



Application of Interactive Teaching Materials Based on Discovery Learning Digestion System Subjects to Improve 21st Century Skills

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Abstract

21st century skills that students need to have include critical thinking abilities, learning motivation, and collaboration abilities. Class XI MIPA students at SMAN 4 Semarang are still learning using printed teaching materials, so interactive teaching materials based on Discovery Learning are needed to improve 21st century skills. This research aims to analyze the application of Discovery Learning-based interactive teaching materials on the human digestive system to improve the 21st century skills of class XI-MIPA students at SMAN 4 Semarang. The independent variable is interactive teaching materials based on Discovery Learning digestive system material. The dependent variables are students' critical thinking abilities, learning motivation, and collaboration abilities. Data were analyzed using descriptive percentages, t -test, and N-Gain Score. The research results obtained were the aspect of critical thinking ability with the greatest increase in the analysis aspect of 29%. The indicators of learning motivation with the highest percentage are readiness, persistence and enthusiasm. The collaboration ability indicators with the highest percentage are flexible (95%) and mutual respect (100%). The conclusion obtained is that the application of interactive teaching materials based on Discovery Learning material on the human digestive system can improve students' critical thinking skills, learning motivation and collaboration abilities.

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INTRODUCTION

Learning in the 21st century is more focused on learning that involves the use of technology and mastery of the 4C skills, namely critical thinking, creative and innovative, communication and collaborative skills (Rosnaeni, 2021). Critical thinking skills are a student learning outcome that is very necessary in the 21st century. Class XI MIPA students at SMAN 4 Semarang have not been able to answer questions or problems given by the teacher critically. Students only answer questions briefly without any explanation. The critical thinking ability indicators used in this research are guided by the critical thinking ability indicators according to Facione, including interpretation, explanation, analysis, evaluation, inference and self-control (Facione, 2015). The indicators studied are interpretation, analysis and explanation.

Motivation to learn is one of the student learning outcomes which is characterized by improvements in student behavior towards a better direction (Murdi & Heryanto, 2020). The results of observations during biology learning in Lantip activities at SMA Negeri 4 Semarang found that students often forgot to bring printed biology teaching materials. Students play little active role in learning activities. The media that are often used are power point (ppt) and printed teaching materials. The use of learning media has not succeeded in helping students to always be responsive and active in learning. Besides being influenced by factors from within the student, student learning motivation is also influenced by external factors, one of which is the use of teaching materials used by students (Kusumaningrini & Sudibjo, 2021). The indicators of student learning motivation in this research were adapted from previous research conducted by Aina *et al.*, (2021), namely persistence (never giving up), perseverance, enthusiasm, readiness and self-confidence.

The attitude of helping each other among friends or also known as collaboration ability is defined as the ability to establish good relationships with people around you that are mutually beneficial to each other. (Van Leeuwen & Janssen, 2019). Based on the results of observations during the Lantip activity, class XI MIPA SMAN 4 Semarang, some students still relied on diligent group members. Indicators of student collaboration ability were adapted from indicators of collaboration ability according to Greenstein (2012) in research by Zuwariyah *et al.*, (2021), including flexibility, contribution, productivity and mutual respect.

The learning model that is often applied in teaching and learning activities in Biology learning in class XI MIPA SMAN 4 Semarang is Discovery Learning. In the Discovery Learning model, the teacher acts as a facilitator while students actively search in groups for the concepts of the material being studied (Rini *et al.*, 2021). Based on the results of the interview, Mrs. Ririn as a biology teacher more often uses the Discovery Learning model, specifically Guided Discovery Learning, because it is considered effective in improving student learning outcomes. This is proven by the increasing number of students who get scores above the KKM, only around five students in one class have not passed the KKM. The content of interactive teaching materials is prepared according to the syntax of the Discovery Learning model, namely 1) orientation, 2) apperception, 3) motivation, 4) providing references, 5) stimulation, 6) problem formulation, 7) data collection, 8) data processing, 9) verification, 10) generalization, 11) evaluation, and 12) follow-up (Buana & Anugraheni, 2020).

