisted by puzzle media has a greater effect on improving students' learning outcomes compared to learning with traditional methods. Thus, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_a) is accepted.

Discussion

Based on the results of the study that has been conducted, the implementation of the Team Games Tournament (TGT) learning model assisted by puzzle media shows a significant effect on improving the learning outcomes of 11th grade science students on the excretory system material. This is evidenced by data analysis showing an increase in the experimental group's posttest average score to 82.50 compared to the control group, which only reached 56.67. The results of the independent sample t-test with a t-value of -13.592 and a significance of 0.000 ($p < 0.05$) confirm that there is a significant difference between the two groups, thus the alternative hypothesis (H_a) is accepted. These findings indicate that the combination of the TGT model with puzzle media can create a more effective, interactive, and meaningful learning environment for students in understanding the complex concepts of the excretory system.

The findings of this study support the theory of constructivist learning, which emphasizes that knowledge is not only transferred by the teacher but is constructed through the activities and interactions of the students (Sari et al., 2025). The TGT model applied in this study aligns with the student-centered approach promoted by the Kurikulum Merdeka, in which learners are the main subjects in the learning process (Amalia et al., 2025). Through educational games and puzzle activities, students can construct knowledge independently while also collaborating with their groupmates (Zeng et al., 2020). The research results also confirm the theory of cooperative learning, which emphasizes cooperation and interaction among students to achieve shared learning goals (Kardiyanto et al., 2024). Puzzle media as a concrete medium supports the theory of visual-spatial learning, where students can visualize difficult Biological concepts, making understanding better (Septiyani & Yulianto, 2025). The combination of TGT and puzzles also aligns with the principle of learning by doing, which has been shown to improve memory retention and problem-solving skills.

The results of this study are consistent with previous research findings that show the effectiveness of the TGT model in improving student learning outcomes across various levels and subjects. The latest research findings demonstrate that the TGT learning model significantly enhances student learning outcomes, showing a significant impact compared to conventional methods (Unafisah & Febrianti, 2025). These findings have a pattern very similar to this study, where the increase in learning outcomes for the experimental group shows that the TGT model consistently has a positive impact on learning. This

similarity reinforces the validity of the findings that the TGT model is effective in improving learning outcomes with substantial increases, even when applied in different contexts and learning materials.

The consistency of the effectiveness of the TGT model is also seen in research in the more specific field of Biology. The TGT-type cooperative learning model has a positive effect on students' Biology learning outcomes (Zulfira *et al.*, 2019). The obtained value is even slightly higher compared to the results of this study, which reached 82.50, but both are within the range indicating the high effectiveness of the TGT model in Biology learning. This difference can be explained by variations in student characteristics, material complexity, and different learning environment conditions. Nevertheless, both studies indicate that the TGT model is consistently effective for Biology material that has complex conceptual characteristics and requires deep understanding.

The success of the TGT model is not limited to science subjects, but has also been proven effective in other subjects (Nugraha & Subroto, 2020). This indicates that the TGT model is flexible and can be adapted for various subjects with different characteristics. The differences in the magnitude of improvement can be explained by several factors. First, the complexity of the excretory system material in Biology requires more concrete visualization compared to economic concepts, which tend to be more abstract. Second, the use of puzzle media in this study provides added value in helping students visualize concepts clearly and interactively. Third, the characteristics of science class students, who tend to be more responsive to visual-spatial game-based learning, also contribute to a more significant improvement in learning outcomes.

The success of the TGT model assisted by puzzle media in the context of learning the excretory system can be explained through several contextual factors. First, the material on the excretory system has complex characteristics and is full of scientific terms, making it often difficult for students to understand if taught only verbally (Yosefia *et al.*, 2025). The TGT model is able to create an enjoyable competitive atmosphere through team-based quizzes, while puzzle media allows the visualization of organs in the excretory system, making learning more concrete. Second, the characteristics of 11th-grade science students, who are at the formal operational stage of cognitive development, require a learning approach that can accommodate their abstract thinking abilities through challenging and meaningful activities. Third, the context of learning Biology, which requires an understanding of the relationships between organs and physiological processes that occur simultaneously, can be addressed through a combination of team discussions and puzzle-assembling activities that stimulate analytical thinking. Fourth, a school environment that supports interactive learning allows the effective implementation of the TGT model, where students can actively participate in tournaments and group collaborations.

