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The 9E Learning Cycle Model as a 21st Century Learning Solution: An Analysis of Its Impact on Improving High School Students' Habits of Mind in Digestive System Material

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Abstract

Background: Habits of Mind require calm and confidence. High cognitive anxiety can hinder biological learning. This study analyzes the 9E Learning Cycle Model to improve 11th-grade students' Habits of Mind on the digestive system topic. **Methods:** The research employs a Quasi-Experimental method with a Pretest-Posttest Control Group Design. The research sample comprises 11th-grade students from SMA a in Bandar Lampung, selected through Cluster Random Sampling. The research instruments include multiple-choice tests and a habits of mind questionnaire. Data is analyzed using the Independent Samples t-test. **Results:** It is revealed that the Learning Cycle 9E Model Based on Performance Assessment is a solution to improve high school students' habits of mind in biology learning, as evidenced by normally distributed and homogeneous data, with a calculated significance value of 0.001 < 0.05 (α). **Conclusions:** The findings of this study are expected to serve as a literacy source that encourages readers to understand and delve deeper into the Learning Cycle 9E model based on performance assessment that can be applied to enhance students' habits of mind. Additionally, the results of this research can be used as input for educators to improve the quality of learning activities, particularly in biology. The implications of this study indicate that using the 9E Learning Cycle Model can significantly improve students' critical thinking, creative thinking, and self-regulation skills, which are essential for preparing them to face 21st-century challenges.

Keywords: Habits of Mind; 9E Learning Cycle Model; Digestive System; Performance Assessment

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Introduction

Education aims to determine whether students have achieved learning outcomes after completing the learning stage. Learning influences students' character, communication, and thinking (Putri et al., 2021). Achieving learning outcomes does not depend on the role of educators in creating appropriate learning models, methods, and media to be applied to learning (Situmorang et al., 2020). Biology subjects are one of them, and there are many practical activities, so an assessment tool is needed to support biology practicum in assessing student performance during practicum activities (Supriatna, 2022).

Learning in the 21st century, especially in the 2013 curriculum, allows students to understand the material through examples, applications, and real-world experiences inside and outside school (Rahayu et al., 2022). Education in the 21st century focuses on students, where students have the freedom to choose their learning materials (Rahmawati & Atmojo, 2021). Indonesian government policies supporting 21st-century learning

implemented in the 2013 Curriculum include Critical Thinking and Problem-Solving (critical thinking and solving problems), Creativity and innovation (creativity and innovation), Communication Skills (communication skills), and Collaboration (ability to work together) (Fahrozy et al., 2022). One way that can be used to produce students who can compete in the 21st century is to adopt a learning model that encourages students to participate actively during the learning process (Sakundari & Rizqi, 2024).

Robert Marzano developed habits of mind as one of the dimensions of learning outcomes. Habits of mind include attitudes and perceptions about learning, acquiring and integrating knowledge, expanding and refining knowledge, using knowledge effectively, and developing productive thinking habits (Marzano & Pickering, 1993). According to Marzano, Habits of Mind are dispositions that help individuals respond to challenges effectively. Three main habits are self-regulation, critical thinking, and creative thinking. Self-regulation involves awareness of one's thoughts and actions and the ability to respond to feedback and correct mistakes. Critical thinking includes analyzing information, evaluating arguments, and making sound decisions. Creative thinking involves viewing situations from different perspectives, generating new ideas, and finding innovative solutions. With these habits, students become more independent, skilled in problem-solving, and ready to face future challenges (Gloria et al., 2017). Thinking habits can shape a person's abilities if done regularly and continuously. Good habits of mind will help someone understand and solve problems in the real world using what they know (Ahmad et al., 2017). The long-term goal of learning activities is to improve students' ability to build themselves and solve problems in any situation that occurs in everyday life (Rikizaputra et al., 2021). It can be concluded that having habits of mind can help students become successful learners and able to face challenges in any situation (Marzano J.R, 1997).

Performance assessment is when students are asked to demonstrate their abilities. The primary purpose of using assessment in learning is to help teachers make decisions about better learning methods and to measure the level of achievement of learning indicators (Irawati, 2021). Performance assessments can be used as a substitute for assessments, which are usually used to measure student learning success in school (Supriatna, 2022). In assessing students' various abilities, one of which is creativity assessment, performance assessment is considered very important to implement because this form of assessment is comprehensive in scope (Supriatna, 2022). Implementing performance assessments helps improve students' critical thinking skills in practicum activities (Emiliannur et al., 2018).

