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Enhancing Students' Chemistry Learning Outcomes on Buffer Solutions through the Teams Games Tournament Cooperative Learning Model

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ABSTRACT

Purpose of the study: The aim of this study was to improve the chemistry learning outcomes of class XI students at the Kampar Timur Private Islamic Senior High School, Kampar Timur District by implementing the Teams Games Tournament type cooperative learning model.

Methodology: The subjects in this study were 20 students of class XI of Madrasah Aliyah Swasta Kampar Timur, Kampar Timur District. This classroom action research was carried out in 4 stages, namely planning/preparation of action, implementation of action, observation, and reflection. The types of data obtained in this study were qualitative and quantitative data. Data collection techniques in this study used tests and observations. The data analysis technique used was descriptive analysis.

Main Findings: Based on the results of the study, it is known that the average student learning outcomes in the first daily test increased compared to before the action. Before the action, the average student learning outcomes were 64.5% after implementing the Teams Games Tournamenttype of cooperative learning, increasing to 70.5% while in cycle II it increased again to 74.8%.

Novelty/Originality of this study: This study offers novelty by implementing the Teams Games Tournament cooperative learning model specifically on buffer solution material through classroom action research in an Islamic senior high school context. Unlike previous studies, this research simultaneously examines improvements in students' learning outcomes and learning activities, providing empirical evidence on the effectiveness of Teams Games Tournament for abstract chemistry concepts.

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1. INTRODUCTION

Education plays a crucial role in developing students' knowledge, skills, and attitudes, with teachers acting as the main drivers of the learning process [1], [2]. As professional educators, teachers are not only responsible for delivering subject matter but also for designing meaningful learning experiences that actively engage students [3], [4]. The quality of classroom learning largely determines students' learning outcomes, particularly in science subjects such as chemistry, which require both conceptual understanding and active participation [5], [6].

Chemistry is one of the core science subjects that contains abstract concepts, mathematical calculations, and problem-solving processes [7], [8]. Topics such as buffer solutions are often perceived by students as difficult because they require an understanding of chemical equilibrium, logarithmic calculations, and the application of concepts to real-life situations [9]. As a result, conventional teaching methods that rely heavily on lectures tend to make students passive and less motivated, ultimately leading to low learning outcomes [10], [11].

Based on preliminary observations at Madrasah Aliyah Swasta Kampar Timur, several problems were identified in the chemistry learning process. First, students' average learning outcomes on chemistry assessments were below the Minimum Completion Criteria of 70. Second, student participation during learning activities was relatively low, with only a few students actively responding to teachers' questions. Third, most students relied on the teacher's explanation and showed limited collaboration or discussion with peers. These conditions indicate that the learning process has not fully supported active and meaningful student engagement.

Various studies have shown that cooperative learning models can improve students' learning outcomes and engagement by promoting interaction, collaboration, and responsibility among learners [12], [13]. However, many previous studies have focused on cooperative learning in general science topics or have emphasized cognitive outcomes without adequately addressing students' learning activities and motivation, particularly in complex chemistry topics such as buffer solutions [14], [15]. This reveals a research gap, namely the limited empirical evidence on the effectiveness of specific cooperative learning models—especially the Teams Games Tournament model—in improving chemistry learning outcomes in Islamic senior high school contexts.

The Teams Games Tournament cooperative learning model combines teamwork, academic games, and friendly competition, which can increase students' motivation and active participation [16], [17]. Unlike conventional cooperative models, Teams Games Tournament integrates game elements and tournaments that encourage all students to contribute to their group's success [18], [19]. The novelty of this study lies in its application of the Teams Games Tournament model specifically to the buffer solution topic through classroom action research, focusing not only on learning outcomes but also on improvements in student activity during the learning process.

The urgency of this research is grounded in the need to improve the quality of chemistry learning, particularly for abstract and challenging topics that often result in low student achievement. By implementing an innovative and student-centered learning model, this study seeks to provide practical solutions for teachers to enhance student engagement and learning outcomes [20], [21]. The findings are expected to contribute to chemistry education practices by offering empirical evidence on the effectiveness of the Teams Games Tournament model in improving students' understanding of buffer solutions. The aim of this study was to improve the chemistry learning outcomes of class XI students at the Kampar Timur Private Islamic Senior High School, Kampar Timur District by implementing the Teams Games Tournamenttype cooperative learning model

2. RESEARCH METHOD

2.1. Research Subjects and Objects

The subjects of this study were 20 eleventh-grade students of Madrasah Aliyah Swasta Kampar Timur, Kampar Timur District. All students in the class were involved as research subjects because this study aimed to improve the overall classroom learning process rather than comparing groups [22], [23]. The object of this research was the improvement of students' chemistry learning outcomes, particularly on the topic of buffer solutions, which had previously shown low mastery levels.

