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The Influence of Teams Games Tournament (TGT) on Students' Motivation and Collaboration Skills in Learning Acid-Base

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ABSTRACT This study examines the impact of the Teams Games Tournament (TGT) model on students' motivation and collaboration skills in the context of the acid-base topic. Using a quantitative approach with a quasi-experimental pretest-posttest nonequivalent control group design, the study involved 49 students: 28 in the experimental group (TGT model) and 21 in the control group (discovery learning). Two instruments were used: the Science Motivation Questionnaire II (25 items) and the Teamwork Competency Scale (30 items). Data analysis was conducted using the Mann-Whitney U and Wilcoxon tests with SPSS version 30. Results showed a significant increase in learning motivation in the experimental group compared to the control group ($p < 0.05$), particularly in intrinsic motivation, career motivation, self-determination, self-efficacy, and grade motivation. However, no significant difference was found in students' collaboration skills between the two groups ($p > 0.05$), indicating that the TGT model did not significantly improve collaboration. In conclusion, the TGT learning model is effective in enhancing students' motivation for learning acid-base concepts; however, it does not significantly influence their collaboration skills. These findings suggest that combining TGT with other instructional strategies may be necessary to foster both motivation and collaboration among students.

Keywords: Acid-base, Chemistry learning, Collaboration skills, Learning motivation, Teams games tournament

1. INTRODUCTION

Motivation is a process that describes the intensity, direction, and consistency of a person's effort to achieve a goal. It is also related to the sustainability of the chosen action (Judge & Robbins, 2017). Several studies suggest that student motivation and engagement are crucial factors for successful learning and academic achievement, as motivation provides enthusiasm and increases students' initiative to achieve desired goals (Bandura, 2012). Students with high learning motivation tend to be more engaged in the learning process, which ultimately affects the achievement of learning objectives (Guajardo-Leal & Córdova, 2021). According to Hamsyah and Gustina (2025), learning motivation is influenced by internal and external factors that can encourage students to be active and committed to the learning process, set their learning goals, and maintain efforts to achieve those goals. Internal motivation comes from within the student, such as the desire to learn in order to achieve their dreams. Meanwhile, external motivation originates from outside the student, such as motivation that arises from exams or academic demands (Mayasari & Alimuddin, 2023).

In July 2020, Save the Children reported that students experienced a decline in motivation, which was exacerbated by the government's decision to eliminate national exams in schools. This decision reduced the number of additional lessons aimed at exam preparation and led to a less competitive learning atmosphere (Ghani & Zharfa, 2020). In March 2025, Prof. Dr. Abdul Mu'ti, the Minister of Primary and Secondary Education of the Republic of Indonesia, stated that Indonesia is currently facing a concerning phenomenon known as learning loss. The term "*learning loss*" refers to a significant decline in learning motivation, cognitive capacity, and student academic achievement, which affects the overall quality of the learning process and its outcomes. According to the Minister, the decrease in learning motivation was caused by the reduced direct interaction between teachers and students during the learning process throughout the pandemic. During this period, learning was mainly conducted online—or, in some cases, not conducted at

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all—which resulted in a suboptimal teaching and learning process. The Minister also emphasized that the negative impact of this condition can still be felt today, requiring serious attention from various parties to find practical solutions to restore students' motivation and learning quality (Lintang, 2025). Therefore, in addition to students, teachers also play a crucial role in developing and enhancing students' learning motivation and encouraging their active involvement in the learning process—especially amid the advancements of the digital era and globalization.

Currently, globalization and technology are developing rapidly, posing challenges to the education sector. To address these challenges, 21st-century skills have become essential in education and are considered necessary competencies for future workplaces. These skills include the 4Cs: creativity, critical thinking, communication, and collaboration (Thornhill-Miller et al., 2023). One of the key 21st-century skills is collaboration (Child & Shaw, 2016), which is the focus of this study. Collaboration is an action performed to achieve a common goal within a group, promoting socialization skills and social-emotional regulation (Boyraz, 2021). According to the National Research Council (2015), collaboration skills are fundamental as they support project-based and inquiry-based learning. Additionally, students increasingly need skills that enable them to use their knowledge to solve future problems (PISA, 2017).

Collaboration skills are highly significant in education and professional fields today, including in high school chemistry learning (Scager et al., 2016). In chemistry learning, collaborative activities among students may include laboratory experiments, analyzing chemical data, and solving scientific problems together (Pires et al., 2020). Implementing collaboration in learning can enhance students' understanding of chemistry concepts, improve social skills, and foster a sense of care and responsibility (Scager et al., 2016). Students can collaborate to overcome learning difficulties through peer teaching, where more knowledgeable students explain concepts to those who require a more profound understanding (Hidayanti & Savalas, 2020). Consequently, students' academic performance, social skills, and empathy improve.