The findings of this study have several practical implications that are important for the field of education. First, for Biology teachers, the results of this study provide an alternative learning model that has been proven effective in improving student learning outcomes, particularly for complex material such as the excretory system. Teachers can implement a combination of the TGT model with puzzle media as an innovative and engaging learning strategy. Second, for schools, this study offers input for the development of more student-centered learning policies and encourages the use of varied learning media. Schools can provide facilities and support for the implementation of cooperative learning models that involve educational game activities. Third, for curriculum developers, this research can serve as a basis for incorporating a more interactive and collaborative learning approach into the design of the Biology curriculum. Fourth, for students, the implementation of the TGT model assisted by puzzles not only enhances conceptual understanding but also develops social skills such as cooperation, communication, and sportsmanship, which are part of 21st-century competencies (Wulandari & Rosdiana, 2024).

This study has several limitations that need to be acknowledged. First, the research was conducted in only one school with a limited sample (65 students), so generalizing the results to a broader population should be approached with caution. Second, this study focused solely on one learning material, namely the

excretory system, so the effectiveness of the TGT model assisted by puzzles in other Biology topics cannot yet be determined. Third, the measurement of learning outcomes in this study was limited to cognitive aspects through written tests, while affective and psychomotor aspects were not evaluated in depth. Fourth, this study did not strictly control for external factors that may influence students' learning outcomes, such as family conditions, individual learning motivation, or prior learning experiences. Fifth, the relatively short duration of the study cannot yet reflect the long-term effects of implementing the puzzle-assisted TGT model on student learning retention. Sixth, this study has not yet explored in depth the learning processes that occur during the implementation of the TGT model, so the specific mechanisms that lead to improved learning outcomes have not been fully revealed.

This research provides several important contributions to the development of scientific knowledge and educational practice. First, this study confirms the effectiveness of combining the TGT model with puzzle media in the context of Biology learning, specifically on the excretory system material at the high school level. This is a novel contribution because most previous studies only focused on the application of the TGT model separately without integrating it with concrete learning media such as puzzles. Second, this study enriches the literature on cooperative learning by providing empirical evidence that the combination of educational game elements and visualization can enhance learning effectiveness in complex subjects. Third, this study provides a methodological contribution by demonstrating the use of a quasi-experimental design that can be adapted for similar research in the future. Fourth, the findings of this study offer a practical contribution in the form of an alternative learning model that can be implemented by teachers to improve the quality of Biology instruction. Fifth, this study provides a theoretical contribution by confirming the relevance of constructivist theory and cooperative learning in the context of modern science education. Sixth, this study opens up opportunities for further research that can explore the application of the TGT model assisted by visual media on other Biology topics or different science subjects.

CONCLUSION

Based on the data analysis and discussion conducted, it can be concluded that the implementation of the Team Games Tournament (TGT) learning model combined with puzzle media has a positive and significant effect on improving the learning outcomes of 11th-grade science students on the excretory system material at Madrasah Aliyah in Medan. This conclusion answers the research problem statement which questioned the effectiveness of combining the TGT model with puzzle media in addressing the low biology learning outcomes of students caused by passive conventional learning. The research results show that the group of students who participated in learning using the TGT model with the help of puzzle media achieved very good learning outcomes, while the control group using conventional learning only reached a sufficient category. This difference shows that the combination of the TGT model with puzzle media successfully creates a learning environment that is more interactive, engaging, and meaningful compared to conventional teaching methods.

The findings of this study align with the research objective, which aims to analyze the effect of the TGT learning model combined with puzzle media on the learning outcomes of 11th-grade Science students in excretory system material. Statistical analysis results confirmed a significant difference between the experimental and control groups, with the experimental group showing a much more substantial improvement in learning outcomes. The success of the TGT model assisted by puzzles can be explained through three main aspects: first, this model successfully transforms the learning atmosphere from passive to active through competitive and collaborative game activities; second, the puzzle media provides a concrete visualization that helps students understand the complex excretory system concepts; and third, the combination of both creates a meaningful learning experience. Students do not just memorize but truly understand the interrelationships among organs in the excretory system. Thus, the research hypothesis

stating that there is a positive and significant effect of the implementation of the TGT model assisted by puzzle media on students' learning outcomes is empirically proven.

Based on the findings and limitations of this study, it is recommended to conduct further research exploring the application of the TGT model assisted by puzzles on other Biology materials with a larger and more diverse sample. Future research should also integrate a more in-depth evaluation of affective and psychomotor aspects, as well as conduct longitudinal studies to analyze the long-term effects on student learning retention.

AUTHOR'S NOTE

The author declares that there is no conflict of interest in publishing this article. The author also ensures that the data and content of the article are free from plagiarism.

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