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THE EFFECT OF THE GAME-BASED LEARNING MODEL ASSISTED BY CARD SORT ON STUDENTS' ACTIVENESS AND LEARNING OUTCOMES IN THE COORDINATION SYSTEM TOPIC

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ABSTRACT

The low level of students' activeness and learning outcomes are among the many problems found in biology learning. The complexity of biological material, particularly in the coordination system topic, and the use of less innovative learning models are the main factors contributing to these issues. This study aims to determine the effect of applying the game-based learning model assisted by card sort on students' activeness and learning outcomes in the coordination system topic. This research employed a quasi-experimental method with a Nonequivalent Group Posttest Only Design. The study was conducted at SMAN 7 Pekanbaru. The research samples were class XI.2 (experimental class) and class XI.7 (control class). Data were collected through observation using observation sheets, tests using test sheets, and documentation using documentation guidelines. The results showed that: (1) the average activeness score of students in the experimental class was 63.56 (active), while the average activeness score of students in the control class was only 55.83 (fairly active); (2) the average learning outcome score of students in the experimental class was 84.23 (good), while that of the control class was only 77.26 (fairly good). The hypothesis test results indicated that: (1) there was a highly significant effect of applying the game-based learning model assisted by card sort on students' learning activeness (sig. value 0.000 < 0.05); and (2) there was a highly significant effect of applying the game-based learning model assisted by card sort on students' learning outcomes (sig. value 0.000 < 0.05). This study indicates that integrating educational games with card media can enhance students' activeness and learning outcomes in biology learning, especially for complex topics such as the coordination system. This learning model can be implemented at other educational levels to improve students' activeness and learning outcomes.

Keywords: Card Sort; Game-Based Learning; Learning Outcomes; Learning Activeness; Coordination System.

INTRODUCTION

A good education is achieved through an effective learning process, namely teaching that produces a high-quality learning experience by involving students' participation and engagement intensively (Junaedi, 2019). Student participation in learning is indicated by the activeness of students during the learning process. However, in reality, many students are still found to be less actively involved in the learning process.

Interviews conducted with biology teachers of grade XI at three senior high schools (SMA) in Pekanbaru showed that the level of students' learning activeness in biology subjects was still relatively low. During the learning process, students tended to be passive, showed little enthusiasm in asking questions or expressing opinions, appeared easily bored when the teacher explained, and during group presentations, other students tended to only listen.

Not only was students' learning activeness low, but their learning outcomes were also one of the problems found in biology learning. Observations of students' scores showed that some students still obtained grades below the minimum mastery criteria (KKM) (<75).

The low level of students' activeness and learning outcomes in biology learning, particularly in the coordination system topic, is triggered by the complexity of the material and the use of less innovative learning models. Ristiyaningsih (2017) stated that an uninteresting learning model can cause students to become passive and decrease their learning activeness. When students are passive, the learning process occurs without curiosity, questions, or interest in learning outcomes.

Based on the interview results, it was found that teachers often used the lecture method with PowerPoint assistance and discussions to deliver material to students. Meanwhile, survey results showed that students were more interested in game-based learning compared to the learning models commonly used by teachers in biology classes. This indicates a mismatch between the learning model applied and students' interests.

Mirdad (2020) stated that several aspects must be considered by teachers in determining the learning model, one of which is the suitability of the learning model with students' characteristics. Nurdyansyah & Fahyuni (2016) emphasized that the model used should align with students' level of maturity, learning style, condition, interests, and talents. Therefore, the use of the game-based learning model assisted by card sort is considered appropriate to improve students' activeness and learning outcomes in biology learning, especially in the coordination system topic.

Game-based learning is a learning model that uses games or game media specifically designed to support the learning process. Wibawa et al. (2021) stated that the advantages of this model include stimulating students' enthusiasm for learning, providing enjoyable and useful feedback, facilitating material delivery, reducing stress, measuring comprehension levels, training memory, and allowing relaxation after learning.

Learning using the game-based learning model is carried out in six syntax stages: selecting a game according to the topic, explaining concepts, explaining game rules, playing the game, summarizing knowledge, and conducting reflection (Samudera, 2020).