Developing habits of mind is crucial in 21st-century education because it helps students develop critical thinking, creativity, and self-regulation skills needed for success. Previous studies have explored various approaches to enhance students' habits of mind Marzano J.R. (1997) emphasized the importance of productive thinking habits. Ahmad et al. (2017) showed that learning models with a scientific approach improve problem-solving and thinking habits, but a more comprehensive approach is needed. Emiliannur et al. (2018) found that performance assessment improves critical thinking disposition. Hakim et al. (2021) developed augmented reality-based modules that support problem-solving. Putri et al. (2021) demonstrated that the 9E Learning Cycle Model enhances students' science process skills, and Situmorang et al. (2020) highlighted the importance of performance assessment in evaluating creativity. The 9E Learning Cycle Model is an essential alternative as it includes nine stages to optimize learning: Elicitation, Engagement, Exploration, Explanation, Elaboration, Evaluation, Emendation, E-search, and Extension. These stages help students build concepts, draw conclusions, and apply principles learned in new situations, developing more substantial and sustainable thinking habits (Kafka, 2023).

The Learning Cycle 9E learning model in the teaching and learning process integrates learning with learning, investigating subject knowledge, knowledge of difficulties in lessons, knowledge of teaching methods, understanding of assessment, and search knowledge to obtain more detailed and focused learning in the entire education system (Buwono et al., 2022). The 9E Learning Cycle model can allow students to learn new things in a significant

way. In addition, this model can improve students' cognitive abilities through independent learning and active learning (Kaur & Gakhar, 2014).

The Learning Cycle 9E model is the result of developing the Learning Cycle 8E model. This model consists of nine stages that are interconnected and well-planned. In this phase, students will explore teaching materials, build concepts, draw conclusions, and then apply the principles or ideas they have learned (Tukiran et al., 2020). The Learning Cycle 9E learning model allows students to improve their abilities and skills and not imitate other people's knowledge (Buwono et al., 2022). Online learning with the Learning Cycle 9E model at home can improve students' science process skills and is beneficial for the sustainability of the learning process (Putri et al., 2021).

The learning model used in this research is the 9E Learning Cycle Model based on performance assessment in the form of oral feedback, which is included in the exploration and elaboration stages to improve students' habits of mind, including self-regulation, critical thinking, and creative thinking indicators. The 9E Learning Cycle Model consists of nine phases: Elicitation, Engagement, Exploration, Explanation, Elaboration, Evaluation, Emendation, E-search, and Extension. These phases stimulate students' interest, introduce new concepts, involve practical activities, discuss findings, apply concepts, assess understanding, correct mistakes, integrate technology, and apply knowledge beyond the classroom. This model effectively develops self-regulation, critical thinking, and creative thinking, which are essential for 21st-century learning. 21st-century learning demands students to master competencies, including critical thinking, creativity, communication, and collaboration skills. Therefore, a learning model is needed to form productive thinking habits and reduce cognitive anxiety, affecting biological learning outcomes. This research aims to determine the influence of the 9E Learning Cycle Model Based on Performance Assessment on the Habits of Mind of 11th-grade students in biology subjects on the digestive system material.

Method

This research was conducted at one of SMA A's in Bandar Lampung in the even semester of January of the 2023/2024 academic year. This study uses a quantitative approach. This research uses a quasi-experimental method with a Pretest-Posttest control group research design.

Table 1. The Matching only Pretest-Posttest control group design (Freankel, R.J. & Wallen, E.N., 2007)

Groups	Pretest	Treatment	Post-test
Experiment (E)	MT_1	X_1	T_1
Control (K)	MT_1	X_2	T_2

Information:

E **:** Experimental class group
K : Control class group
X1 **:** Treatment for the experimental group (LC9E Model based on performance assessment)
X2 **:** Treatment for the control class (Discovery learning model)
T1 **:** Habits of mind test at the end and habits of mind questionnaire at the end
MT1 **:** Matching

Sample or Participant

This research used all students in class XI Science at one of SMA A's in Bandar Lampung as the research population. The sampling method used is using random techniques. In this research, two sample groups were used. The experimental group received special treatment, and the process in which the learning activities were carried out used the Learning Cycle 9E model, which was based on performance assessment. The control group used the Discovery learning model. There are two variables in this research, namely one independent variable in the form of learning using the Learning Cycle 9E model, which is based on performance assessment, and one dependent variable, namely habits of mind.