2.2. Research Design

This study employed a Classroom Action Research design aimed at improving students' chemistry learning outcomes through the implementation of the Teams Games Tournament cooperative learning model. Classroom action research was selected because it focuses on solving real classroom problems and improving the quality of the learning process in a cyclical and reflective manner [24], [25]. The research was conducted in two cycles, with each cycle consisting of two learning meetings. Each cycle followed four main stages: planning, action, observation, and reflection.

2.3. Research Procedure

In the planning stage, the researcher prepared lesson plans based on the Teams Games Tournament learning model, learning materials, student worksheets, observation sheets, and evaluation instruments [26], [27]. In the action stage, the learning process was carried out according to the planned lesson plans using the Teams Games Tournament model, which included class presentations, group discussions, games, tournaments, and group recognition [28], [29]. During the observation stage, student activities and teacher performance were observed using structured observation sheets. Finally, in the reflection stage, the researcher analyzed the results of observations and learning outcomes to identify weaknesses and determine improvements for the next cycle.

2.4. Data Types and Data Collection Techniques

The data collected in this study consisted of qualitative and quantitative data. Qualitative data were obtained from observations of student activities and teacher performance during the learning process [30], [31]. Quantitative data were collected through learning outcome tests, administered at the end of each cycle in the form of daily tests related to buffer solution material [32], [33]. The data collection techniques used were tests and direct classroom observations.

2.5. Research Instruments

The instruments used in this study included learning outcome test items, student activity observation sheets, and teacher activity observation sheets [34], [35]. The learning outcome tests were designed to measure students' understanding of buffer solution concepts and calculations. Observation sheets were used to assess students' participation, cooperation, responsiveness, and engagement during the implementation of the Teams Games Tournament learning model [36], [37]. All instruments were reviewed to ensure clarity and relevance to the learning objectives.

2.6. Data Analysis Techniques

The data analysis technique used in this study was descriptive analysis. Quantitative data from learning outcome tests were analyzed by calculating the average score and the percentage of students who achieved mastery learning based on the Minimum Completion Criteria of 70. Qualitative data from observations were analyzed by describing changes in student activity and learning behavior across cycles. The results of the analysis were used as a basis for reflection and decision-making in subsequent cycles.

2.7. Indicators of Research Success

This study was considered successful if: (1) at least 75% of students achieved mastery learning based on the Minimum Completion Criteria, and (2) there was an observable improvement in student learning activities during the implementation of the Teams Games Tournament learning model. If these indicators were achieved, the research cycle was terminated.

3. RESULTS AND DISCUSSION

3.1. Cycle I

In the first meeting of cycle I, the average student completion rate was still below 75%, which represents the overall completion rate. This was due to students' unfamiliarity with the Teams Games Tournament learning model implemented by the teacher. Students remained confused about working in groups. Only a few students were willing to present their solutions to problems on the board. Only high-ability students were willing to present their work, and even then, they appeared shy. Many other students were still playing and joking around, ignoring their peers' presentations.

Student activity increased in the second meeting of cycle I. This was because, at the end of the first meeting, the teacher emphasized the steps for implementing the Teams Games Tournament learning model to help students better understand the learning strategy. Furthermore, the teacher encouraged students to further improve their learning outcomes through the Teams Games Tournament learning model.

Student activity in the second meeting of cycle I showed an increase compared to the first meeting. However, these observations did not indicate significant progress. The average student learning outcome in cycle I was 70.50, with a completion rate of 65%. Classically, student learning outcomes had not yet reached completion, so the learning process continued to cycle II. This was because student activities and learning outcomes did not meet the established standards. Therefore, the researcher continued the learning process in cycle II.