Card sort is one of the game media that can be used in the game-based learning model. Card sort is a learning medium in the form of paper pieces designed like cards containing information or learning material (Sholichah, 2020). Besides facilitating material delivery, this medium also promotes active learning, where students work in groups and are given cards containing information about the material to be discussed. Then, students classify the cards according to the main category cards (Darnika, 2020).

A previous study by Wilda & Maulana (2023) showed that the game-based learning model assisted by spin wheel media affected the learning activeness of eighth-grade students at SMP Negeri 2 Marioriwawo. The average activeness observation score of the experimental class was 83.26, while that of the control class was only 71.33.

Putri & Jayantika (2023) also conducted a similar study, which showed that game-based learning improved students' learning outcomes. The study results revealed an increase in the average student score and the percentage of learning mastery from 54.34% to 71.73% and 86.95%, respectively, in each cycle. The average student score increased from 74.45 in the initial condition to 81.41 and 87.06 in the subsequent cycles.

Research conducted by Desriani et al. (2023) indicated a significant positive effect of using the active learning type card sort on the biology learning outcomes of tenth-grade students at SMA N 1 Palembayan. Data analysis showed a calculated t-value of 2.07, which was greater than the t-table value of 1.68.

Previous studies have shown that the game-based learning model assisted by card sort has a positive impact on students' activeness and learning outcomes. Therefore, the hypothesis in this study states that there is an effect of the game-based learning model assisted by card sort on students' activeness and learning outcomes in the coordination system topic.

RESEARCH METHODS

This research is an experimental study using a quantitative approach. It employs a quasi-experimental design, specifically the Nonequivalent Group Posttest Only Design, in which both groups do not receive a pretest but only a posttest.

Learning activities in the experimental class were conducted using the Game-Based Learning model assisted by card sort, while in the control class, learning was carried out as usual using the Discovery Learning model. The assessment of students' activeness was conducted in every meeting, for a total of four meetings during the main learning activities. The assessment of learning outcomes was conducted in the final meeting, which was the fifth meeting.

This research was conducted at SMAN 7 Pekanbaru during the even semester of the 2024/2025 academic year. The population of this study consisted of all grade XI biology students at SMAN 7 Pekanbaru, totaling 142 students. The sampling technique used was purposive sampling, resulting in two sample classes: XI.2 (experimental class) and XI.7 (control class), each consisting of 35 students.

Data collection methods are techniques or procedures used by researchers to collect research data (Sugiyono, 2018). The methods of data collection used in this study were observation, tests, and documentation. Data on students' learning activeness were obtained through observation using activeness observation sheets. Data on learning outcomes were obtained through tests using test sheets. Documentation was used to strengthen the research findings.

Game-based learning is a learning model that integrates games into the learning process to facilitate understanding. Learning through the game-based learning model is conducted in six syntax stages: selecting a game according to the topic, explaining concepts, explaining game rules, playing the game, summarizing knowledge, and conducting reflection (Samudera, 2020). In this study, the game-based learning model used card sort as the game medium.

Card sort is a type of game using card media in the learning process, played by sorting or grouping cards into specific categories. According to Silberman (2011), the card sort activity is carried out in six steps: (1) players are given several card sort sheets; (2) players in groups select and classify cards according to the requested central category card; (3) players discuss and analyze the core material or main topic on the central card through the selected branch cards, followed by presenting the analysis results to verify the accuracy of the selected card groups; (4) players write and summarize the knowledge obtained from the card sort activity; (5) players explain the summary results. The use of this medium is expected to increase students' activeness and learning outcomes in the coordination system topic.

Learning activeness refers to all student activities in the learning process, both mental activities such as analyzing and physical activities such as conducting experiments. Students' learning activeness was observed based on seven indicators: visual activity, oral activity, listening activity, writing activity, motor activity, mental activity, and emotional activity (Sardiman, 2016).

Learning outcomes are the results of assessment given by the teacher to students after the learning process, which include cognitive, affective, and psychomotor aspects. Learning outcomes were measured through test sheets containing multiple-choice questions covering knowledge aspects (C1–C4).