Instrument

The research instruments used multiple-choice habits of mind questions and habits of mind questionnaires previously tested for validity, reliability, difficulty level, distinguishability, and distraction level. The analytical prerequisite tests used are normality and homogeneity tests, which are then continued with independent sample tests used to analyze the data.

Data collection

Data collection techniques are data collection techniques used by researchers, namely (Freankel, R.J. & Wallen, E.N., 2007)

1. Students will be given a multiple-choice test related to digestive system material. This test uses an online form created using Google Forms. The test assessment results are based on the student's answers to the habits of mind indicators. The learning outcomes test used is the same as the one created based on the formulation of learning objectives in the test grid. The results of this test are then used to collect data about students' habits of mind abilities.
2. Questionnaires given to students can be answered online using the Google form. Using the Learning Cycle 9E model based on performance assessment, this questionnaire aims to determine students' responses to material related to the digestive system. Questions or statements are given to respondents as a data collection method. Researchers use a non-test instrument known as a closed questionnaire, a type of question structured into statement sentences with available answer options. Then, the data was measured using a Linkert scale with specific values indicating SS (Strongly Agree), S (Agree), TS (Disagree), and STS (Strongly Disagree).
3. The documentation method collects written or printed data about the research topic. This data will be used as physical evidence of the existence of research and to strengthen research results. Researchers use documentation methods to obtain data or documents such as students' grades in pictures and videos during learning activities and tools that can help the learning process.

Procedure

This research was carried out at one of SMA A in Bandar Lampung in the even semester of the 2023/2024 academic year, namely January 25-February 2, 2024. The learning process in this research focused on the digestive system material. The learning process is done offline in 3 meetings with a total time allocation of 135 minutes per meeting. Learning is carried out in two classes, namely class XI IPA 4 as an experimental class and XI IPA 5 as a control class. The control and experimental classes were selected using the Cluster Random Sampling Technique. The experimental and control classes used different treatments in the learning process. There were 31 participants in the control class (XI IPA 5) using the discovery learning model and 34 students in the experimental class (XI IPA 4) using the Learning Cycle 9E learning model.

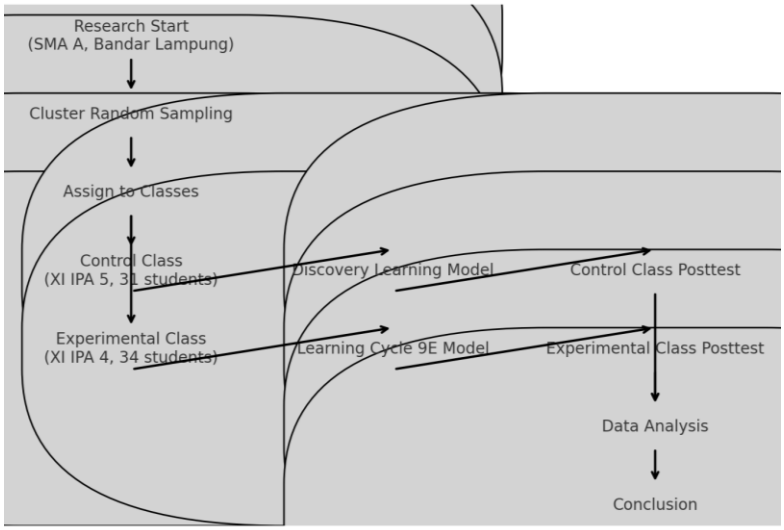

Figure 1. Research Flowchart

Data analysis

Data collection for this research is done by providing test questions and habits of mind questionnaires before the learning process takes place (pretest), then at the end of the lesson, giving test questions and habits of mind questionnaires (post-test). After the learning process is complete, the data that has been obtained is analyzed using the N-Gain test, normality test, homogeneity test, and independent sample t-test (Sugiyono, 2017).

Results

Biology learning with the Learning Cycle 9E model based on performance assessment to improve students' habits of mind.