In the era of the industrial revolution, the use of technology in learning in the form of effective interactive teaching materials to increase the learning motivation of class VIII E students at SMPN 22 Jambi City (Zaharah & Susilowati, 2020). Septiani (2022) stated in his research that the use of Discovery Learning-based interactive teaching materials can improve students' critical thinking skills in cell material (Septiani, 2022). The use of interactive teaching materials based on Anyflip is effective in improving the cooperative abilities of class X on living thing classification (Suryani & Saparuddin, 2022).

Based on the problems found at SMAN 4 Semarang as well as the biology learning needs required by students, researchers will conduct research related to the application of Discovery Learning-based interactive teaching materials on the human digestive system to improve critical thinking skills, learning motivation and collaboration abilities for class XI students MIPA SMAN 4 Semarang.

RESEARCH METHOD

The research carried out was a type of experimental research with the research method used, namely quasi experimental research. This research method was carried out to determine the application of Discovery Learning-based interactive teaching materials to improve critical thinking skills, learning motivation and collaboration abilities of class XI MIPA students at SMAN 4 Semarang. The research design used was pretest and posttest nonequivalent control group design. This research used two groups, namely a control group and an experimental group. In both groups each pretest and posttest were carried out. The treatment given to the experimental class was the use of interactive teaching materials based on Discovery Learning, digestive system material during learning. Learning in the control class uses power point media which contains material on the human digestive system according to the Erlangga textbook used at SMAN 4 Semarang. The research was conducted at SMA Negeri 4 Semarang which is located on Jalan Karang Rejo Raya No. 12A, Srandol Wetan, Banyumanik District, Semarang City, Central Java. The research was conducted from January - February 2024. The population in this research was all class XI students of SMA Negeri 4 Semarang for the 2023/2024 academic year. The selection of research samples was carried out using non-random sampling techniques consisting of XI-3 Lamarc 1 as the control class and XI-4 Lamarc 2 as the experimental class.

The data in this research consists of data on students' critical thinking abilities, results of observations of students' learning motivation, self-assessment of students' learning motivation, results of observations of student collaboration, self-assessment of students' collaboration abilities and implementation of learning. Data collection techniques were carried out using interviews, observation, tests, and filling out questionnaires. Interviews and observations are initial techniques for identifying problems in biology learning. Tests in the form of pretests and posttests to determine students' critical thinking abilities. Filling out the questionnaire is used to determine students' learning motivation and collaboration abilities. Observation to determine the implementation of learning. The data analysis techniques used in this research consist of prerequisite tests, test instrument data analysis techniques, non-test instrument data analysis techniques which consist of data on learning motivation, collaboration ability, and learning implementation. The prerequisite test consists of normality and homogeneity tests using SPSS 22 software. Analysis of the test instrument which includes testing the validity of the questions, reliability, differentiability of the questions, level of difficulty of the questions using the ANATES application. Critical thinking ability data analysis was analyzed using normality and homogeneity tests, descriptive techniques for the percentage of each aspect of critical thinking ability, and the N-Gain score test. Data analysis of students' learning motivation and collaboration abilities was analyzed using normality and homogeneity tests, descriptive percentages for each aspect, and the N-Gain Score test. Students' collaboration abilities were only analyzed using percentage descriptive techniques only.

RESULTS AND DISCUSSION

The results of research on students' critical thinking abilities in the treatment class showed that each of the three aspects of their critical thinking abilities had increased. Figure 1.1 shows that the increase in three aspects of students' critical thinking abilities in the treatment class before and after the research was greater than in the control class

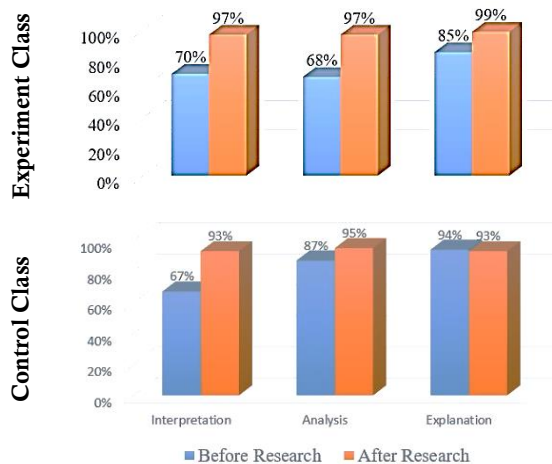


Figure 1.1 Level of critical thinking ability of treatment class and control class students in each aspect