However, in practice, several challenges hinder effective collaboration. Students tend to be more motivated when working individually. While they may generate good ideas for problem-solving, they often struggle to articulate and develop these ideas effectively with others (Astutik et al., 2017). One of the primary factors contributing to students' limited collaborative competence is their tendency to avoid assuming responsibility within group settings (Mu'arifah et al., 2023). This is supported by Haryanti et al. (2024), who associate students' poor collaboration skills with individualistic attitudes. Similarly, Putri and Qosyim (2021) emphasize that some students tend to rely heavily on their peers to complete group tasks. Moreover, several students report reluctance to participate in collaborative activities due to a perceived lack of appreciation for their input by other group members. Consequently, collective understanding within groups is often underdeveloped (Le et al., 2018). When seeking assistance from peers, students also face difficulties in clearly expressing their needs, resulting in ineffective interactions between those offering and receiving help (Le et al., 2018). As a result, students' collective understanding within a group is not always well-constructed (Le et al., 2018). Furthermore, when seeking help from group members, students often struggle to express their needs clearly, resulting in ineffective collaboration between the helper and the recipient of help (Le et al., 2018).

Learning motivation and collaboration skills are two key factors that support students' academic success, especially in subjects like chemistry, which require conceptual understanding and problem-solving skills (Zheng, 2024). Learning motivation is closely tied to students' engagement and willingness to understand the material, while collaboration fosters social interaction that enriches understanding through discussion and teamwork (Wang et al., 2024). However, conventional teaching methods, which remain dominant in schools, are often teacher-centered, making it difficult for students to grasp complex concepts such as those found in chemistry (Hirca, 2011). Teacher-centered learning reduces opportunities for students to be active participants in the learning process, thereby hindering deep comprehension of chemistry topics (Anzovino & Bretz, 2015).

Chemistry is an abstract and challenging subject to learn and understand. Burrows and Mooring (2015) also state that chemistry is a complex subject with many abstract topics and concepts, one of which is acid-base chemistry. Acid-base topics are considered complex and abstract because students must connect the material with chemical representations at macroscopic, microscopic, and symbolic levels to fully understand the concept (Kidanemariam et al., 2013). Additionally, while acid-base concepts are frequently encountered in daily life, they are often not taught effectively at an early age, leading to misconceptions (Jiménez-Liso et al., 2020). Therefore, this study encompasses a range of acid-base topics, from theoretical concepts to acid-base calculations. To actively engage students and enhance their understanding of acid-base material, teachers must design innovative learning strategies.

Innovative learning strategies are needed to boost students' motivation and collaboration skills. One such strategy is the Teams Games Tournament (TGT) learning model, a game-based cooperative learning approach that combines teamwork and academic competition (Wijaya et al., 2025). TGT is a student-centered cooperative learning model that encourages active participation and increases students' interest in learning (Luo et al., 2020). Studies have shown that game-based methods, such as TGT, can enhance students' intrinsic motivation by providing a more enjoyable and interactive learning experience compared to conventional approaches (Huang & Wang, 2024). This is supported by research from Tolla and Ali (2017), which found that the TGT model increases students' learning motivation, as indicated by higher learning outcomes in experimental groups compared to control groups. The competitive element in TGT motivates students to study harder, while teamwork enables them to engage in discussions and develop a shared understanding of the subject matter (Munkvold & Sigurdardottir, 2024). Beyond motivation, TGT also plays a crucial role in improving students' collaboration skills. Team-based learning requires students to work together, share responsibilities, and develop better communication skills (Gui et al., 2025). Research indicates that students involved in collaborative learning are better at independent problem-solving compared to those who study individually (Munkvold & Sigurdardottir, 2024). A study by Nur Fauziah (2024) also found that the TGT cooperative learning model has a positive impact on collaboration skills, as students tend to be more active in class discussions.

Based on this background, this study aims to analyze the impact of the Teams Games Tournament model on increasing students' learning motivation and collaboration skills in understanding acid-base material. Through active group interactions and a healthy competitive element, it is expected that students will not only be more motivated to learn but also develop better collaboration skills in completing academic tasks. This research is expected to provide teachers with insights into designing more effective and innovative teaching methods, as well as serve as a reference for schools in implementing approaches that enhance student engagement in chemistry learning.

2. METHOD

This research employs the quantitative method of Quasi-Experimentation. A quasi-experiment was used because it was not possible to randomize the class members (Polit & Beck, 2020). This used study experimental and control groups. The classes were already formed before the research was conducted.

2.1 Participants

This study was conducted in February 2024/2025 at a public high school in Jakarta. The research involved 49 eleventh-grade students. The participants consisted of 32 female and 17 male students, with an average age of 16.6 ± 0.6 years. The study utilized pre-existing classes, as they had already been formed before the research was conducted. Of the 49 students, 28 were assigned to the experimental group, while 21 were assigned to the control group.

