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The Effectiveness of TGT Learning Model with STEM-Based 3D Audio-Visual Kit Box on The Collaboration Skills of Senior High School Students

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Abstract: Collaboration skills are essential for students to develop to meet the demands of 21st-century skills. Collaboration skills help students engage with their classmates (peers) during the learning activities. Learning outcomes are achievements achieved by students academically through various assignments and exams. Learning outcomes are a benchmark for improving thinking skills. This study examines the effectiveness of STEM media on teamwork skills and the learning outcomes of class XII students at SMAN 2 Tanggul. The research design is a pretest-posttest control based on a group design. The experimental class was treated using STEM learning media, while the control class applied traditional learning. This study used two types of groups, namely large groups and small groups, which aimed to determine the effect of the number of members in the group on collaboration skills. Based on the one-way ANOVA test analysis in the control and experimental classes, the research results obtained a sig 000<0,05 with the hypothesis H_a rejected, which means there is a difference in collaboration skills between students in large and small groups. While the results of the one-way ANOVA test analysis in the control and experimental classes obtained a sig. 000 < 0,05 with the hypothesis H_0 rejected, which means there is a difference in student learning outcomes.

Keywords: collaboration skills, learning outcomes, team games and tournaments (TGT)

INTRODUCTION

Several vital skills need to be taught to students in line with the times. The advancement of science and technology in the 21st century necessitates that Indonesia equip its human resources to exhibit excellence in contributing to the nation's development (Ulfa et al., 2021). These skills include various abilities such as creativity, communication, critical thinking, and collaboration (Riaz & Din, 2023). The skill that some science learning research is currently focusing on is collaboration. Collaboration is a group learning process to discuss different views and knowledge. This activity involves discussion, where group members give each other advice, listen, and respect the various opinions that arise (Astuti et al., 2024). Collaboration skills are critical to optimizing the learning process because they can increase knowledge, social interaction, self-confidence, and motivation (Sari et al., 2023; Hardinata et al., 2023).

Collaboration between students can improve learning that focuses on them, help distribute tasks, encourage a sense of responsibility for the tasks given, and improve social skills. The research revealed that collaboration impacts learning processes and knowledge retention (Nurwahidah et al., 2021). In addition, learning that emphasizes collaboration has positive impacts, such as increasing the sense of responsibility, experience, creativity, and quality produced by group ideas (Dooley & Sexton-Finck, 2017). However, problems still often arise today, such as the results of research conducted by Siagan et al. (2019) showing that students need help to complete the tasks given well and comprehensively, and there are difficulties in describing thought processes and a lack of cooperation with

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friends. This state aligns with research conducted by Ulhusna et al. (2020), where collaboration skills are still low, impacting student learning outcomes. Therefore, appropriate learning methods are needed to succeed in student learning (Arifin et al., 2023; Perdana et al., 2023).

The Team Games and Tournaments (TGT) model is a learning approach that can support STEM-based education because it is a type of cooperative learning where students work together in small groups. The TGT learning model encourages students to help each other complete the assigned tasks (Firdaus et al., 2020). The TGT learning model is easy to use and suitable for measuring collaboration abilities. This is because it can demonstrate group collaboration and leadership skills, responsibility for working productively with others, and respect for different perspectives. Erviani et al. (2022) state that the TGT-type cooperative learning model can improve collaboration skills by around 95%. This also aligns with Nurhidayah (2018), which states that using the TGT model increases student learning outcomes. By applying innovative learning models, collaborative learning activities can facilitate interaction in constructing knowledge to improve learning outcomes.

The TGT learning model emphasizes student cooperation within groups. For the learning process to take place interactively, innovative learning media is needed to help students construct knowledge through an active learning process. It is well-suited for use alongside 3D box learning media, where students actively engage in learning and deepen their understanding of the material. According to Sari et al. (2024), the 3D learning media with the TGT learning model shows that student learning activities are increasing because of student interaction and mutual assistance based on participation and activities in the teaching and learning process.

