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Think-Talk-Write Strategy in Biology Learning: Its Impact on Mastery of the Human Digestive System Concept

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ABSTRACT

Purpose of the study: This study aims to determine the effect of the Think-Talk-Write learning strategy on the mastery of the concept of the human digestive system in junior high school students and to determine the activities and responses of students during Biology learning using this strategy.

Methodology: This study used a quasi-experimental method with a two-group pretest-posttest design. The research instruments included multiple-choice tests, observation sheets, and student response questionnaires. The sampling techniques used were purposive sampling and random sampling. Data analysis was performed using the Liliefors test, Fisher's exact test, t-test, and N-Gain analysis.

Main Findings: The results of the study showed that the Think-Talk-Write learning strategy significantly influenced mastery of the concept of the human digestive system. Students in the experimental class achieved better learning outcomes than those in the control class. Student activity during learning increased at each meeting, and most students responded positively to the implementation of the Think-Talk-Write strategy in Biology learning.

Novelty/Originality of this study: The novelty of this research lies in the specific application of the Think-Talk-Write strategy to the human digestive system to measure junior high school students' conceptual mastery. This study also integrates analysis of conceptual mastery, learning activities, and student responses, providing a more comprehensive picture of the effectiveness of the Think-Talk-Write strategy in biology learning.

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1. INTRODUCTION

Biology learning plays a crucial role in helping students understand various life phenomena scientifically and contextually [1], [2]. One topic considered quite complex in Biology is the human digestive system, as it involves the interrelated concepts of structure, organ function, and biological processes. In school learning, students often struggle to understand the relationships between concepts [3], [4]. This difficulty leads to low student conceptual mastery, which impacts overall Biology learning outcomes. Therefore, learning strategies are needed that can help students understand concepts actively, communicatively, and meaningfully [5], [6].

Conceptual mastery is a crucial indicator of successful Biology learning [7], [8]. Students with strong conceptual mastery are more likely to explain biological processes, solve problems, and relate concepts to

everyday life [9], [10]. However, the reality in the field shows that the learning process is still dominated by lectures, resulting in students tending to be passive during the learning process [11], [12]. This situation leads to students simply memorizing material without a deep understanding of the concepts. As a result, students' ability to interpret material on the human digestive system remains relatively low.

Efforts to improve student conceptual mastery can be achieved through the implementation of student-centered learning strategies [13], [14]. One strategy that can be used is Think-Talk-Write. This strategy emphasizes thinking, discussion, and writing as the main learning processes [15], [16]. In the think phase, students are given the opportunity to understand and analyze information independently [17], [18]. Next, in the talk phase, students engage in discussions to exchange ideas and strengthen their conceptual understanding before finally expressing their thoughts in written form in the write phase.

The Think-Talk-Write strategy is considered capable of creating a more active and collaborative learning environment [19], [20]. Through the process of thinking and discussion, students can develop their ability to express opinions and refine their understanding of a concept. Furthermore, writing activities help students organize ideas systematically, making the concepts learned easier to grasp. In biology, this strategy can help students understand the abstract and complex processes of the human digestive system [21], [22]. Therefore, the application of Think-Talk-Write has the potential to optimally improve students' conceptual mastery.

Several previous studies have shown that the Think-Talk-Write strategy can improve learning activities, critical thinking skills, and student learning outcomes in various subjects [16], [23]. However, research specifically examining the effect of the Think-Talk-Write strategy on mastery of the concept of the human digestive system is still relatively limited. Most research focuses solely on improving general learning outcomes without measuring the depth of students' conceptual mastery [24], [25]. Furthermore, the application of this strategy to biology learning at the secondary school level has not been explored in depth. This situation indicates the need for further research into the effectiveness of Think-Talk-Write in biology learning.

Based on a research gap analysis, it was found that there are still limited studies linking the Think-Talk-Write strategy to conceptual mastery in the human digestive system specifically. Previous research has primarily examined the effect of Think-Talk-Write on communication skills or general learning outcomes rather than conceptual mastery. The novelty of this study lies in its focus on conceptual mastery of the human digestive system through the application of the Think-Talk-Write strategy in Biology learning. This research also contributes to the development of active learning strategies appropriate for conceptual and complex Biology material. This study is expected to provide an empirical overview of the effectiveness of the Think-Talk-Write strategy in improving students' conceptual mastery.