2.2 Research Design

This study used a pretest-posttest nonequivalent control group design. This research design was conducted to see the effectiveness of a treatment. This design was conducted without randomizing group members and using pre-formed groups (Goodwin & Goodwin, 2016). Research activities are divided into three parts: pre-test, treatment, and post-test. The pre-test was conducted before the treatment. Meanwhile, the post-test was conducted after the treatment had been administered. The treatment in each class was conducted for one meeting with a total duration of 90 minutes. The research is illustrated in Figure 1.

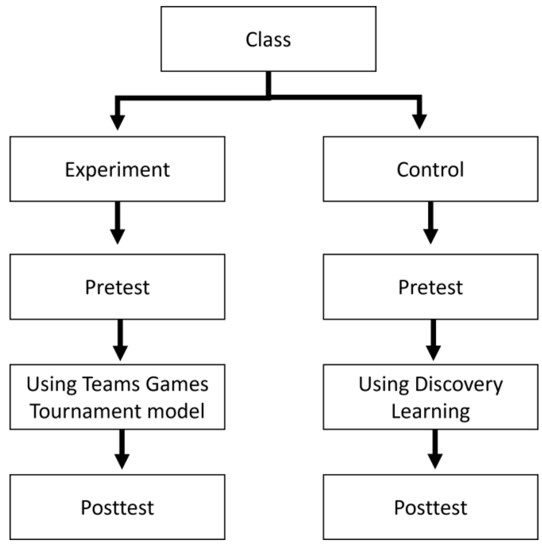

Figure 1 Research flow

As shown in Figure 1, the experimental group employs the TGT model. The syntax for the experimental group follows the TGT model, as described in the article written by Y. Hu et al. (2022). In this learning process, the first stage is pre-training, where the teacher explains the sequence of activities and the rules of the game designed for the lesson. The next stage is feedback, in which students are allowed to ask questions and provide responses to the teacher's explanation. The teacher then addresses the students' questions and feedback. The next stage is games, where students receive a review of the material previously learned. In this session, students will play Snakes and Ladders as a learning medium. The flow of the Snakes and Ladders game is as follows in Figure 2.

The final stage of the lesson is a review of the material. The teacher validates the students' answers to ensure their understanding of the material they have learned.

The Discovery Learning model was used for the control group. The syntax used refers to the article written by De Jong and Van Joolingen (1998). The first stage of this learning is hypothesis formation. At this stage, students are given a Learner Worksheet that contains problems related to acid-base indicators and pH issues in soil. Then, the teacher explains the content and how to complete the Learner Worksheet. After that, students understand and analyze the contents of the Learner Worksheet in the group.