The 3D media presents information in a three-dimensional visual format without projection. This media can be natural objects, both living and dead, and imitations representing the original object (Siregar et al., 2022). According to Husnah et al. (2021), using the TGT learning model with 3D media increases student involvement, makes them more active, and does not feel bored during biology learning. The results of his research show the effect of 3D media with the use of the TGT learning model on student learning outcomes. Therefore, the utilization of 3D media in the TGT learning model needs to be tested to determine its impact on collaboration skills and student learning outcomes

Students must have collaboration skills to succeed in the modern era. These skills are not only crucial for learning, but they are also essential for solving problems (Fitriyani et al., 2019; Ilma et al., 2021). Moreover, collaboration skills must be developed because students must often work together in groups to prepare for the globalized era of the 21st century (Aini & Narulita, 2020). According to Sidi (2020), learning media can improve collaboration skills from 63.44% to 83.33% and increase achievement learning from an average of 69.10% to 80.97% and learning completeness from 54.84% to 93.55%.

▪ METHOD

The research used a quasi-experimental method with a pretest-posttest control group design. The scheme of the study involving experimental and control classes is shown in Table 1. Research variables include independent variables and dependent variables. Independent variables include the TGT learning model with protein synthesis kit box 30 audio-visual learning media, while the dependent variables include collaboration skills and student learning outcomes. The research was conducted in two experimental classes (XII MIPA 4 and MIPA 6) and two control classes (XI MIPA 2 and MIPA 3). The subjects

of this research were 142 students of class XII MIPA for the 2023/2024 academic year at SMAN 2 Tanggul, East Jawa, Indonesia.

Table 1. Research design

Pretest	Treatment Group	Number of students	Posttest
PR_1	X	36	PO_1
PR_2	X	35	PO_2
PR_3	-	36	PO_3
PR_4	-	35	PO_4

Description:
X : media protein synthesis kit box 3D STEM-based audio-visual model
PR1: Pretest of large group experimental class PO1: Posttest of large group experimental class
PR2: Pretest of small group experimental class PO2: Posttest of small group experimental class
PR3: Pretest of large group control class PO3: Posttest of large group control class
PR4: Pretest of small group control class PO4: Posttest of small group control class

The instruments used include 1) a questionnaire to determine collaboration skills and 2) a test to obtain student learning outcome data. The collaboration skills questionnaire developed in this study consists of self and peer assessments. The questionnaire in this study provides five categories: strongly agree, agree, sufficient, less agree, and strongly disagree. The questionnaire is objective, so students only put a tick (√) on one of the answers they consider most appropriate to the situation. The questionnaire, assessed in Table 2, has ten aspects and 50 questions. The Google link form questionnaire was given at the end of each class meeting. Meanwhile, the learning outcomes test with 20 questions was conducted at the beginning of the pretest and the posttest.

Table 2. The Assessment of collaboration skills aspects

No.	Aspek
1	Readiness
2	Problem-solving and feedback
3	Information Sharing
4	Listening, questioning, and discussing
5	Quality of work
6	Working productively
7	Compromise to the group
8	Task-focused and engagement
9	Responsibility: All members contribute
10	Respect for opinions

The results of the up-validation of the collaboration skills questionnaire were declared valid, with an average value of 85% for self-assessment and 86.67% for peer assessment. The research design used was a Randomized Block Design with two factors or variables.

Table 3. Factorial design 2x2

	Model TGT (B)	
Media (A)	**Large group (B_1)**	**Small group (B_2)**
Learning Media (A_1)	A_1B_1	A_1B_2
Without Learning Media (A_2)	A_2B_1	A_2B_2

The research data were analyzed using the One-way ANOVA statistical test. Data were normalized and homogeneity tested before being analyzed. The normality test was carried out with One Sample Kolmogorov-Smimov at a significance level of >0.05. At the same time, the homogeneity test was carried out using Levine's test. One-way ANOVA was carried out when the data had been declared normal and homogeneous so that it could determine the difference in the effectiveness of learning media on collaboration skills and student learning outcomes. Duncan's further test was then conducted to provide more information on class differences.