Figure 2. Elicitation Stage

Teacher's Role: The teacher provides initial stimulation to attract students' attention by showing a picture of food that contains essential nutrients. The teacher asks prompting questions to initiate a discussion about the food and its nutritional content, encouraging students to think critically about the importance of each nutrient found in the food. Student Activities: Students carefully observe the picture, note the various nutrients contained in the food, and discuss in small groups the importance of these nutrients for the body. They delve deeper into how these nutrients contribute to health and bodily functions. After the group discussion, students share their findings with the entire class, explaining what they have learned about the nutritional value and benefits of the food shown in the picture. They may also compare their findings with information they know or have learned from other sources.

Figure 3. Engagement Stage

The teacher provides initial understanding by involving Students in introducing new concepts related to food using learning videos as a source. Teacher's Role: The teacher presents new food-related concepts by using an educational video as a source. The teacher ensures that all students are attentive and understand the content of the video. Student Activities: Students watch the video, take notes on key points, and create questions that arise from the video. Afterward, students participate in a Question and answer session to clarify their understanding.

Figure 4. Exploration Stage

Teacher's Role: The teacher divides students into discussion groups of 5-6 people to discuss problems presented in the Student Worksheet. The teacher supervises the groups, ensuring that all students are participating and staying on task, and provides oral feedback to guide their discussions and help clarify any misunderstandings. Student Activities: Students collaborate in groups to read, analyze, and discuss the problems in the Student Worksheet. They work together to understand the questions, share their ideas, and seek additional information. Students write down their answers and solutions, ensuring that they reflect the group's collective understanding and analysis of the problems.

Figure 5. Implementation of oral feedback

Teacher's Role: The teacher provides assessment, appreciation, and suggestions based on students' presentation of answers as a form of performance assessment through oral feedback. The teacher asks clarification questions to probe deeper into the student's understanding and evaluates their answers to provide constructive feedback. Student Activities: Students present their group answers, clearly explaining their thoughts and findings. They respond to the teacher's clarification questions, providing additional details or elaboration as needed. Students then receive feedback through suggestions and appreciation from the teacher, which helps them identify areas for improvement and reinforces their understanding of the material.

Figure 6. Explanation Stage

Teacher's Role: The teacher allows students to convey the results of their group discussions to the whole class. The teacher facilitates this process by guiding and structuring their presentations and encouraging an open and respectful environment for sharing ideas. The teacher also asks questions to help clarify points and ensure that all students are engaged and understand the presented material. Student Activities: Students prepare group presentations, organizing their discussion results and findings clearly and coherently. They show their results to the class, explaining their thoughts and conclusions. After the presentation, students answer the teacher's and their peers' questions, further clarifying and elaborating on their findings. This helps reinforce their understanding and communication skills.

Figure 7. Echo Stage

Teacher's Role: The teacher provides feedback by adding more in-depth material related to the discussion results presented by the students. The teacher elaborates on key points, clarifies misconceptions, and offers additional insights to enhance students' understanding of the topic. The teacher also encourages students to ask questions and engage in further discussion to solidify their learning. Student Activities: Students listen attentively to the additional explanations from the teacher, take detailed notes on the critical information provided, and discuss these points with their group members to ensure a thorough understanding. They ask questions if they need further clarification and actively participate in discussions to deepen their comprehension of the material.

Figure 8. Elaboration Stage

Teacher's Role: The teacher uses the pro and con teaching technique between groups to present arguments and apply them to new situations. The teacher facilitates the discussion by ensuring that each group understands their position, whether pro or contra, and guides them in constructing strong arguments. Additionally, the teacher gives oral feedback to students during and after the debate to help them improve their argumentation skills and conceptual understanding. The teacher also ensures that the discussion remains orderly and that all students can participate. Student Activities: Students participate in group debates, express their opinions, and discuss various perspectives related to the topic. They collaborate with group members to develop strong and relevant arguments, using evidence and examples they have learned. Students also apply the concepts they have learned to new situations simulated through the debate, deepening their understanding and honing their critical thinking and problem-solving skills. After the discussion, students receive feedback from the teacher and their peers, helping them reflect on their performance and make necessary improvements.