Based on Figure 4.1, the greatest increase in the aspect of critical thinking skills of students in the treatment class was in the analysis aspect and the smallest increase was in the explanation aspect. Mann Whitney test results with Asymp Sig value. (2-tailed) < 0.05, which means there is a significant difference between the critical thinking abilities of students who apply Discovery Learning-based interactive teaching materials and students who apply teaching materials from school. The results of the Mann Whitney Test show that the application of interactive teaching materials based on Discovery Learning regarding the human digestive system can improve students' critical thinking abilities. The category of increasing critical thinking skills can be seen from the results of the N-Gain test. The N-Gain test results can be seen in Table 1.1.

Table 1.1 N-Gain Score for treatment class and control class

N-Gain Score	Experiment Class (using Discovery Learning Model)	Control Class (using Conventional Learning Model)
Lowest Score	0.32	-3.50
Highest Score	1.00	0.95
Average	0.96 (High)	0.11 (Low)

The increase in critical thinking skills in the treatment class was 0.96, which is included in the high category, while the increase in critical thinking skills in the control class was 0.11, which is included in the low category. The application of interactive teaching materials based on Discovery Learning regarding the human digestive system can improve students' critical thinking skills with a high improvement category

The biggest increase in treatment class students in the critical thinking ability aspect was the analysis aspect, namely 29%. In Discovery Learning-based interactive teaching materials, each sub-material is equipped with learning videos that help students get a clear picture of what they are learning. Interactive teaching materials accompanied by videos make it easier for students to get a clear picture of abstract material so that they can increase students' understanding of concepts (Putri, Risdianto, & Rohadi, 2019). Interactive teaching materials are also equipped with pictures of the anatomy and histology of digestive organs which makes it easier for students to get an overview of the material presented. In their research, Agung *et al.*, (2020) stated that the image media contained in electronic modules can stimulate students so that material concepts are easily conveyed to students.

Discovery Learning-based interactive teaching materials at the end of each sub-material are also equipped with practice questions created based on aspects of critical thinking skills. The research results of Takele & Melese (2022) state that formative assessments on each sub-material need to be given to students to realize student understanding so that the material is more meaningful. Having videos in interactive teaching materials can help students get a clear picture of the material so that the concept of the material is easy for students to understand. Understanding the concept of material makes it easier for students to connect a problem they encounter with the concept of the material so that students' analytical skills can increase. The aspect of critical thinking ability with the smallest increase in the treatment class is the explanation aspect. This shows that before conducting research, students are able to provide explanations regarding material concepts, data, or statements. The explanation regarding the digestive system in the textbook has been explained in detail, especially regarding the understanding of the process and function of digestive enzymes. These explanations help train students to explain a material concept or a statement. The explanation regarding the digestive system in the textbook has been explained in detail, especially regarding the understanding of the process and function of digestive enzymes. These explanations help train students to explain a material concept or a statement. Learning with the help of interactive teaching materials has been proven to help improve students' explanation abilities as indicated by an increase in the explanation aspect in the treatment class by 14%. This is in line with research conducted by Rukmi & Diyana (2023) where interactive modules on Newton's law material equipped with videos, images and formative assessment links help students gain meaningful understanding so that students can explain the concepts of the material well. These results are in line with research conducted by Nurlaili *et al.*, (2021) who in their research stated that the use of electronic modules in Discovery Learning-based trait inheritance material during effective learning helps improve students' critical thinking skills as indicated by the N-Gain value in the aspect interpretation, analysis, and explanation are classified as moderate. The research results, which are strengthened by previous research, further strengthen that the application of Discovery Learning-based interactive teaching materials regarding the human digestive system can improve students' critical thinking abilities.