3.2. Cycle II

Student activity in the first meeting of Cycle II was found to be better than in the first meeting of Cycle I. However, some students still performed poorly, particularly among lower-ability students. Student activity in the second meeting of Cycle II was good, with an average percentage of 75.6%. Students were already accustomed to the Teams Games Tournament model implemented by the teacher. Furthermore, students were happy and excited to follow the steps of the Teams Games Tournament learning strategy. Because student activity in the second meeting of Cycle II showed significant improvement, the researcher did not continue the study to the next cycle. Student learning outcomes in Cycle II were obtained through the second daily test. The average student learning outcome in Cycle II was 74.75%. Seventeen students achieved mastery. The percentage of chemistry learning completion in Cycle II was 85%. Because student learning outcomes met the established success indicators, the researcher did not continue the study to the next cycle.

3.3. Student Activities

To determine student activity through the implementation of the Teams Games Tournament learning model, observations were conducted throughout the learning process. Data obtained through observation sheets were then analyzed. Based on the observations, based on the observation sheets and the researcher's implementation in Cycle I, there were still shortcomings. At each meeting, some students were reluctant to cooperate during partner work. However, overall, students were more active in the learning process. This was evident in the students' willingness to present questions they received from other pairs.

In Cycle II, based on observations based on the observation sheets, each step of the activity progressed well. Each pair began to collaborate effectively. Students presented better than in the previous meeting. Overall, the implementation of the Teams Games Tournament learning model ran smoothly because students participated effectively in the learning process.

Observations of student activity in Cycle I revealed that the average student activity in indicator 1, namely students forming groups based on teacher-determined groups, was 56.7%, categorized as "fairly good." Indicator 2, namely students pay attention to the teacher explaining the material and motivating by relating it to daily life, amounting to 59.2% with the category of "quite good". Indicator 3, namely students pay attention to the teacher explaining the learning steps of the Teams Games Tournament type and ask for steps that are not yet understood, amounting to 53.3% with the category of "less good". Indicator 4, namely students receive Student Worksheets then complete the Student Worksheets by discussing with their group mates with teacher guidance, amounting to 55.8% with the category of "less good". Indicator 5, namely students present the results of their work with their group mates, amounting to 55% with the category of "less good". Indicator 6, namely students answer questions asked by the teacher by raising their fingers which are answered individually, amounting to 54.2% with the category of "less good". Indicator 7, namely students provide responses to their friends' answers, amounting to 48.3% with the category of "less good". Indicator 8, namely students together with the teacher conclude the material learned, amounting to 54.2% with the category of "quite good".

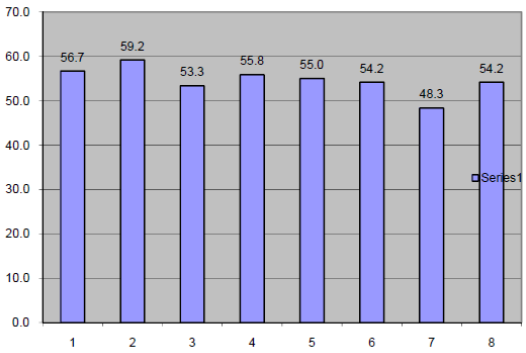

Figure 1. Graph of Student Activities in Cycle I

In general, the average percentage of student activity in cycle I was above 50% and was categorized as “less good”. This was because students were still confused about carrying out the observed activities. The results of observations of student activities in cycle II showed that the average student activity in indicator 1, namely students forming groups based on groups determined by the teacher, was 78.3% with a “good” category. Indicator 2, namely students paying attention to the teacher explaining the material and motivating by relating it to everyday life, was 80.8% with a “good” category. Indicator 3, namely students paying attention to the teacher explaining the learning steps of the Teams Games Tournament type and asking for steps that were not yet understood, was 72.5% with a “fair” category. Indicator 4, namely students receiving Student Worksheets then completing Student Worksheets by discussing with their group mates with teacher guidance, was 71.7% with a “fair” category. Indicator 5, namely students presenting the results of their work with their group mates, was 72.5% with a “fair” category. Indicator 6, namely students answering questions asked by the teacher by raising their fingers which were answered individually, was 65% with a “fair” category. Indicator 7, namely students providing responses to their friends' answers amounted to 64.2% with a category of "quite good". Indicator 8, namely students and teachers summarizing the material learned amounted to 69.2% with a category of "quite good". It can be concluded that the lowest average student activity in cycle II was in the indicator of students providing responses to their friends' answers, this was caused by some students being insecure in providing responses and being unsure of their answers.