Figure 9. Implementation of oral Feedback Stage

After discussing the contents of an article with the theme "The term 4 Healthy 5 Perfect for Nutrition Guidelines is Outdated". Using the pros and cons teaching technique, the teacher will then provide assessment, appreciation, and suggestions from the results of the explanation of the answers as a form of the performance assessment activity process in the form of oral feedback. At the Elaboration stage in this first meeting, the teacher asked why some groups agreed with the statement that the terms 4, healthy, and five perfect were no longer suitable for use today as a form of clarification. Then, students provided answers related to the question. Next, the teacher will assess the students' answers by adding suggestions and appreciation to the students.

Figure 10. Evaluation Stage

Teacher's Role: The teacher provides evaluation questions in the student worksheet and monitors students' progress as they work on them. The teacher ensures the questions align with the learning objectives and covers the key concepts taught. Additionally, the teacher can offer guidance and clarification if students encounter difficulties and ensure that all students are actively engaged in the task. Student Activities: Students work on the evaluation questions in the student worksheet, applying the concepts learned during the lessons. They carefully read and analyze each question, using their knowledge to find accurate answers. Students then record their results in the worksheet, ensuring that they explain their reasoning and methods where necessary. This activity helps reinforce their understanding of the material and allows them to demonstrate their learning effectively.

Figure 11. Emendation Stage

Teacher's Role: The teacher allows students to share the positive things they have learned during the learning process. The teacher creates a supportive environment where students feel comfortable sharing their experiences. Additionally, the teacher facilitates reflective discussions where students can talk about the aspects of learning they found most beneficial or enjoyable. The teacher also provides guidance on how to reflect on their learning experiences critically and constructively. Student Activities: Students reflect on their learning experiences, write down the positive things they have learned, and share their reflections with the class. They may write reflective journals, create brief presentations, or participate in group discussions. Students are also encouraged to give feedback to their peers and receive feedback openly. These activities help students identify and appreciate their achievements and enhance their self-reflection and communication skills.

Figure 12. E-search Stage

Teacher's Role: The teacher maximizes learning by utilizing various technological tools and platforms as educational media to reinforce and expand upon the material that has been taught. This may include using interactive simulations, educational software, online databases, and digital collaboration tools to provide students with diverse and engaging learning experiences. The teacher also guides students in effectively using these technologies to enhance their research skills and knowledge acquisition. Student Activities: Students actively engage with technological devices such as tablets, computers, or smartphones to search for additional information related to the topic. They access and read relevant articles, journals, and other credible sources online to deepen their understanding. Students also participate in online forums, collaborate with peers through digital platforms, and use educational apps to conduct virtual experiments or simulations. This technological engagement helps them explore the topic more comprehensively and apply their newfound knowledge practically.

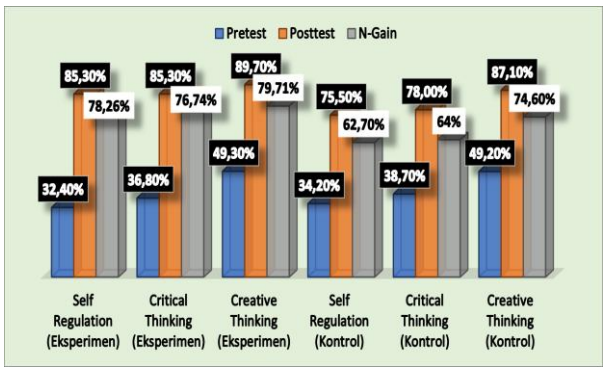

Figure 13. Presentation of Results of Analysis of Habits of Mind Test Indicators for Experimental Class and control class

Figure 13 shows the test scores obtained for the Habits of Mind test for the experimental and control class indicators. The results show differences in the level of habits or minds of students in both experimental and control classes. In the Self-Regulation indicator, the experimental class was better than the control class. The experimental class received a post-test score of 85.30%, which was included in the robust category. In comparison, the control class received a post-test score of 75.50%, which was included in the robust category. On the Critical Thinking indicator, the experimental class was also better than the control class. The experimental class received a post-test score of 85.30%, which is included in the robust category. On the Creative Thinking indicator, the experimental class received a post-test score of 89.70%, while the control class received a score of 87.1%, both of which were very good.