The coordination system is a system consisting of organs that work together to receive stimuli, process them, and transmit responses to stimuli. The scope of the coordination system material studied includes the nervous system, endocrine system (hormones), sensory system, and disorders of the coordination system (Irnaningtyas, 2023).

The research data were analyzed using descriptive statistical analysis and inferential statistical analysis. Descriptive statistical analysis was used to analyze data on students' activeness and learning outcomes, which were then categorized into specific classifications. Inferential statistical analysis was used to draw conclusions or test the research hypotheses.

RESULTS AND DISCUSSION

The implementation of the game-based learning model assisted by card sort was carried out in six learning steps, including: (1) selecting a game according to the topic conducted by the teacher, (2) explaining the concept, (3) explaining the rules of the game, (4) playing the game, (5) summarizing knowledge, and (6) conducting reflection (Samudera, 2020). The results of the observation on the implementation of the game-based learning model assisted by card sort showed that the learning process was carried out effectively.

The Effect of the Game-Based Learning Model Assisted by Card Sort on Students' Learning Activeness

The observation results of learning activeness showed that the level of students' activeness in the experimental class was higher than that in the control class. The average activeness score of students in the experimental class was 63.56 (active), while the control class obtained an average score of 55.83 (fairly active). The hypothesis test using the Mann–Whitney test showed a significance value of 0.000 < 0.05, indicating that the use of the game-based learning model assisted by card sort had a highly significant effect on students' learning activeness in the coordination system topic.

The results of the analysis of students' learning activeness for each category in both classes are presented in the following table.

Table 1. Categories of Students' Activeness in Each Class

Interval	Category	Control Class		Experimental Class	
		Number of Students	Score (%)	Number of Students	Score (%)
80 < score ≤ 100	Very Active	0 (None)	0,00	1	2,86
60 < score ≤ 80	Active	11	31,43	20	57,14
40 < score ≤ 60	Fairly Active	22	62,86	14	40,00
20 < score ≤ 40	Less Active	2	5,71	0 (None)	0,00
0 < score ≤ 20	Very Inactive	0 (None)	0	0 (None)	0,00
Total		35	100	35	100

Based on the data in the table above, it can be seen that students' learning activeness in the control class was predominantly in the "fairly active" category at 62.86%, while students' learning activeness in the experimental class was predominantly in the "active" category at 57.14%.

The students' activeness scores were obtained from observations of seven indicators of learning activeness. The comparison of students' activeness levels across the seven indicators is presented in the following table.

Table 2. Comparison of Students' Learning Activeness Indicator Scores per Class

Indicators of Activeness	Score of Each Class (%)	
	Control	Experimental
Visual Activity	68,66	71,48
Oral Activity	61,61	63,43
Listening Activity	68,32	76,90
Writing Activity	43,68	45,52
Motor Activity	51,07	66,32
Mental Activity	44,32	46,84
Emotional Activity	60,66	79,03
Average	**56,90**	**64,21**

Based on the data in the table above, it can be seen that students' learning activeness in the experimental class was higher in all observed activeness indicators compared to the control class.

Visual Activity

Students' visual activities in learning are processes of receiving and understanding information that involve the sense of sight or vision (Sardiman, 2016). Students' visual activities were observed through four sub-indicators. The students' involvement in these four sub-indicators is presented in the following table.

Table 3. Student participation in visual activity indicators

Sub-Indicator	Number of Students	
	Control Class	Experimental Class
Paying attention to information in learning resources	29	34
Paying attention to other students during presentations	15	21
Paying attention to the material delivered by the teacher	18	20
Paying attention to explanations related to the game	17	15

Based on the data in the table above, it can be seen that the highest student participation in the visual activity indicator occurred when paying attention to information from learning resources. The number of students participating in this activity was 29 in the control class and 34 in the experimental class.

The activity of paying attention to information from learning resources was observed during the fourth syntax of the game-based learning model, namely when students played the game. In this activity, students appeared active in observing and understanding the information presented on the cards to find answers to the teacher's questions.

Paying attention to the information on the cards in the card sort game is essential for participating in the game as well as a strategy to win it. Cahyanti (2024) stated that in the card sort game, students must search, sort, and group cards according to the same categories. This makes it necessary for players (students) to read or pay attention to the information on the cards before grouping them, resulting in a high level of student participation in observing information from the cards.