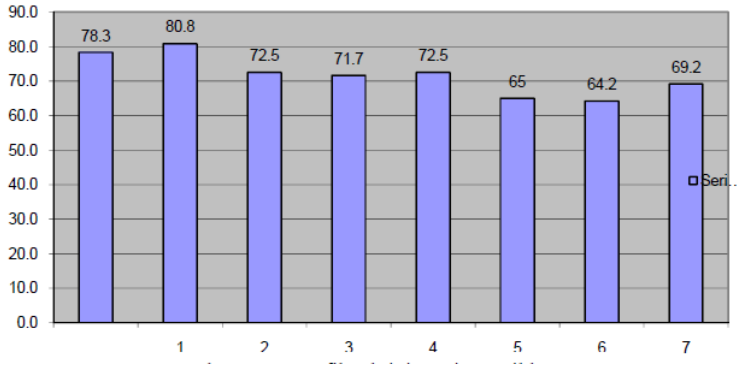

Figure 2. Graph of Student Activities in Cycle II

Overall, the average student activity rate in Cycle II was 71.8%, categorized as "quite active." In Cycle II, students were already quite good at participating in the learning process. This was due to the teacher providing detailed explanations of the steps for implementing Teams Games Tournament learning at the end of Cycle II, which helped students better understand the steps involved.

3.4. Learning Outcomes

It is known that the number of students who completed the learning outcomes before the action was only 9 students, while in cycle I it increased to 13 students, and in cycle II it increased again to 17 students. In this study, it can be seen that the number of students who achieved completeness in learning on the first daily test with the second daily test increased. This is because students have been able to master the material taught well. In addition, student motivation and activity to participate in the chemistry learning process has increased. This indicates that the implementation of Teams Games Tournament type learning can improve the activity and chemistry learning outcomes of class XI students of Madrasah Aliyah Swasta Kampar Timur, Kampar Timur District. The distribution of the frequency distribution of student learning outcomes is also shown in the following bar chart.

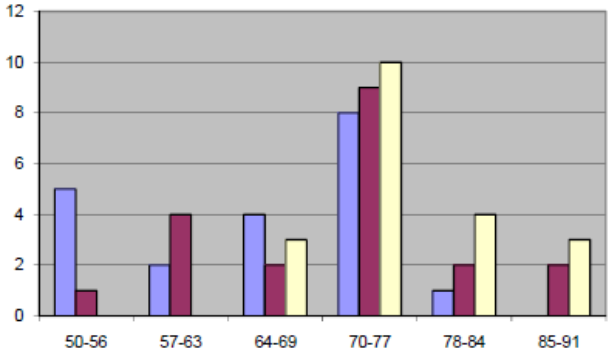

Figure 3. Histogram of Student Learning Outcomes

Meanwhile, the average value before the action, cycle I and cycle II can be seen in the following graph.

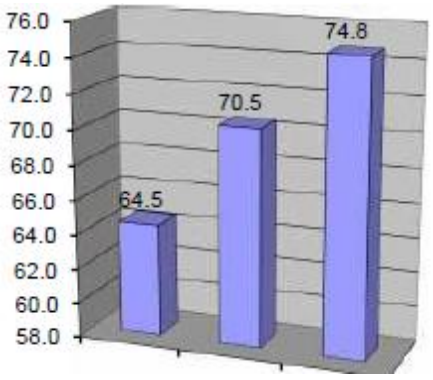

Figure 4. Graph of Student Learning Outcomes

The graph above shows that before the intervention, the average student score was 64.5. It increased to 70.5 in Cycle I, and even higher in Cycle II, reaching 74.8. Researchers observed that by implementing the Teams Games Tournament learning model, students were more active in learning and participated more actively in the learning process. Students began to gain confidence in participating in each learning activity, coming to the front of the class to solve problems and present their group work, and asking questions of their peers and the teacher to help them understand the material. This finding aligns with Silberman's statement that one surefire way to retain a lesson is to allocate time to review what has been learned. Material that has been discussed by students tends to be five times more retained in their minds than material that has not been discussed.