Value of Pretest Post-test Results of Habits of Mind Test for Experimental Class and Control Class

Data on students' habits of mind test scores were obtained from the initial (pretest) and final (post-test) tests on the Digestive System Material in the following table:

Table 2. N-gain Results of HOM Test Scores for Control and Experiment Class Students

Mark	Experiment	Control
Pretest	37,35%	38,54%
Posttest	86,02%	78,54%
N-Gain	79,5%	69,5%
Criteria	Tall	Currently

Table 2. shows that the average habit of mind test score is higher in the experimental class compared to the control class. The experimental class received an average score of 79.5% in the high category, and the control class received an average score of 69.5% in the medium category. According to the data above, the habits of mind of the two classes are different. The experimental class's score was higher than the control class, which shows that the experimental class tends to have better habits of mind than the control class.

Table 3. Normality Test of Habits of Mind Test

Class	Kolmogorov Smirnov			Shapiro-Wilk		
	Statistics	Df	Sig.	Statistics	Df	Sig.
Experiment (*Learning Cycle 9E*)	0,139	34	**0,094**	0,932	34	0,035
Control (*Discovery Learning*)	0,147	31	**0,086**	0,955	31	0,208

Based on Table 3. the normality test of the habits of mind test data shows that the experimental class result is 0.094 and the control class result is 0.086 with a significance > ÿ 0.05. Thus, it can be concluded that the experimental and control classes have a normal distribution.

Table 4. Homogeneity Test of Habits of Mind Test

Results	Test of Homogeneity of Variance			
	Levene Statistic	df1	df2	Sig.
Based on Mean	0,325	1	63	0,571
Based on Median	0,439	1	63	0,510
Based on the Median and with adjusted df	0,439	1	62,299	0,510
Based on trimmed mean	0,347	1	63	0,558

The results of the homogeneity test using the Lavene statistical test on the habits of mind test in the final test (post-test) for both the experimental and control classes are shown in Table 4. The test results show a significance value of 0.571, which shows that the significance value is by the existing criteria; if sig > ÿ 0.05, then the habits of mind test data in the final test (post-test) of the experimental and control classes are homogeneous.

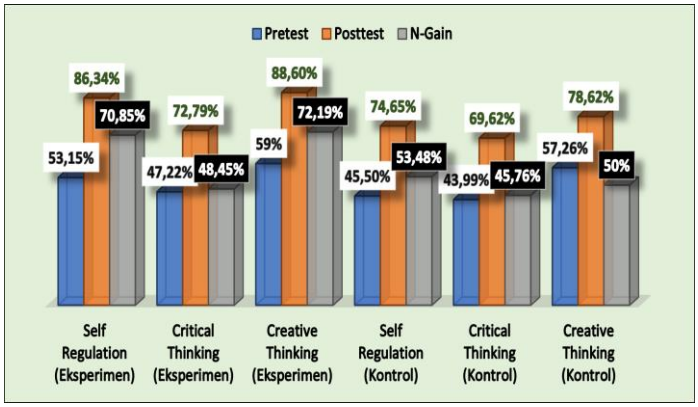

Figure 14. Presentation of Analysis of Results of Control Class Habits of Mind Questionnaire Indicators and Experiment Class

Figure 14. the scores obtained for the Habits of Mind test for the experimental and control class indicators are shown. The results show differences in the level of habits of mind of participants in the experimental and control classes. In the Self-Regulation indicator, the

experimental class was better than the control class. The experimental class obtained a post-test score of 86.34%, which was included in the robust category.

In comparison, the control class obtained a post-test score of 74.65%, which was included in the strong category. On the Critical Thinking indicator, the experimental class was better than the control class. The experimental class obtained a post-test score of 72.79%, which was included in the strong category. In the control class, the post-test score was only 69.62%, which was included in the strong category. On the Creative Thinking indicator, the experimental class received a post-test score of 88.60% in the robust category, while the control class received 78.62% in the strong category.

Value of Pretest Post-test Results of Habits of Mind Questionnaire for Experiment Class and Control Class

Table 5. Results of N-gain HOM Test Scores for Experimental and Control Class Students

Mark	Experiment	Control
Pretest	51,73%	47,25%
Posttest	81,08%	73,22%
N-Gain	61,98%	51,25%
Criteria	**Currently**	**Currently**

Table 5. shows that the results of the N-gain habits of mind questionnaire in the experimental class were better than the scores for the control class. The average post-test score in the experimental class was 81.08%, and the N-gain score was 61.98% in the medium category, while the average post-test score in the control class was 73.22% and the N-gain score was 51 .25% in the medium category.