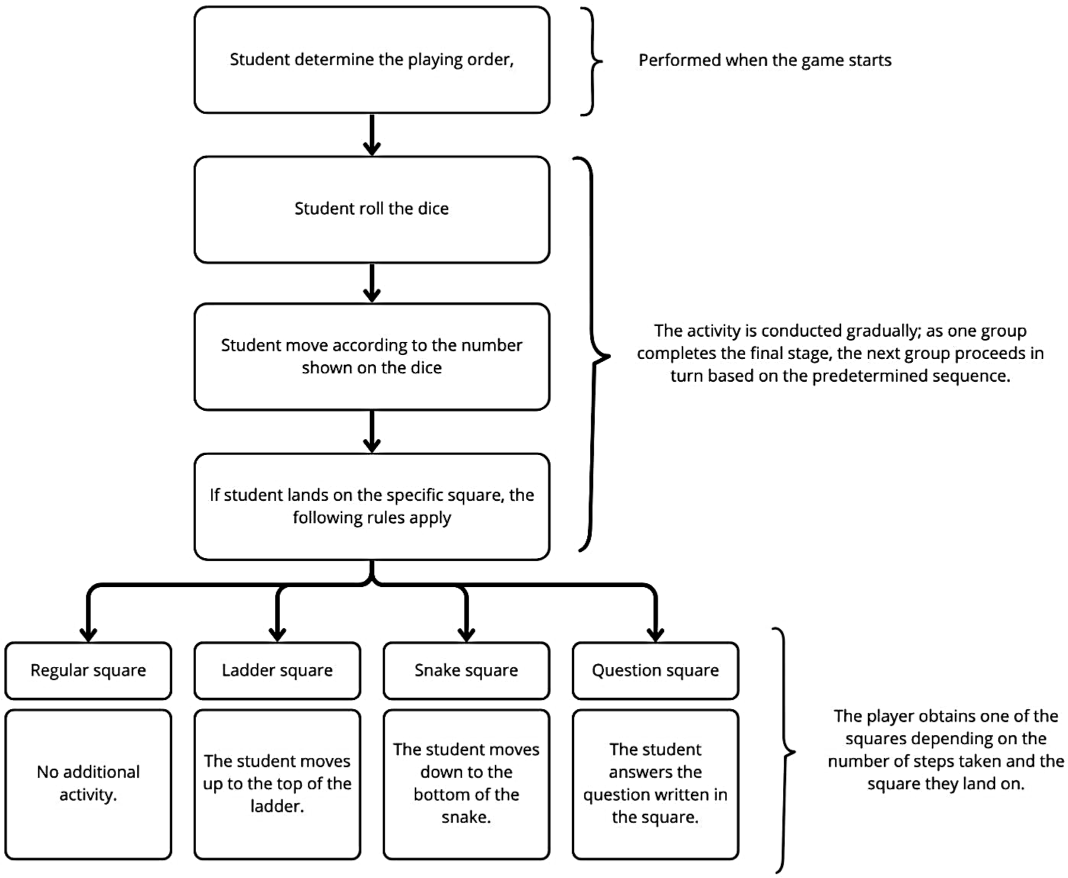

Figure 2 Snakes and ladders game flow

Furthermore, during the experimental design stage, students continue to analyze the contents of the Learner Worksheet, complete the assigned tasks, and gain an understanding by searching for information within the Learner Worksheet. The last stage is data interpretation, where students understand the results of the data search that has been done. At this stage, students will conclude their understanding of the entire series that has been completed.

2.3 Motivation Measurement

The measurement of students' motivation used the "Science Motivation Questionnaire II," developed by Glynn et al. (2011). This instrument is a questionnaire with the following Likert scale: “Strongly Agree” (5 points), “Agree” (4 points), “Neutral” (3 points), “Disagree” (2 points), and “Strongly Disagree” (1 point). The motivation instrument consists of five main dimensions: “Intrinsic Motivation” (5 items), “Career Motivation” (5 items), “Self-Determination” (5 items), “Self-Efficacy” (5 items), and “Class Motivation” (5 items), totaling 25 items. The reference instrument has a reliability score of 0.92, while the instrument used in this study has a reliability score of 0.949. According to the book written by DeVellis (2021), a reliability score above 0.8 falls into the “very good” category.

2.4 Collaboration Measurement

The measurement of students' collaboration used the "Teamwork Competency Scale (TCS)," developed by Hebles et al. (2022). This instrument is a questionnaire with the following Likert scale: "Strongly Agree" (5 points), "Agree" (4 points), "Neutral" (3 points), "Disagree" (2 points), and "Strongly Disagree" (1 point). The collaboration instrument consists of nine main dimensions: "Shared Success" (3 items), "Learning Orientation" (4 items), "Planning and Coordination" (4 items), "Work Monitoring" (3 items), "Supportive Habits" (3 items), "Group Goal Setting" (3 items), "Problem-Solving" (3 items), "Problem Management" (3 items), and "Communication" (4 items), totaling 30 items. The reference collaboration instrument has a reliability score of 0.93, while the instrument used in this study has a reliability score of 0.977. According to the book written by DeVellis (2021), a reliability score above 0.8 falls into the “very good” category.

2.5 Data Analysis Techniques

This study aims to examine changes in motivation and collaboration across different classes. The instrument used in this study is a questionnaire, which is an ordinal-scale instrument. According to an article written by Philip Sedgwick (2015), ordinal scales cannot be analyzed using parametric methods because the data obtained cannot be assumed to be homogeneous. The analysis used to assess changes in motivation, and collaboration employs the Mann-Whitney U test for the control and experimental groups. Meanwhile, the Wilcoxon test is used to determine differences in motivation and collaboration after the learning process. To test these objectives, the researcher used SPSS version 30 software for the Mann-Whitney U test and the Wilcoxon test, with a significance level of 0.05.

3. RESULT AND DISCUSSION

The data obtained by the researcher, analyzing the improvement in learning motivation and collaboration, consisted of five indicators for motivation and nine indicators for collaboration. The indicators used to measure the improvement in motivation include intrinsic motivation, career motivation, self-determination, self-efficacy, and classroom motivation (Glynn et al., 2011). The indicators used to measure improvement in collaboration include joint success, learning orientation, planning, and coordination, task monitoring, support-giving habits, group goal formation, problem-solving, conflict management, and communication (Hebles et al., 2022).

These indicators form the basis for designing learning activities in the lesson plan, where each stage of the TGT model is deliberately structured to encourage the development of student motivation and collaboration. In particular, the pre-training and peer teaching sessions aim to enhance both intrinsic motivation and classroom motivation, as well as group goal-setting and supportive habits. Meanwhile, the game-based learning and feedback stages provide opportunities to develop self-determination, problem-solving, and communication skills. The lesson plan is shown in Table 1.