The use of card sort media has also been proven to increase students' attention in understanding information related to the coordination system material. Arsyad (2015) and Astuti (2017) stated that using learning media such as cards in the card sort game can attract students' interest and attention, as well as improve information retention.

Verbal Activities

Verbal activities in learning are learning activities related to speaking skills, such as presenting facts, asking questions, conducting interviews, and engaging in discussions (Hamalik, 2001). Verbal activities were observed through five sub-indicators of learning activeness. The number of students participating in these five sub-indicators is presented in the following table.

Table 4. Student participation in verbal activity indicators

Sub-indicators	Number of Students	
	Control Class	Experimental Class
Discussing with group members	29	34
Presenting group analysis results	29	30
Expressing opinions related to the material	2	4
Asking questions about things not yet understood	5	10
Presenting conclusions	2	7

Based on the data in the table above, it can be seen that the highest student participation in the verbal activity indicator occurred during group discussions. The number of students participating in this activity was 29 in the control class and 34 in the experimental class.

The card sort game, which was conducted in groups, required each member to discuss and agree on the answers for the selected cards. Syari (2019) stated that implementing learning assisted by card sort encourages students to actively interact with both the media (cards) and their group members during discussion activities throughout the game.

The high level of activity among students in the experimental class during discussions was also influenced by the competition between groups. As expressed by Cinta et al. (2021), the game-based learning model creates competition among players. This competition motivates each group member to engage in spontaneous, intensive, and quick discussions in order to win the game.

Listening Activities

Sardiman (2016) states that listening activities are processes of receiving information through the sense of hearing (ears). Listening activities were observed through four sub-indicators of learning activeness. The number of students participating in these four sub-indicators is presented in the following table.

Table 5. Student Participation in Listening Activity Indicators

Sub-indicators	Number of Students	
	Control Class	Experimental Class
Listening to the teacher's explanation of the material	19	22
Listening to the explanation related to the game	19	16
Listening to opinions of group members	28	33
Listening to other students or groups	18	28

Based on the data in the table above, it can be seen that the highest student participation in the listening activity indicator occurred when listening to the opinions of group members during the game. The number of students participating in this activity was 28 in the control class and 33 in the experimental class.

The high level of student activeness while listening to their group members during the game was due to the implementation of the game-based learning model assisted by card sort, which required students to collaboratively find information. Azkiya (2017) stated that in the card sort game, students are required to find solutions to problems in their own way through group discussions. This process encourages students to discuss and listen to various inputs or opinions so that they can jointly understand, compare, and draw conclusions from the information presented on the card sort cards.

Writing Activities

Writing activities are activities carried out to convey information through written form, such as writing reports and completing assignments (Sardiman, 2016). Writing activities were observed through four sub-indicators of learning activeness. The number of students participating in these four sub-indicators is presented in the following table.

Table 6. Student Participation in Writing Activity Indicators

Sub-Indicators	Number of Students	
	Control class	Experimental class
Writing down important material during the game	4	12
Completing tasks on LTPD	28	30
Writing important information from the teacher's explanation	7	4
Taking notes of key points during presentations	3	1

Based on the table above, it can be seen that the highest student participation in the writing activity indicator occurred when completing tasks on the LTPD. The number of students participating in this activity was 28 in the control class and 30 in the experimental class.

The high participation of students in the experimental class during the LTPD tasks was influenced by the enjoyable learning environment, which stimulated students' enthusiasm for learning. The game-based activity in card sort encouraged students to move while selecting and arranging cards according to their relationships, reducing boredom during learning. This aligns with the statements of Muttaqin (2006) and Ambarini et al. (2013), who noted that physical movement in the card sort game can help eliminate boredom and enhance students' motivation during learning.

In addition, the time constraints during the LTPD task stage also encouraged student involvement in completing the tasks. Shofiyah & Fauziah (2025) stated that the game process imposes a limited learning duration, which affects the effectiveness of learning during task completion. Therefore, each group must develop its own strategies to maximize the available time, one of which is by involving all members in completing the tasks.

Motoric Activities

Motor activities in learning refer to students' physical activities during the learning process (Sinar, 2018). Motor activities were observed while students played the card sort game. The number of students participating during the game is presented in the following table.