This research is crucial because conceptual mastery is the primary foundation of science learning, particularly Biology. Students' poor conceptual understanding can impact their ability to understand advanced material and solve scientific problems in everyday life. The implementation of innovative and interactive learning strategies is one solution to improving the quality of the learning process in schools. The Think-Talk-Write strategy is expected to help students build conceptual understanding through an integrated process of thinking, communication, and written reflection. Therefore, the main objective of this study is to determine the effect of Think-Talk-Write learning on mastery of the concept of the human digestive system.

2. RESEARCH METHOD

2.1. Research Methods and Design

This study employed a quasi-experimental method, a research method applied to determine the effect of a treatment while maintaining control over certain variables through characteristic matching and randomization techniques. The quasi-experimental method involves a control group, but this group does not fully control all external variables that could affect the course of the experiment [26], [27]. This study employed a design involving two groups: the experimental group and the control group. Both groups were given treatment in the form of different learning strategies in the use of Student Worksheets. Before the learning process was implemented, both groups were first given an initial test (pretest), then after the learning activities were completed, a final test (posttest) was administered. The research design used can be seen in the Table 1.

Table 1. Two Group Pretest-Posttest Design Research Design

Class	Pre-test	Treatment	Post-test
Experiment	T_1	X_e	T_2
Control	T_1	X_c	T_2

Based on the research design above, the research subjects were given two concept mastery tests: before the learning began (pretest) and after all concepts were taught by the teacher (posttest). The concept mastery test

conducted before the experiment (T_1) was called the pretest, and the concept mastery test conducted after the experiment (T_2) was called the posttest. The instruments for the pretest and posttest were the same.

2.2. Research Population and Sample

A population is all subjects targeted in a study. In this study, the target population was all students at Al-Azhar 3 Bintaro Islamic Junior High School, while the accessible population was all eighth-grade students at the school. The research sample was a portion of the population selected to represent the characteristics of the population as a whole. The sampling technique used in this study was two methods: purposive sampling and random sampling. Purposive sampling is a sampling technique based on specific considerations tailored to the research objectives [28], [29]. This technique was used because the population was considered to have relatively similar characteristics and an equal opportunity to be selected as a research sample. Based on these considerations, the researcher selected classes VIII B and VIII D as the research samples. Furthermore, the experimental and control classes were determined using random sampling. The results of the randomization showed that class VIII B was designated as the experimental class, receiving instruction using the Think-Talk-Write strategy with the aid of Student Worksheets, while class VIII D was designated as the control class, using conventional instruction with the aid of Student Worksheets.

2.3. Data Collection Techniques

Data collection techniques are the methods researchers use to obtain data to support the achievement of research objectives. In this study, researchers used three data collection techniques: tests, observations, and questionnaires, as they were considered the most appropriate for uncovering and describing the required data. The first technique was a test, used to measure student learning outcomes in accordance with the established learning objectives. This study employed two types of tests: a pretest and a posttest, each with multiple-choice objective questions. The pretest was administered before the treatment to determine students' initial abilities, while the posttest was administered after the treatment to determine students' improvement in concept mastery after the implementation of the Think-Talk-Write learning strategy. The questions used in the pretest and posttest were identical to ensure that differences in instrument quality would not influence the research results. Questions were formulated based on the learning indicators to be achieved at each meeting.

The second technique was observation, conducted through direct observation of student activities during the learning process. Observations aimed to determine student engagement and activity during learning using the Think-Talk-Write strategy. The observation instrument used was an observation sheet in the form of a checklist or rating scale containing aspects of the observed student activities [30], [31]. Observers simply checked the boxes corresponding to the activities that occurred during the lesson. Furthermore, the observation sheet also included information on the number of students engaging in specific activities during the learning process.

The third technique was a questionnaire, used as a non-test instrument to determine students' responses to the implementation of the Think-Talk-Write learning strategy. Through this questionnaire, researchers were able to obtain information regarding students' opinions, interests, and responses to the learning process. The questionnaire data was expected to provide an overview of students' level of acceptance of the implemented learning strategy. Thus, the use of the questionnaire provided supporting data that could strengthen the research findings regarding the influence of the Think-Talk-Write strategy on mastery of the concept of the human digestive system.

2.4. Data Analysis Techniques

Data analysis in this study was conducted to determine the effect of the Think-Talk-Write learning strategy on mastery of the human digestive system concept. Prior to hypothesis testing, prerequisite analysis tests were conducted, including normality and homogeneity tests. The normality test was conducted using the Lilliefors test to determine whether the research data were normally distributed [32], [33]. The test criteria were: the null hypothesis (H_0) is accepted if the calculated L value is less than the L table, indicating a normal distribution. Conversely, if the calculated L value is greater than the L table, the null hypothesis is rejected, and the data are declared non-normally distributed. Meanwhile, the homogeneity test was conducted using the Fisher exact test to determine the equality of variance between the experimental and control groups. Data are considered homogeneous if the calculated F value is less than the F table, whereas if the calculated F value is greater than the F table, the data are declared non-homogeneous.