In the control class, treatment was given using the discovery learning model. The Discovery Learning model is suitable for use in the control class because it is a common and relevant instructional approach for chemistry topics such as acids and bases, which require conceptual exploration through experimentation (Balazinec et al., 2024). Although it encourages students to discover scientific principles on their own actively, Discovery Learning remains individualistic and limited in collaboration, making it an ideal comparison for the TGT model, which emphasizes teamwork and social motivation. Methodologically, using Discovery Learning as the control provides a fair and valid basis for measuring the effectiveness of TGT in enhancing students' learning motivation and collaborative abilities, as both are active learning approaches but differ in social orientation and interaction structure. Students were provided with a case study through the worksheet, then discussed the case in groups and presented their results. A summary of the discovery learning plan for the control class is presented in Table 2.

Table 1 Summary of TGT learning lesson plan

Meeting	Activity	Syntax TGT
Fri, 21 Feb 2025	Motivation and Collaboration Pre-test Introduction Game Peer teaching between groups	Pre-training Students can understand the procedures for playing games In groups, students can share their understanding of the material Students have high motivation to teach each other the material
	Students are allowed to ask questions related to games and materials Teacher gives review for games and feedback for materials	Feedback Students can ask about difficulties and obstacles experienced by the group related to the material and the game.
	Briefing on how to play The game begins by dividing the group, and each group takes turns playing Score collection based on points for doing questions and the number of steps in the snakes and ladders Post-test of motivation and collaboration	Games Students can play according to the agreed rules Students do game-based learning with enthusiasm

Table 2 Summary of discovery learning lesson plan

Meeting	Activity	Syntax Discovery
Fri, 21 Feb 2025	Case studies with the provision of Student Worksheets	Hypothesis formation Students are given a Learner Worksheet, which contains problems related to acid-base indicators and pH levels in soil.
	The teacher explains how to work on the case study in the worksheet	Explains the contents The teacher explains how to work on the Learner Worksheet

Table 2 Summary of discovery learning lesson plan (*Continued*)

Meeting	Activity	Syntax Discovery
	Students discuss the case presented in the worksheet	Understand and analyze the contents
	The teacher monitors the discussion process of each group	Students analyze the contents of the Learner Worksheet in the group
Fri, 21 Feb 2025	Students gather information about the case from various sources, including books and the internet, and record it in the worksheet.	The experimental design stage Students continue to analyze the contents of the Learner Worksheet, work on the assigned tasks, and gain understanding by searching for information within the Learner Worksheet.
	Students present the results of the case discussion in front of the class	Data interpretation Interpretation of data through class presentations
	The teacher provides feedback on the students' presentations	

The study was conducted at a public senior high school in Jakarta and employed a questionnaire as the data collection instrument. According to Sangthong (2020), the data obtained from the questionnaire are ordinal and do not meet the assumption of normal distribution. Therefore, non-parametric statistical tests were used for data analysis, specifically the Mann-Whitney U test for comparing two independent groups and the Wilcoxon test for comparing two related groups.

3.1 Student Motivation

The Wilcoxon test results were used to examine the differences between pre-test and post-test scores within each class. The results of the Wilcoxon test are shown in Table 3.

Based on Table 3, the p-values for each indicator in the control group were greater than 0.05, indicating that the null hypothesis was accepted and that there was no significant improvement in any of the motivation indicators in the control group. In contrast, the p-values in the experimental group were all less than 0.05, indicating that the TGT model had a significant influence on students' motivation regarding the topic of acids and bases. Overall, the p-value in the experimental group was < 0.05, while the control group had a p-value > 0.05. Therefore, the application of the TGT model had a significant effect on improving students' motivation in learning acids and bases.

Subsequently, a Mann–Whitney U test was performed to compare the post-test motivation scores between the

Table 3 Mean ± standard deviation of pre-test and post-test motivation scores (Wilcoxon test)

Indicators	Pre-test		Post-test		Wilcoxon Test	
	M	DT	M	DT	Z	Sig.
Control Group						
Intrinsic Motivation	18.33	3.89	18.05	4.62	-0.112	0.911
Career Motivation	19.29	2.95	19.81	4.83	-0.767	0.443
Self-determination	19.05	3.99	19.14	4.45	-0.121	0.904
Self-efficacy	19.00	3.28	18.86	4.83	-0.285	0.776
Grade Motivation	21.24	2.93	21.57	4.08	-0.154	0.878
Overall indicators	19.38	3.40	19.48	4.56	-0.296	0.768
Experimental Group						
Intrinsic Motivation	19.21	3.40	22.14	2.25	-3.538	0.000
Career Motivation	18.68	3.47	22.21	2.25	-4.465	0.000
Self-determination	20.36	3.74	22.82	2.22	-3.291	0.001
Self-efficacy	20.36	3.89	22.93	2.03	-3.592	0.000
Grade Motivation	22.14	3.97	23.43	2.04	-3.194	0.001
Overall indicators	20.15	3.69	22.70	2.15	-3.406	0.001