Table 7. Student Participation in Motoric Activity Indicators

Sub-Indicators	Number of Students	
	Control class	Experimental class
Playing according to the rules, very agile in teamwork, and quick in selecting the correct cards	0 (None)	3
Playing according to the rules, agile in teamwork, and fairly quick in selecting the correct cards	0 (None)	11
Playing according to the rules, fairly agile in teamwork but slow in selecting the correct cards	18	14
Playing according to the rules, less agile in teamwork and slow in selecting the correct cards	17	7
Not involved in the game/presentation	0 (None)	0 (None)

Based on the data in the table above, it can be seen that all students were involved in motor activities during the game. Each student in every group participated in selecting, arranging, and grouping the cards, as well as competing to raise their hands when wanting to give answers. Syari (2019) stated that the card sort learning model makes students more active in motor activities (physical movements) through sorting or selecting cards.

Mental Activities

Mental activities in learning are activities that involve students' thinking processes, such as remembering, problem-solving, analyzing, recognizing relationships, and making decisions (Sardiman, 2016). Mental activities were observed through four sub-indicators of learning activeness. The number of students participating in these four sub-indicators is presented in the following table.

Table 8. Student Participation in Mental Activity Indicators

Sub-Indicators	Number of Students	
	Control class	Experimental class
Analyzing information from learning resources	30	35
Daring to ask questions	4	10
Daring to express opinions	2	1
Daring to draw conclusions	1	1

Based on the data in the table above, it can be seen that the highest student participation in the mental activity indicator occurred when students analyzed information from learning resources. The number of students participating in this activity was 30 in the control class and 35 in the experimental class.

The high level of activeness in the experimental class during the activity of analyzing information on the cards was due to the challenges in the card sort game, which stimulated students' curiosity and encouraged them to complete the challenges. Zulfadli et al. (2024) stated that successfully completing challenges makes students feel satisfied and motivates them to engage more actively in learning.

The process of completing challenges in the card sort game involves analyzing the relationships between information on the cards. This provides students with the opportunity to think analytically, which triggers high student activeness in mental activities. Andayani et al. (2023) stated that the activity of connecting information in the card sort game can improve students' analytical skills.

Emotional Activities

Students' emotional activities refer to students' emotional responses that reflect their level of engagement, interest, or boredom during the learning process (Tang et al., 2025; Syah et al., 2025). Emotional activities were observed during the core learning activities. These activities were assessed through students' responses (facial expressions). The forms of students' responses during learning are presented in the following table.

Table 9. Student Participation in Emotional Activity Indicators

Sub Indicators	Number of Students	
	Control class	Experimental class
Very cheerful and enthusiastic	0 (None)	6
Cheerful and enthusiastic	8	20
Neutral (just ordinary)	19	7
Less cheerful (lethargic)	7	1
Not cheerful (lethargic, sleepy, and bored)	1	1

Based on the data in the table above, it can be seen that the highest emotional response (facial expression) of students in the experimental class occurred in the sub-indicator "cheerful and enthusiastic," with 20 students. In the control class, the highest emotional response was in the sub-indicator "neutral (just ordinary)," with 19 students.

The high level of positive emotional response in the experimental class was due to the presence of the game element (card sort) in the learning process. Khalizha (2024) stated that learning that incorporates the concept of learning through play can create an enjoyable, interesting, and challenging learning environment, as well as increase enthusiasm due to competition. Silberman (2011) mentioned that the card sort game can stimulate the left brain (cognitive) and right brain (emotional), triggering feelings of enjoyment during learning.

The Effect of the Game-Based Learning Model Assisted by Card Sort on Students' Learning Outcomes

Students' learning outcomes were assessed based on the test scores of the coordination system material conducted in the final meeting (posttest). The posttest results showed that students' learning outcomes in the experimental class were higher than those in the control class.

The average learning outcome score of students in the experimental class was 84.23 (good category), while the control class had an average score of 77.26 (fair category). The hypothesis test using the t-test showed a significance value of 0.000 < 0.05, indicating that the use of the game-based learning model assisted by card sort had a highly significant effect on students' learning outcomes in the coordination system material.