Furthermore, this study also used normal gain analysis (N-Gain) to determine the increase in students' conceptual mastery after the learning process. The gain value is obtained from the difference between the posttest and pretest scores, indicating an increase in students' understanding after the treatment [34], [35]. The N-Gain score categories are high if the gain is greater than 0.70, medium if the gain is between 0.30 and 0.70, and low if the gain is less than 0.30. This analysis allows researchers to determine the effectiveness of the Think-Talk-Write learning strategy in improving students' conceptual mastery of the human digestive system.

Observation data were analyzed to determine the implementation of the Think-Talk-Write strategy during the learning process. Observation data were obtained from student activity observation sheets completed

by observers during the learning process. The results were processed by calculating the total score obtained for each observation aspect and then converted into a percentage. This percentage was used to determine the level of implementation of the Think-Talk-Write strategy stages in the learning process. Observation result criteria included none of the stages, a small number of stages, almost half of the stages, half of the stages, most of the stages, almost all stages, and all stages implemented. This observation analysis aims to provide an overview of student activities during learning using the Think-Talk-Write strategy.

Next, the questionnaire data was analyzed to determine students' responses to the implementation of the Think-Talk-Write learning strategy. The questionnaire consisted of positive and negative statements with the following response options: Strongly Agree (SS), Agree (S), Disagree (TS), and Strongly Disagree (STS). Each answer received a specific score according to the type of statement. Questionnaire data analysis was conducted by grouping each statement item based on the observed aspect and then calculating the total score obtained for each aspect. Student responses were considered positive if the percentage of Strongly Agree and Agree responses was greater than the percentage of Disagree and Strongly Disagree responses. If the percentage of positive student responses reached more than 50%, the student response to learning using the Think-Talk-Write strategy was considered good.

Hypothesis testing in this study was conducted after the data met the requirements for normality and homogeneity. Because the research data were normally distributed and had homogeneous variance, the hypothesis testing was conducted using parametric statistics in the form of a t-test. The t-test was used to determine whether there was a significant difference between the average learning outcomes of the experimental and control classes. The null hypothesis (H_0) states that there is no influence of the Think-Talk-Write learning strategy on the mastery of the concept of the human digestive system, while the alternative hypothesis (H_a) states that there is an influence of the Think-Talk-Write learning strategy on the mastery of the concept of the human digestive system. The testing criteria are H_0 is accepted if the calculated t value is smaller than the t table, and H_0 is rejected if the calculated t value is greater than the t table. Thus, the results of the hypothesis test will show whether the Think-Talk-Write strategy has a significant effect on students' mastery of concepts in the human digestive system material.

3. RESULTS AND DISCUSSION

Before carrying out hypothesis testing, analysis prerequisite tests are first carried out in the form of normality tests and homogeneity tests.

3.1. Normality Test

To determine whether the data obtained comes from a normally distributed population or not, a Liliefors test is performed. The results of the pretest and posttest normality tests for the experimental and control groups can be seen in the Table 2.

Table 2. Normality Test of Experimental and Control Groups

Statistical Data	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
L_{count}	0.144	0.124	0.136	0.138
L_{table}	0.149		0.150	
Conclusion	H_0 accepted		H_0 accepted	

Based on the normality test results table, the calculated L_0 value in the experimental group for the pretest was 0.144 and the posttest was 0.124. With a sample size of 35 students at a significance level of 5%, the L_0 value was 0.149. Because the L_0 value in both the pretest and posttest was smaller than L_0, the null hypothesis (H_0) was accepted. Thus, it can be concluded that the data in the experimental group was normally distributed. Meanwhile, the results of the normality test calculation in the control group showed that the calculated L_0 value for the pretest was 0.136 and the posttest was 0.138. The number of samples in the control group was 36 students with a significance level of 5%, so the L_0 value was 0.150. Because the L_0 value for the pretest and posttest was smaller than L_0, the null hypothesis (H_0) was accepted. Therefore, it can be concluded that the sample data in the control group was also normally distributed.