Table 4 Mean ± standard deviation of final differences between the control group (CG) and experimental group (EG) using the Mann–Whitney U test (post-test)

Indicators	CG		EG		Mann-Whitney U	
	M	DT	M	DT	Z	Sig.
Intrinsic Motivation	18.05	4.62	22.14	2.25	- 2.519	0.012
Career Motivation	19.81	4.83	22.21	2.25	- 2.069	0.039
Self-determination	19.14	4.45	22.82	2.22	- 2.849	0.004
Self-efficacy	18.86	4.83	22.93	2.03	- 3.005	0.003
Grade Motivation	21.57	4.08	23.43	2.04	- 2.323	0.020
Overall indicators	19.48	4.56	22.70	2.15	- 2.968	0.003

control and experimental groups. The results are presented in Table 4.

Based on Table 4, all indicators had p-values less than 0.05, and the overall p-value was 0.003, which indicates that the hypothesis was accepted. Thus, there was a significant difference in the average post-test motivation scores between the control and experimental groups.

This study was conducted to investigate the impact of the TGT model on students' motivation in learning acid-base concepts. The results of the Wilcoxon test showed a significance value of < 0.05 for the overall score and each indicator. These findings suggest that the TGT learning model is effective in enhancing students' motivation for learning chemistry, particularly in the context of the acid-base topic. This finding aligns with a study by Edwin Byusa et al. (2022), which revealed that the TGT model has the potential to significantly impact students' learning motivation, as game-based learning enables students to develop deeper thinking and interactive skills while enjoying the learning process. Game-based learning refers to the use of games, enjoyable interactions, and engaging design to motivate students to participate actively in classroom learning, thereby fostering high learning motivation (Hartt et al., 2020).

According to Slavin (1995), the Teams-Games-Tournament (TGT) model consists of five stages: class presentation, team learning, educational games, tournament, and team recognition, all carried out in a competitive yet enjoyable atmosphere. These five stages are highly relevant when integrated into the teaching of acid-base material, which fundamentally involves chemical concepts that require both conceptual understanding and mathematical calculation skills.

In the Teams stage, students work in small, heterogeneous groups to learn acid-base material through discussion and collaborative problem-solving. This approach can enhance conceptual understanding through peer discussion and cooperation, allowing students with different levels of comprehension to support one another and reinforce their grasp of fundamental concepts and pH calculations (Maulida et al., 2024).

The Games stage allows students to practice acid-base concepts interactively through games, such as answering questions about pH calculations, identifying solution properties, or predicting acid-base reactions using question cards. This activity encourages repeated exposure to the material in a fun way, strengthening memory through playful experiences (Bandaso et al., 2023).

The Tournament stage becomes a competitive arena for teams to answer acid-base questions that they have previously studied. The competitive mechanism in game-based learning environments has a positive impact on learning outcomes and student motivation. Students in competitively designed classrooms demonstrate better learning outcomes and higher motivation than those in non-competitive settings (C.-C. Chen & Tu, 2021). The tournament serves as a vital element that not only fosters individual responsibility but also strengthens teamwork and builds students' confidence in applying the knowledge they have acquired.

TGT helps students improve their speed in answering questions and reinforces learning while refreshing memory in a fun and less stressful way (Zhang et al., 2021). As a result, students feel more enthusiastic and motivated to engage in the learning process. TGT-based learning is consistently considered more enjoyable and engaging, making students more absorbed in activities and stimulating intrinsic motivation that drives them to enjoy learning and continue learning beyond the classroom (Wichadee & Pattanapichet, 2014). This is illustrated in Figure 3a, where students appear enthusiastic as they roll the dice to determine their moves in the ongoing round.

(3a)

(3b)

Figure 3a The students were enthusiastic about rolling the dice; **3b** The students were motivated to complete the challenges

Game-based learning can sustain student interest and foster commitment due to its enjoyable nature, which helps students stay positive even when they face challenges. Students can position themselves comfortably when facing challenges, as shown in Figure 3b.

The use of the TGT model creates a learning environment in which students actively participate, thus generating high learning motivation (Al-Khayat & Gargash, 2023). Students with higher motivation tend to achieve better academic performance than those with lower motivation (Wu et al., 2022). Learning motivation enables learners to engage deeply and actively in the learning process, ultimately enhancing student achievement (Baek et al., 2015). Active participation makes the teaching and learning process more meaningful, encouraging students to be motivated, which can positively affect their academic achievement (Partovi & Razavi, 2019). Research by Sulistyo Widodo et al. (2018) suggests that implementing the TGT model in acid-base materials significantly enhances student engagement and learning outcomes as the learning process becomes more active, contextual, and meaningful. Therefore, the TGT syntax is highly suitable for improving students' learning motivation and understanding of topics that are considered abstract and challenging, such as acid-base chemistry.