The analysis of students' learning outcome scores for each category in both classes is presented in the following table.

Table 10. Students' Learning Outcome Categories in Each Class

Interval	Category	Control class		Experimental class	
		Number of Students	Percentage (%)	Number of Students	Percentage (%)
93 – 100	Very Good	0	0,00	22	62,86
84 – 92	Good	6	17,142	0	0,00
75 – 83	Fair	21	60,00	11	31,43
< 75	Poor	8	22,86	2	5,71
Total		35	100	35	100

Based on these scores, it can be seen that students' learning outcomes in the control class were predominantly in the "fair" category at 60.00%, while students' learning outcomes in the experimental class were predominantly in the "very good" category at 62.86%.

Students' learning outcomes were obtained from the assessment of their answers on the learning outcome test sheets. These test sheets contained questions on the coordination system material, consisting of LOTS (Lower Order Thinking Skills), MOTS (Middle Order Thinking Skills, and HOTS (Higher Order Thinking Skills) questions. The comparison of students' learning outcomes across each question level is presented in the following table.

Table 11. Comparison of Students' Learning Outcomes by Question Level

Question Level	Question Number	Control Class Student Scores (%)		Experimental Class Student Scores (%)	
		Correct	Incorrect	Correct	Incorrect
LOTS	1-7	97,14	2,86	97,14	2,86
MOTS	8-19	81,66	18,34	85,47	14,53
HOTS	20-25	40,47	59,53	63,33	36,67

Based on the table above, it can be seen that for LOTS-level questions, students in both the control and experimental classes achieved the same scores. However, for MOTS and HOTS-level questions, students in the experimental class performed better than those in the control class. Therefore, the learning outcomes of students in the experimental class were higher than those in the control class.

The equivalence of LOTS-level learning outcomes between the experimental class using the game-based learning model assisted by card sort and the control class using lecture and discussion methods indicates that both learning models are equally effective in helping students understand the coordination system material. LOTS questions, which emphasize comprehension skills, can be trained through direct instruction (lectures) as applied in the control class (A'yun et al., 2024). Meanwhile, the use of card sort media with the Cognitive Load Theory (CLT) principle makes it easier for students to remember and understand the complex coordination system material (Rahmawati et al., 2024).

The high learning outcomes of students in the experimental class on MOTS and HOTS-level questions indicate that the game-based learning model assisted by card sort can enhance students' higher-order thinking skills. Andayani (2023) stated that the card sort learning media can foster students' analytical and critical thinking abilities. Winarsih et al. (2014) and Halendra et al. (2020) noted that the activity of analyzing relationships between information on the cards in the card sort game directly stimulates students' analytical skills.

The high level of student participation or activeness during the game-based learning with card sort also contributed to the high learning outcomes. Sepriyaningsih et al. (2019) and Duwit (2016) stated that the higher the students' activeness in the learning process, the higher their learning outcomes, and vice versa. Nehru & Olahairullah (2022) emphasized that learning involving students actively can improve their understanding of the material being studied.

The game-based learning model assisted by card sort engages students directly in the learning process. During the card sort game, students in groups actively select, analyze, and categorize cards. This activity trains communication, collaboration, critical thinking, and conceptual understanding in a meaningful way, positively impacting learning outcomes. Nissak (2025) stated that the game-based learning model enables students to interact with the material, develop analytical skills, and discuss with group members to make collective decisions.

CONCLUSIONS

This study shows that: 1) The implementation of the game-based learning model assisted by card sort has a highly significant effect on students' learning activeness in the coordination system material. This is indicated by the higher activeness of students in the experimental class compared to the control class across all observed activeness indicators. 2) The implementation of the game-based learning model assisted by card sort has a highly significant effect on students' learning outcomes in the coordination system material. This is demonstrated by the higher learning outcomes of students in the experimental class compared to the control class. The game-based learning model assisted by card sort can be used as an alternative in the learning process, especially for materials considered difficult and complex. Schools are expected to facilitate teachers in developing and implementing innovative learning models, such as game-based learning assisted by card sort, through training or workshops. This learning model can also be implemented at other educational levels or further developed with more innovative game media.

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