Table 6. Habits of Mind Questionnaire Normality Test

Class	Kolmogorov Smirnov			Shapiro-Wilk		
	Statistics	Df	Sig.	Statistics	Df	Sig.
Experiment (*Learning Cycle 9E*)	0,137	34	**0,104**	0,933	34	0,038
Control (*Discovery Learning*)	0,143	31	**0,105**	0,941	31	0,088

Table 6. shows the normality test results of the Habits of Mind questionnaire data. The results obtained for the experimental class were 0.104, and the results for the control class were 0.105 with a significance of more than 0.05, which shows that the habits of mind in the experimental class and control class were normally distributed. Thus, the homogeneity test can be continued after the normality test is fulfilled and the data is normally distributed.

Table 7. Homogeneity Test for Habits of Mind Questionnaire

Result	Test of Homogeneity of Variance			
	Levene Statistic	df1	df2	Sig.
Based on Mean	0,487	1	63	0,488
Based on Median	0,155	1	63	0,695
Based on the Median and with adjusted df	0,155	1	56,113	0,695
Based on trimmed mean	0,423	1	63	0,518

The results of the homogeneity test using the Lavene statistical test on the habits of mind questionnaire in the final test (post-test) for both the experimental and control classes are shown in Table 7. The test results show a significance value of 0.488, which shows that the significance value is based on the existing criteria if sig. > 0.05, then the habits of mind questionnaire data in the final test for the experimental and control classes are homogeneous.

After obtaining normally distributed and homogeneous data, the hypothesis is tested using the independent sample T-test. It is known that the Learning Cycle 9E learning model based on Performance Assessment is a solution for improving the habits of mind of high school students in learning biology, as proven by the data having a normal and homogeneous

distribution and a calculated significance value of 0.001 < 0.05 (ÿ). It is hoped that the results of this research can be used as a literacy source that encourages readers to recognize and deepen the Learning Cycle 9E learning model based on performance assessment that can be applied to improve students' habits of mind. Apart from that, the results of this research can also be used as input for educators to enhance the quality of learning activities, especially in biology subjects.

Discussion

This study found that the 9E Learning Cycle Model Based on Performance Assessment significantly improves the Habits of Mind of eleventh-grade students on the digestive system topic. This improvement is observed in the indicators of self-regulation, critical thinking, and creative thinking. The research indicates that the 9E Learning Cycle model positively affects students' habits of mind compared to the Discovery Learning model used in the control class. The 9E Learning Cycle model enhances students' thinking habits, making them more active, creative, and critical. Performance assessments, including group discussions, presentations, and practical work, greatly support this model as they require students to demonstrate their performance through active discussion, Collaboration, investigation, and learning outcomes. These results show that this learning model effectively enhances understanding of biology material and develops broader and deeper thinking skills.

This study employed a quasi-experimental method with a pretest-posttest control group design. Data analysis showed that the experimental class using the 9E Learning Cycle Model scored higher on the post-test than the control class using the Discovery Learning model. The first indicator of habits of mind is self-regulation, which significantly impacts learning, as evidenced by the research results above. Students involved in learning with self-regulation indicators showed higher scores in the habits of mind test, with 85.30% in the experimental class compared to 78.0% in the control class. This indicates that learning that encourages self-regulation can enhance students' awareness of their thoughts, plan appropriately, know and use the necessary information, and respond to feedback appropriately. Students with good self-regulation skills are more aware of their thoughts and actions. They can monitor and evaluate their mental strategies, which helps them make better decisions. Self-regulation also enables students to make appropriate and realistic plans to achieve their learning goals, including setting goals, managing time, and determining the steps needed to achieve the desired results. Additionally, students with good self-regulation skills know how to seek and use the necessary information to complete their tasks effectively. They can also respond well to feedback and evaluate the effectiveness of their actions, which is essential for self-improvement and long-term learning success.