▪ RESULT AND DISCUSSION

The data on collaboration skills were first tested for normality and homogeneity as prerequisites for performing the one-way ANOVA and Duncan's posthoc test. The analysis results indicate that the data are normally distributed and homogeneous, with a significance value of> 0.05. Thus, the one-way ANOVA test can be performed to assess the differences in the effectiveness of various learning media on collaboration skills.

Table 4. One-way ANOVA test results for collaboration skills of control class (A_2B_1) and experimental class (A_1B_1) (large group)

	Df	Mean Square	F	Sig.
Between Groups	3	3.500	4.698	.064

Based on Table 4 above, the results of the one-way ANOVA test on collaboration skills obtained a sig. value of 0.064 > 0.05, so H_0 is accepted. This means there is no difference in collaboration skills between large group students without media and large group collaboration skills with media. The statement means that the one-way ANOVA test results showed no significant difference in collaboration skills between the two groups of students. In other words, the use of media in learning has a similar impact on the collaboration skills of the two groups. The collaboration skills of class A_2B_1 students showed that several group members did not actively participate in group activities when completing the assigned tasks, such as students often playing on cellphones, chatting, and playing. Moreover, class A_2B_1 does not use learning media during the learning process, making students feel bored. While the collaboration skills of class A_1B_1 students who use learning media, some students still need to play an active role in group activities. This is because the amount of media used still needs to be increased, while the number of members in each group is 8-10. This is why the collaboration skills of the two classes are the same. Duncan then further tested the results of the one-way ANOVA test in Table 5.

Table 5. Duncan's advanced test results for collaboration skills of control class (A_2B_1) and experimental class (A_1B_1) (large group)

	Class	N	1	2	3
Duncan	PA A2B1	36	21.050		
	SA A2B1	36		21.575	
	PA A1B1	36		21.914	21.914
	SA A1B1	36			22.294
	Sig.		1.000	.113	.075

PA : *Peer Assessment* SA : *Self Assessment*

The results of the Duncan test showed that the average self-assessment of class A_1B_1 was 22,294, significantly different from the self-assessment of class A_2B_1 of 21,575. The average peer assessment of class A_1B_1 was 21,914, significantly different from the peer assessment of class A_2B_1 of 21,050. Thus, the average value of extensive group collaboration skills of class A_1B_1 students is better than that of class A_2B_1. Overall, these results indicate that the collaboration skills of A_1B_1 students were better than those of A_2B_1 students, both in self-assessment and peer assessment. In class A_1B_1, self-assessment and peer assessment are still better than in class A_2B_1 because the group activities are more active, such as students discussing, collaborating, and helping group members. Learning media affects collaboration skills, and students feel more enthusiastic when using it because it is new. Meanwhile, in class A_2B_1, which did not use learning media, students were less active in discussions; only the group members who stood out were active. So, the use of learning media has a positive impact on collaboration skills.

Table 6. Results of one-way ANOVA test of collaboration skills of control class (A_2B_2) and experimental class (A_1B_2) (small groups)

	Df	**Mean Square**	**F**	**Sig.**
Between Groups	3	32.800	55.868	.000

Based on Table 6, it can be seen that the results of the one-way ANOVA test on collaboration skills obtained a sig. A value of 0.000 <0.05, so H_0 is rejected, which means there is a difference in collaboration skills between small group students without media and small group collaboration skills with media. Overall, these results show that using media in learning positively affects collaboration skills in small groups. Examples include collaboration skills in class A_1B_2 during the learning process when each group member showed suitable collaborative activities. As each member gets a task/responsibility, communicate with each other if there are obstacles so that all group members focus on completing the task. This is due to the use of exciting learning media, which makes students look more enthusiastic, and the number of members in each group is only 4-6 people. So that students can operate learning media optimally. The collaboration skills appear pretty good in class A_2B_2. However, some students must be more active in group discussions when completing assignments because they depend on more prominent students. So, using learning media is efficacious in improving collaboration skills. Duncan further tested the one-way ANOVA test results in Table 7.