The implementation of the Teams Games Tournament learning strategy in the 11th grade of Madrasah Aliyah Swasta Kampar Timur (Village Islamic Senior High School) enabled students to become more active in learning, thus reducing teacher-dominated learning. From the data analysis on the success of the action, it was found that there was an increase in the number of students who had scores above 70 after the action compared to the number of students who had scores above 70 before the action with the percentage of completion on the first daily test was 70.5%. There was an increase from the first daily test to the second daily test to 74.8%. The results of this study indicate that the application of the Teams Games Tournament type learning model in the chemistry learning process on the topic of buffer solutions will improve the chemistry learning outcomes on the topic of buffer solutions for class XI students of Madrasah Aliyah Swasta Kampar Timur, Kampar Timur District.

The improvement in students' chemistry learning outcomes through the implementation of the Teams Games Tournament cooperative learning model indicates that student-centered and interactive learning strategies play a crucial role in facilitating conceptual understanding, particularly for abstract topics such as buffer solutions. The Teams Games Tournament model encourages students to actively engage in learning through discussion, peer interaction, and academic games, which helps reduce learning anxiety and increases confidence in problem-solving [38], [39]. This active engagement allows students to construct knowledge collaboratively rather than relying solely on teacher explanations.

From a constructivist perspective, the learning process implemented in this study aligns with the view that knowledge is built through social interaction and meaningful experiences [40], [41]. The cooperative structure of Teams Games Tournament provides opportunities for students to exchange ideas, clarify misconceptions, and reinforce understanding through repeated exposure during games and tournaments [42], [43]. These activities support deeper cognitive processing, which is essential for mastering complex chemistry concepts involving calculations and equilibrium principles.

The motivational aspect of the Teams Games Tournament model also contributed significantly to improved learning outcomes [44], [45]. The integration of games and tournaments created a positive learning atmosphere that encouraged healthy competition and responsibility among students [19], [46]. Students were motivated not only to achieve individual success but also to contribute to their group's performance. This finding supports motivation theory, which emphasizes that intrinsic motivation and enjoyment in learning activities enhance students' persistence and engagement.

Furthermore, the gradual improvement observed across learning cycles suggests that students require time to adapt to innovative learning models [47]. Initially, students may experience confusion or hesitation, particularly those with lower academic ability. However, consistent implementation and clear guidance from the teacher enable students to become more comfortable with cooperative roles and collaborative learning routines [48], [49]. This highlights the importance of teacher facilitation in ensuring the effectiveness of cooperative learning strategies.

The findings of this study are consistent with previous research indicating that cooperative learning models, particularly Teams Games Tournament, can enhance student participation and academic achievement [50], [51]. However, this study extends existing research by demonstrating the effectiveness of Teams Games Tournament specifically in the context of buffer solution material at the Islamic senior high school level. This

contribution strengthens empirical evidence that Teams Games Tournament is suitable for chemistry topics that require both conceptual understanding and active student involvement.

Despite its positive impact, the implementation of the Teams Games Tournament model also revealed challenges, such as students' initial lack of confidence in responding to peers' answers. This suggests that cooperative learning should be complemented with strategies that foster self-confidence and communication skills. Future instructional practices may integrate reflective activities or structured peer feedback to further enhance student interaction and critical thinking skills.

4. CONCLUSION

Based on the results of the research and discussion, it can be concluded that the application of the Teams Games Tournament type learning model in the chemistry learning process on the subject of buffer solutions can improve chemistry learning outcomes on the subject of buffer solutions for class XI students of Madrasah Aliyah Swasta Kampar Timur, Kampar Timur District, namely with the percentage of completion on the first daily test is 70.5%. There was an increase from the first daily test to the second daily test to 74.8%. This study was limited to a single class with a relatively small number of participants and focused only on the buffer solution topic, so the findings may not be fully generalizable to other chemistry topics or educational contexts. Future studies are recommended to apply the Teams Games Tournament learning model to different chemistry topics, involve larger and more diverse student populations, and integrate comparative or experimental designs to further examine its effectiveness across various educational contexts.

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AUTHOR CONTRIBUTIONS

Conceptualization, N. and I.; Methodology, N. and I.; Software, N.; Validation, N. and I.; Formal Analysis, N.; Investigation, N. and I.; Resources, I.; Data Curation, N.; Writing – Original Draft Preparation, N.; Writing – Review & Editing, N. and I.; Visualization, N.; Supervision, I.; Project Administration, N.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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