The second indicator is critical thinking habits, Which significantly impact learning, as reflected in the research results above. Students involved in learning with essential habits of thinking indicators showed higher scores in the habits of mind test, with 85.30% in the experimental class compared to 78.0% in the control class. This indicates that learning that encourages critical thinking can enhance students' abilities to analyze information in-depth, evaluate arguments, and make accurate decisions. Students who think critically can better analyze data, evaluate arguments, and distinguish between facts and opinions, helping them understand the lesson material more comprehensively. Furthermore, critical thinking enables students to identify problems, explore various solutions, and choose the best solution based on the available evidence, which is crucial for completing complex tasks and projects. Students who think critically also tend to be more independent in their learning as they actively seek and verify information rather than passively receiving it. Thus, critical thinking improves learning outcomes and develops essential skills that benefit students. Research conducted by Irhamna et al. (2017) also shows that the 5E Learning Cycle model can improve students' critical thinking skills, specifically in problem-solving indicators.

The research above shows that the third indicator is creative thinking, which significantly impacts learning. Students involved in learning with creative thinking indicators showed

higher results in the habits of mind test, with 89.70% in the experimental class compared to 87.1% in the control class using the discovery learning model. This indicates that learning that encourages creative thinking can enhance students' ability to see situations differently and produce innovative solutions. Students who think creatively in learning tend to engage in various tasks, make efforts according to their skills and knowledge, and create and use their evaluation standards. They can also generate new ways by looking at situations from different perspectives. Examples of behaviors of students who think creatively include active participation in learning activities, trying different approaches to complete tasks, asking deep and critical questions, and generating new and innovative ideas. This research aligns with previous findings by Wicaksono & Widiyaningrum (2020), which showed that the Learning Cycle 9E model in respiratory system material with practical assistance can enhance the creative attitudes of students in the high category. Therefore, encouraging innovative thinking in learning improves learning outcomes and develops essential skills that will benefit students in the future.

Several studies from international journals support these findings. Research by Assi et al. (2023) found that the 9E Learning Cycle Model enhances high school students' critical and creative thinking skills. Hakim et al. (2021) also showed that mobile augmented reality-based learning modules developed according to the 9E Learning Cycle Model can improve students' problem-solving abilities. Furthermore, a study by Hakim et al. (2021) demonstrated that the 9E Learning Cycle Model and e-learning methodologies can effectively optimize teaching and learning.

Comparisons with other studies also show consistent results Emiliannur et al. (2018) found that performance assessment effectively enhances critical thinking disposition in physics students, which aligns with the finding that performance assessment in the 9E Learning Cycle Model also improves critical thinking skills in biology students. The performance assessment used during research is in the form of group discussions, presentations, and practicums where this assessment is in line with the Learning Cycle 9E learning model, which in its learning steps requires students to be able to demonstrate their performance by actively discussing, collaborating, investigating and conveying the learning results they have obtained. Performance assessment is a form of assessment of students' abilities and attitudes demonstrated through performance or actions. This is in line with research conducted by Situmorang et al. (2020), where performance assessment is considered very important to implement because this form of assessment can assess various skills, one of which is assessing students' creativity. Additionally, it indicated that performance assessment is crucial in measuring students' creativity on the respiratory system topic, supporting the findings of this study in the context of the digestive system. This differs from the control class, which uses the Discovery Learning learning model. Thorley (2020) states that activity Learning failure is a tricky part to avoid, with some students whose improvement is still relatively low, indicating that there is a process that must be passed effectively to obtain creativity.

Overall, the performance assessment-based 9E Learning Cycle Model has proven more effective in enhancing students' habits of mind than the Discovery Learning model. Students in the experimental class showed more significant improvements in post-test questionnaire scores for each habits of mind indicator, demonstrating that this learning model is effective in developing better thinking habits. The conclusion of this study confirms that the 9E Learning Cycle Model Based on Performance Assessment is an effective solution for improving students' Habits of Mind and can be applied across various subjects to support 21st-century learning.

Conclusion

This study shows that the 9E Learning Cycle Model Based on Performance Assessment significantly improves students' Habits of Mind. Therefore, it is recommended that educators implement this model in the learning process to optimize student learning outcomes.

Training for educators on the implementation of this model is also highly recommended. Additionally, it is suggested that technology and digital resources be integrated into learning to support this model's application further. By applying this model, students will become more active, creative, and critical in their learning. This enhances their understanding of the subject matter and develops broader and more profound thinking skills, which are essential for facing the challenges of the 21st century.

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Declaration statement

The authors report no potential conflict of interest.

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