Table 7. Duncan's advanced test results for collaboration skills of control class (A_2B_2) and experimental class (A_1B_2) (small groups)

	Class	**N**	**1**	**2**
Duncan	PA A_2B_2	35	21.523	
	SA A_2B_2	35	21.583	
	SA A_1B_2	35		23.040
	PA A_1B_2	35		23.383
	Sig.		.744	.063

PA : *Peer Assessment* SA : *Self Assessment*

The results of the Duncan test showed that the average value obtained by the peer assessment of class A_1B_2 was 23,383, significantly different from the peer assessment of class A_2B_2 of 21,583. The self-assessment of class A_1B_2 was 23,040, substantially different from the self-assessment of class A_2B_2 of 21,583. As a result, the average collaboration skills of the small group in the experimental class are higher than those in the control class. These results show that small-group collaboration skills in the experimental class (A_1B_2) were better than those in the control class (A_2B_2), both from self-assessment and peer assessment. This indicates that the media used in the experimental class contributed positively to collaboration skills. Collaboration skills, self-assessment, and peer assessment in class A_1B_2 are better than in class A_2B_2. This is because using learning media in class A_1B_2 positively impacts student collaboration activities, where students are more active and enthusiastic when completing assignments. Each group member discusses, works together, and divides tasks according to the abilities of the group members. This is because using 3D learning media is new for them, increasing enthusiasm for learning and collaboration skills. Meanwhile, collaboration skills are pretty good in class A_2B_2, without learning media. However, some students still need to be more responsible when given assignments and complete them better, depending on the students who stand out more. This proves that using learning media positively impacts collaboration skills.

Table 8. One-way ANOVA test of collaboration skills of large media group (A_1B_1) and small media group (A_1B_2)

	Df	**Mean Square**	**F**	**Sig.**
Between Groups	3	16.060	29.655	.000

Based on Table 8, it can be seen that the results of the one-way ANOVA test on collaboration skills obtained a sig. A value of 0.000 <0.05, so H_0 is rejected, which means there is a difference in collaboration skills between students in the large media group and students in the small media group. This shows that grouping (large or small) can impact student collaboration outcomes. Both classes, A_1B_1 and A_1B_2, use 3D learning media, and collaboration skills are significantly different. These differences are primarily due to varying group sizes.nClass A_1B_1 has 8-10 students per group. Although the collaboration skills in this class are considered good, the large group size can decrease individual student engagement in activities. With so many members, students may feel less confident in actively contributing, which can reduce collaborative dynamics.

In contrast, class A_1B_2 consists of 4-6 students per group. This smaller group size encourages students to participate more actively in group activities. With a limited number of members, each student has a more incredible opportunity to contribute and interact, making learning media more effective. This contributes to the improvement of collaboration skills in class A_1B_2. A Duncan test was conducted to gain a deeper understanding of these differences, as described in Table 9. This test aims to provide additional insights into the relationship between group size and collaboration outcomes,

helping to identify how variations in group structure can influence students' collaboration skills.

Table 9. Duncan's Advanced test results for large media group (A_1B_1) and small media group (A_1B_2) collaboration skills

	Class	N	1	2	3
Duncan	SA A_1B_1	36	21.914		
	PA A_1B_1	36		22.294	
	SA A_1B_2	35			23.040
	PA A_1B_2	35			23.383
	Sig.		1.000	1.000	0.52

Description:
PA : *Peer Assessment* SA : *Self Assessment*

Based on Table 9, the average value of the A_1B_2 peer assessment, 23,383, significantly differs from the A_1B_1 peer assessment, 22,294. Similarly, the average value of the A_1B_2 self-assessment, 23,040, substantially differs from the A_1B_1 self-assessment, 21,914. Thus, the average value of A_1B_2 collaboration skills is better than A_1B_1. These results show that collaboration skills in class A1B2 are better than those in class A_1B_1, both from the self-assessment and peer-assessment perspectives. The results of the collaboration skills questionnaire, both self- and peer-assessment, showed that class A_1B_2 had the highest/best score compared to class A_1B_1. This is because groups with a few members are more active in discussions, distribute tasks more evenly, work together, and help each other if members have difficulties.