This is supported by a study by Daubenfeld and Zenker (2015), which stated that game-based learning contributes to stimulating and increasing student motivation in higher-level chemistry education, such as undergraduate physical chemistry. Similarly, Ebrahimzadeh and Alavi (2017) found that game-based learning fosters higher motivation levels by creating a comfortable and calming environment that nurtures students' curiosity. Another study by Franco-Mariscal et al. (2016) reported that game-based learning led to significant improvements in students' understanding of the periodic table, its properties, and its history. Students found the TGT model engaging, as it generated interest, motivated them to complete tasks and understand the content, and facilitated the learning process.

The research results show that among the five indicators of student learning motivation, the highest-achieving indicator was grade motivation. This indicates that students have a strong drive to achieve good grades as a form of academic accomplishment. The high score on this indicator is closely related to the implementation of the Team Games Tournament (TGT) learning model, which structurally incorporates elements of competition, collaboration, and evaluation into the learning process. The TGT model integrates group-based games and tournaments, which directly stimulate students to perform well in order to gain academic recognition in the form of scores or rewards (Slavin, 1995).

In this context, grade-oriented motivation increases because students are encouraged to actively participate in order to win the tournament and achieve optimal learning outcomes. A study by Franco-Mariscal et al. (2016) confirmed that game-based learning, such as TGT, can enhance student interest and motivation through a fun and competitive learning atmosphere. Furthermore, a structured evaluation system in game-based learning models can drive students to focus on achieving high scores, as they feel responsible for their group. This sense of responsibility fosters collaboration among group members to solve problems given by the teacher (Rumape et al., 2020).

Conversely, the indicator with the lowest achievement was intrinsic motivation. This indicates that while students may be motivated to learn due to external factors such as grades and rewards, they are not yet entirely driven by personal interest and satisfaction with the learning material. According to Ryan and Deci (2020), intrinsic motivation can grow when learning provides space for autonomy, personal relevance, and a sense of accomplishment. The low score on this indicator suggests that while the TGT-based learning approach is effective in enhancing extrinsic motivation, it has not fully accommodated these psychological needs.

3.2 Student Collaboration

The Wilcoxon test was used to compare the average pre-test and post-test scores within each group. The results of the Wilcoxon test are presented in Table 5.

Table 5 Mean ± standard deviation of the pre-test and post-test comparison using the Wilcoxon test

Indicators	Pre-test		Post-test		Wilcoxon Test	
	M	DT	M	DT	Z	Sig.
Control Group						
Collective Efficacy	11.29	2.22	11.05	3.25	-0.081	0.936
Learning Orientation	14.76	2.81	14.24	3.83	-0.418	0.676
Planning & Coordination	15.57	2.32	13.52	3.56	-0.017	0.896
Performance Monitoring	11.19	1.94	10.24	2.91	-0.379	0.768
Supportive Behaviour	11.05	1.99	10.62	3.04	-0.588	0.556
Establishment of Group Objectives	11.05	2.01	10.62	3.26	-0.524	0.600
Problem-Solving	11.52	1.75	10.67	3.10	-0.451	0.680
Conflict Management	11.19	1.83	10.33	2.96	-0.404	0.650
Communication	14.48	2.38	14.43	2.96	-0.790	0.937
Overall Indicators	12.46	2.14	11.75	3.21	-0.406	0.744

Table 5 Mean ± standard deviation of the pre-test and post-test comparison using the Wilcoxon test (*Continued*)

Indicators	Pre-test		Post-test		Wilcoxon Test	
	M	DT	M	DT	Z	Sig.
Experimental Group						
Collective Efficacy	12.04	2.08	12.36	2.91	-0.920	0.357
Learning Orientation	16.68	2.89	16.68	3.69	-0.243	0.808
Planning & Coordination	16.61	2.80	16.61	3.66	-0.359	0.720
Performance Monitoring	13.04	1.90	12.50	2.38	-0.665	0.506
Supportive Behaviour	13.11	2.13	12.43	2.63	-0.887	0.375
Establishment of Group Objectives	12.89	2.15	12.54	2.81	-0.223	0.824
Problem-Solving	12.68	2.42	12.36	2.93	-0.189	0.850
Conflict Management	12.46	2.20	12.07	2.92	-0.607	0.544
Communication	16.64	2.31	16.36	3.68	-0.410	0.682
Overall Indicators	14.02	2.32	13.75	3.07	-0.500	0.629

Table 6 Mean ± standard deviation of post-test differences between the control group (CG) and experimental group (EG) using the Mann–Whitney U test