3.2. Homogeneity Test

The homogeneity test in this study was conducted using the F (Fisher) test to determine the equality of variance between the experimental group and the control group. The testing criteria used were that the null hypothesis (H_0) was rejected if the calculated F value was greater than the F table, while H_0 was accepted if the calculated F value was smaller than the F table. Acceptance of H_0 indicates that both groups have homogeneous variances. Thus, the data from the experimental group and the control group meet the homogeneity requirements and can be used for further analysis. The results of the homogeneity test calculation can be seen in the Table 3.

Table 3. Homogeneity Test Calculation

Mark	Pretest		Posttest	
Variance (S^2)	Experimental Group	Control Group	Experimental Group	Control Group
F_{count}	112.78	171.61	81	78.68
F_{table}	1.52		1.03	
Conclusion	H_0 accepted		H_0 accepted	

Homogeneity testing was conducted at a 95% confidence level (α = 0.05) with degrees of freedom (db) of (35:34). Based on the calculation results in table 4.5, the F-count value of the pretest data between the experimental group and the control group was 1.52, while the F-table value was 1.76. Because the F-count value was smaller than the F-table, the pretest data was declared homogeneous. Furthermore, the results of the posttest data homogeneity test showed an F-count value of 1.03 and an F-table value of 1.76, so that F-count < F-table was obtained. This indicates that the null hypothesis (H_0) is accepted at a significance level of α = 0.05 (5%). Thus, it can be concluded that both research samples came from populations that had homogeneous variance.

3.3. Hypothesis Testing

After conducting the prerequisite data analysis test, it was found that the conceptual mastery test results for both groups met the requirements for hypothesis testing. The pretest results for the experimental and control groups showed normally distributed and homogeneous data, while the posttest results indicated that both groups had homogeneous variances. Therefore, data analysis could proceed to the hypothesis testing stage using a t-test. The t-test was conducted to determine the effect of the Think-Talk-Write learning strategy on students' conceptual mastery of the human digestive system. The test was conducted by comparing the pretest and posttest results for each research group.

The hypothesis testing criteria used were: H_0 is accepted and H_a is rejected if the calculated t value is less than the t table. Conversely, if the calculated t value is greater than the t table, H_0 is rejected and H_a is accepted. Based on the calculation results, the calculated t value for the pretest score was 0.23. At a significance level of 5% with 69 degrees of freedom (df), the t value was 1.99. Because the calculated t value is smaller than the t table, H_0 is accepted and H_a is rejected. This indicates that there is no difference in initial concept mastery ability between the experimental and control groups before being given treatment. The calculated data can be seen more clearly in the Table 4.

Table 4. Hypothesis Testing Results of Pretest

Statistics	Experiment	Control
N	35	36
$\bar{x}$	41.87	40.50
S^2	112.784	171.61
Dk	69	
t_{count}	0.48	
t_{table}	1.99	
Conclusion	H_0 accepted	

The results of the hypothesis testing indicate that the t-test value falls within the H_0 acceptance range, i.e., t-test < t-table or 0.48 < 1.99. Therefore, H_0 is accepted and H_a is rejected at a significance level of α = 0.05. These results indicate that there was no difference in students' initial abilities between the experimental and control groups before the Think-Talk-Write learning strategy was implemented on the human digestive system. In other words, both groups had relatively similar initial abilities before the treatment.

Furthermore, the t-test calculation results on the posttest data yielded a t-test value of 3.97. At a significance level of 5% with 69 degrees of freedom (df), the t-test value was 1.99. Because the t-test value is greater than the t-table value, H_0 is rejected and H_a is accepted. This indicates that there is a significant difference between the posttest results of the experimental and control groups after the implementation of the Think-Talk-Write learning strategy. Thus, the Think-Talk-Write learning strategy impacted students' conceptual mastery of the human digestive system. The results of these calculations can be seen more clearly in the Table 5.

Table 5. Hypothesis Testing Posttest Results

Statistics	Experiment	Control
N	35	36
$\bar{x}$	82.6	74.17
S^2	81	78.68
Dk	69	
t_{count}	3.97	

t_{table}	1.99
Conclusion	H_a accepted

Based on the table, $t_{count} > t_{table}$ obtained, so the null hypothesis (H_0) is rejected. Thus, it can be concluded that there is a significant difference between the control and experimental groups. This indicates that there is an influence on mastery of the concept of the human digestive system using the think-talk-write learning strategy.