What is more, you can make maximum use of learning media, and all members can operate it so that all group members work together. Meanwhile, even though class A_1B_1 also uses learning media, collaboration skills still need to improve compared to class A_1B_2. This is because many group members need to maximize learning media properly. Some group members were still seen playing on cell phones, joking, not participating in discussions, etc. So, only some students operate learning media well.

The results of the study showed that there were differences in collaboration skills between the control class and the experimental class. In this study, we also wanted to determine the effect of the number of members in a group on collaboration skills. The table of hypothesis test results above shows that there are differences between large-group classes and small-group classes. So, the number of members in a group affects collaboration skills. This is because the number of members in a group can affect collaboration skills. Most students in large groups are less active in group activities, as some students are busy playing with their cellphones, lack communication between group members, and group assignments are assigned to students who contribute highly. In addition, there are differences between students in the large media group class (A_1B_1) and the small media group class (A_1B_2) when using or utilizing learning media. In the small media group class (A_1B_2), students are more enthusiastic or active when using the learning media. STEM-based learning media is new to them, so it becomes a unique attraction and increases interest in learning. In the large media group class (A_1B_1), it can be seen that only a few students are active in using the learning media, while the other students are less active.

The TGT learning model emphasizes student cooperation, making it suitable for pairing with 3D box learning media. This approach promotes active student engagement in the learning process and enhances their comprehension of the material. Thus, 3D learning media and the TGT learning model can synergistically improve collaboration skills, creating an interactive, practical, and fun learning environment. The 3D media helps students convert natural objects into visual objects, such as real objects (Tarial et al., 2022). Students can learn the phenomenon of a science event based on the events seen in the learning media.

There were varying activities between the control and experimental classes throughout the learning process. In the experimental class, students look more active and enthusiastic about listening to the material when the learning process uses learning media. Learning media is formed with an attractive appearance and easy to use so that students can operate the media freely. This causes students to understand the material more efficiently to improve learning outcomes. Students who feel connected to the material are more motivated to learn. In addition, using learning media with TGT learning model also affects the atmosphere during learning. During the learning process, they were seen interspersed with games, making the classroom atmosphere more fun and preventing students from feeling bored. Collaboration skills also improve because students must discuss, communicate, negotiate, and be responsible for completing the challenges the teacher gives to each group.

According to Le H et al. (2018), collaboration skills have several obstacles, such as coordinating an action to negotiate, receive, and give assistance. Students who contribute highly do not use their time to help other members, so students who contribute less feel marginalized. Group formation in the learning process can improve collaboration skills. Students get more opportunities to express their opinions, take the initiative in making decisions, develop social interaction habits, and train students to have a sense of responsibility. According to Putri et al. (2024), groups of 4-6 students (small groups) can maximize group learning. In addition, according to Michaelsen et al. (2023), small groups of 4-5 allow students to work together optimally to solve a problem and achieve success in the group. The hypothesis test results in this study were reinforced by previous research conducted by Al Mulhim & Eldokhny (2020), which stated that the value of collaboration skills in smaller groups resulted in higher collaboration skill values than in large groups. This is because small groups have more effective communication, more explicit division of tasks, and a more even level of participation. In addition, according to Li et al. (2020), learning that uses small groups will result in more optimal learning conditions to achieve learning goals.

▪ CONCLUSION

The protein synthesis kit box 3D audio-visual learning media and the TGT learning model effectively enhanced collaboration skills and learning outcomes in this study. Additionally, the number of members in the group also affects collaboration skills. Smaller groups encourage active participation and interaction, allowing members to contribute more effectively. Smaller groups provide more opportunities for students to interact with the media and other students during the learning process. Collaboration skills and cognitive learning outcomes are crucial competencies for students. In addition, collaboration skills must be internalized in the learning and teaching process as part of the groundwork related to the era of globalization in the 21st century. Using innovative learning media is crucial in teaching the various skills required of students.

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