Indicators	CG		EG		Mann-Whitney U Test	
	M	DT	M	DT	Z	Sig.
Collective Efficacy	11.05	3.25	12.36	2.91	-1.571	0.116
Learning Orientation	14.24	3.83	16.68	3.69	-2.443	0.015
Planning & Coordination	13.52	3.56	16.61	3.66	-2.884	0.004
Performance Monitoring	10.24	2.91	12.50	2.38	-2.922	0.003
Supportive Behavior	10.62	3.04	12.43	2.63	-2.271	0.023
Establishment of Group Objectives	10.62	3.26	12.54	2.81	-2.186	0.029
Problem-Solving	10.67	3.10	12.36	2.93	-2.159	0.031
Conflict Management	10.33	2.96	12.07	2.92	-2.025	0.043
Communication	14.43	2.96	16.36	3.68	-1.785	0.074
Overall Indicators	11.75	3.21	13.75	3.07	-2.668	0.008

Based on Table 5, p-values greater than 0.05 were obtained for each collaboration indicator in the control group. Therefore, the null hypothesis is accepted, indicating that there is no significant improvement in any of the collaboration indicators in the control group. Similarly, in the experimental group, p-values greater than 0.05 were also found for all collaboration indicators. Thus, the null hypothesis is accepted, suggesting that the implementation of the TGT model did not lead to significant improvement in students' collaboration skills for any of the indicators. Furthermore, the overall p-values in both the control and experimental groups were also greater than 0.05. Hence, there was no significant improvement in collaboration within either group.

Subsequently, a Mann–Whitney U test was performed to determine whether there was a significant difference in post-test collaboration scores between the control and experimental groups. The results are shown in Table 6.

According to Table 6, 7 out of 9 collaboration indicators had p-values less than 0.05, meaning the null hypothesis is rejected. This indicates a significant difference in post-test collaboration scores for these seven indicators between the control and experimental groups. However, two indicators—Shared Success and Communication—had p-values greater than 0.05, specifically 0.116 and 0.074, respectively. For these two indicators, the null hypothesis is accepted, suggesting no significant difference in post-test scores between the groups. Overall, the p-value obtained was 0.008 ($p < 0.05$), indicating that a significant difference exists in the average post-test collaboration scores between the control and experimental groups.

This study also aimed to examine the impact of the TGT learning model on students' collaborative skills. Based on the results of the Mann-Whitney U test, the significance value was < 0.05, indicating a significant difference in the post-test scores of students' collaboration skills between the control and experimental groups. This result is supported by Hendra and Rahayu (2020), who stated that the implementation of the TGT model resulted in significant differences between the control and experimental groups.

However, the Wilcoxon test showed a significance value > 0.05, suggesting no significant difference between the pre-test and post-test results within each class. Nevertheless, there was an improvement in collaboration from the control group to the experimental group, although not statistically significant. This implies that the TGT model did not significantly affect the increase in students' collaborative skills. This finding is supported by Norfadila et al. (2024), who reported that the implementation of the TGT model resulted in an improvement in collaborative skills; however, the difference was not statistically significant.

Figure 4 Only a few students made decisions for the group

Figure 5 A sense of tension while playing the game

This could be attributed to the researcher's limitations in managing heterogeneous classrooms. The diversity of students—in terms of skill levels and game preferences—often causes challenges in promoting collaborative behavior (Marklund & Alklind Taylor, 2016). The selection of tasks and group formation in games also plays a crucial role. Selecting appropriate challenges is crucial for the game's success. Too many or too complex tasks may discourage students instead of inspiring them to engage enthusiastically (S. Chen et al., 2020).

Group formation should consider the extent to which members share and spread positive emotions (Volet et al., 2019). In practice, many students were not yet flexible in collaborating within groups due to shyness or discomfort with group members. Furthermore, students often did not fully engage in shared decision-making, with some simply agreeing with others' opinions without engaging in meaningful discussion, as shown in Figure 4.

Additionally, the competitive nature of game-based learning may influence collaboration. The TGT model introduces an element of competition, as games involve winners and losers. The competitive aspect of game-based learning can drive each student to strive for victory (Pransiska, 2021), and this competitive tension in chemistry learning may impact students' ability to collaborate (Volet et al., 2019). The majority of students experienced a sense of tension while anticipating the challenge to be presented by the teacher during the ongoing round, as illustrated in Figure 5.

4. CONCLUSION

Based on the research conducted, the TGT learning model can influence students' motivation. This is supported by the Mann-Whitney U hypothesis test, which yielded a significance value of 0.003 (0.003 < 0.05), indicating that the null hypothesis is rejected. Furthermore, the following research result showed that the TGT learning model does not affect students' collaboration skills. This is supported by the hypothesis test result, which yielded a significance value of 0.629 (0.629 > 0.05), indicating that the null hypothesis is rejected. Therefore, the TGT learning model can increase students' motivation but does not improve their collaboration skills in acid-base material. Future researchers are expected to select more suitable learning media to enhance both students' motivation and collaboration skills, thereby optimizing learning outcomes. Additionally, future studies are expected to investigate the relationship between collaboration and learning motivation in greater depth to understand how these two aspects interact and contribute to enhancing students' academic achievement.

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