3.4. Results of Student Activity Observation Data Analysis

Observations in this study were conducted to observe student activities during the learning process using the Think-Talk-Write strategy through simple experimental activities. The observation activities aimed to determine the implementation of each stage of the Think-Talk-Write strategy in the learning process. All observation indicators used in this study were developed based on the main aspects of the Think-Talk-Write strategy, namely think, talk, and write. Through these observations, researchers were able to obtain an overview of student engagement during the learning process. The recapitulation of the observation data can be seen in the Table 6.

Table 6. Data from Student Activity Observation Results

No.	Aspect Think-Talk-Write	Meeting		Average
		1	2	
1.	Think	50%	100%	75%
2.	Talk	42.86%	71.43%	57.15%
3.	Write	50%	50%	50%
	Average percentage of Think-Talk-Write aspects			60.72%

The table below shows the calculation results for each stage of the Think-Talk-Write strategy based on the indicators established for each learning session. The analysis shows that the percentage of student activity implementation in each aspect of Think-Talk-Write during the learning process reached an average of 60.72%. This percentage indicates that most of the stages of the Think-Talk-Write strategy were implemented in student activities during the lesson. Therefore, the Think-Talk-Write strategy was able to encourage student engagement in the learning process quite effectively.

In the first session, the calculation results for all observation indicators showed a percentage of 45.45%, indicating that nearly half of the Think-Talk-Write stages were implemented in student activities. This low percentage was due to students still adjusting to the implementation of the Think-Talk-Write learning strategy. Furthermore, in the second session, the percentage of implementation increased to 72.73%, indicating that most of the Think-Talk-Write stages were implemented in student activities during the lesson. This increase indicates that students are becoming accustomed to and are more actively participating in the Think-Talk-Write learning phase. Thus, it can be concluded that there was an increase in student activity in every aspect of the Think-Talk-Write strategy from the first meeting to the second meeting.

3.5. Results of Student Response Questionnaire Data Analysis

The questionnaire distributed in this study aimed to determine students' overall responses to the use of the think-talk-write learning strategy. This questionnaire could assess positive and negative responses, or whether the strategy was effective or not. Therefore, all indicators in this questionnaire were developed by the researcher. The following is a summary of the questionnaire data.

Table 7. Student Response Questionnaire Results Data

No.	Indicator	Total Score	Average
1.	Demonstrates a liking for biology	365.72	92.43%
2.	Demonstrates a liking for learning using the think-talk-write strategy	1034.26	73.88%
3.	Demonstrates agreement with learning using the think-talk-write strategy to improve students' conceptual mastery	511.42	73.06%

Based on the calculations in the table above, each indicator has a fairly high percentage, exceeding 50%. This indicates that the think-talk-write learning strategy, according to each student, has a positive or good response. The results of the study indicate that the think-talk-write learning strategy positively contributes to students' conceptual mastery of the human digestive system. The success of this strategy is inseparable from the learning stages that place students at the center of learning activities. In the think stage, students are given the opportunity to understand information independently, making the learning process more meaningful. The talk

stage allows students to exchange ideas, clarify concepts, and refine their understanding through group discussions. Next, the write stage helps students reorganize their thoughts into written form, making the concepts learned more structured and easier to understand.

The improvement in students' conceptual mastery also demonstrates that the think-talk-write strategy can create more active learning than conventional learning. In conventional learning, students tend to receive information passively, resulting in conceptual understanding often limited to rote memorization. In contrast, the think-talk-write strategy encourages students to directly engage in the process of thinking, discussing, and concluding the learning material [14], [36]. These activities provide opportunities for students to construct knowledge based on their own learning experiences. This way, learning becomes more interactive and improves students' conceptual understanding of the human digestive system.

The human digestive system is a complex subject in biology, involving interrelated organ structures, functions, and physiological processes. Therefore, students need learning strategies that help them systematically understand the relationships between concepts. The Think-Talk-Write approach helps students connect information gained through discussion and written reflection [37], [38]. The writing activities within this strategy also play a crucial role in strengthening students' memory and conceptual understanding. This demonstrates that learning involving communication and reflection can improve students' understanding of biology.

Student activity during the lesson demonstrated increased student engagement at each meeting. This indicates that students are becoming accustomed to the Think-Talk-Write learning stages and are adapting to the active learning pattern. Student engagement in the learning process is a crucial factor in improving conceptual mastery because students not only receive information but also process and discuss it directly [39], [40]. Group discussions provide opportunities for students to express opinions, ask questions, and correct misconceptions through interaction with peers. With increased student learning activity, the learning process becomes more effective and learner-centered.

The results of the student response questionnaire showed that the majority of students responded positively to the use of the Think-Talk-Write strategy in Biology learning. These positive responses indicate that students feel more engaged and understand the material more easily through learning that involves thinking, discussing, and writing. Furthermore, the collaborative learning environment makes students more confident in expressing ideas and questions during the learning process [41], [42]. Student interest in learning is also a factor that can increase their motivation to learn and their engagement in class activities. Thus, the Think-Talk-Write strategy not only impacts cognitive aspects but also positively influences students' attitudes and learning interests.

The findings of this study align with several previous studies that found the Think-Talk-Write strategy effective in improving student learning outcomes and conceptual mastery [43], [44]. This strategy provides students with the opportunity to simultaneously develop critical thinking, communication, and reflection skills. In science learning, particularly in Biology, these skills are crucial because students are required to understand concepts deeply, not simply memorize information. Therefore, the use of active and communicative learning strategies needs to be continuously developed in the learning process at school. The implementation of Think-Talk-Write can be an alternative, innovative learning strategy to improve the quality of Biology learning.

Overall, the research results indicate that the Think-Talk-Write strategy is effective in teaching the human digestive system. This strategy can improve students' conceptual mastery through integrated thinking, discussion, and writing activities. In addition to improving conceptual understanding, the Think-Talk-Write strategy also increases student activity and positive responses during the learning process. This demonstrates that learning that involves active student participation can produce more optimal learning outcomes. Thus, the Think-Talk-Write strategy is worthy of being used as an alternative learning strategy in Biology subjects, especially for conceptual and complex material.

This research has had a positive impact on the development of Biology learning, particularly in improving students' conceptual mastery of the human digestive system. The implementation of the Think-Talk-Write strategy has been shown to encourage students to be more active in the learning process through integrated thinking, discussion, and writing activities. This strategy not only improves student learning outcomes but also helps them develop a deeper and more systematic understanding of concepts. Furthermore, the increased student activity and positive responses indicate that learning using the Think-Talk-Write strategy can create a more interactive, communicative, and student-centered learning environment. The results of this study also provide teachers with an alternative, innovative learning strategy that can be applied to complex and conceptual Biology material.

However, this study still has several limitations. The study was conducted only on the human digestive system and involved a sample from a single school, thus limiting the generalizability of the results. Furthermore, the relatively short research period meant that the implementation of the Think-Talk-Write strategy could not be observed in depth over the long term. This study also focused more on conceptual mastery and did not measure other aspects such as critical thinking skills, creativity, or students' collaborative skills more broadly. External factors such as learning motivation, students' initial abilities, and the learning environment were also not fully

controlled, which could influence the research results. Therefore, further research is recommended to involve a larger sample size, more diverse materials, and examine the influence of the Think-Talk-Write strategy on various other 21st-century skills.

4. CONCLUSION

Based on the data processing and research discussion, it can be concluded that the Think-Talk-Write learning strategy significantly improves junior high school students' mastery of the human digestive system concept. This is evidenced by the hypothesis testing results, which showed a calculated t-value of 3.97, while the t-value was 1.99. Because the calculated t-value was greater than the t-value, the null hypothesis (H_0) was rejected. Therefore, it can be concluded that the use of the Think-Talk-Write learning strategy significantly impacts students' mastery of the human digestive system concept. Furthermore, the research results also show that the majority of students responded positively to the implementation of the Think-Talk-Write learning strategy. This is evident from the 73.88% of students who stated they enjoyed using this learning strategy in the learning process. This positive response indicates that the Think-Talk-Write strategy can create more engaging learning and actively engage students. However, 26.12% of students still expressed disfavor with this learning strategy. This was due to the difficulties some students experienced in following each stage of the Think-Talk-Write learning process. Further research is recommended to apply the Think-Talk-Write strategy to other Biology materials or at different educational levels to determine the strategy's consistent effectiveness in improving students' conceptual mastery. Furthermore, future research could examine the influence of the Think-Talk-Write strategy on other 21st-century skills, such as critical thinking, creativity, communication, and collaboration skills, with a wider sample size.

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AUTHOR CONTRIBUTIONS

Conceptualization, D.C.N., B. and M.K.; Methodology, D.C.N.; Software, D.C.N.; Validation, B. and M.K.; Formal Analysis, D.C.N.; Investigation, D.C.N.; Resources, B.; Data Curation, D.C.N.; Writing – Original Draft Preparation, D.C.N.; Writing – Review & Editing, B. and M.K.; Visualization, D.C.N.; Supervision, B. and M.K.; Project Administration, D.C.N.; Funding Acquisition, B.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

Not applicable.

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