Data on student learning motivation was obtained in two ways, namely self-assessment and observation by observers. Figure 1.2 shows the increase in student learning motivation for each indicator in self-assessment. Figure 1.3 illustrates the increase in student learning motivation for each indicator on the observation sheet. The indicators for self-assessment and observation of learning motivation for treatment class students are classified as high, namely readiness, perseverance and enthusiasm. In the treatment class, each indicator, both self-assessment and observation, increased. If there is an increase in each indicator of student learning motivation, it is necessary to carry out a Mann Whitney parametric test to determine the difference in the average learning motivation score of students who use interactive teaching materials and students who use textbooks at school. The results of the Mann Whitney test showed that only observation data showed that there was a difference in the average value of learning motivation with the Asymp. Sign (2-tailed) value < 0.05. The category of improvement in critical thinking skills of the treatment class after implementing interactive teaching materials based on Discovery Learning on digestive system material, can be seen in Table 1.2.

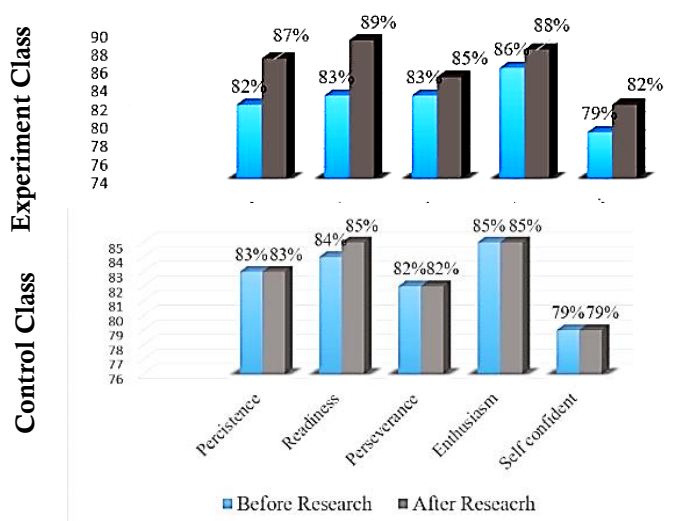


Figure 1.2 The level of learning motivation of students in the treatment class and control class for each indicator self-assessment

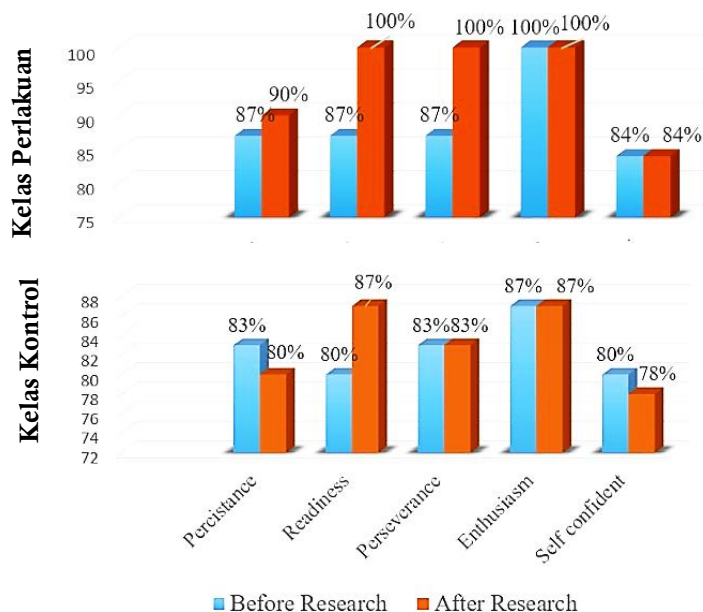


Figure 1.3 The level of learning motivation of students in the treatment class and control class for each indicator observation

Table 1.2 Results of the N-Gain score test for observing learning motivation

N-Gain Score	Experiment Class (using Discovery Learning Model)	Control Class (using Conventional Learning Model)
Highest	0.50	0.10
Lowest	0.33	-0.33
Average	0.41	0.03

The indicator of persistence has two aspects, namely students diligently reading Discovery Learning-based interactive teaching materials and students diligently working on the tasks contained in the teaching materials. Interactive teaching materials equipped with videos and images can minimize boredom and increase students' enthusiasm for learning (Fitriyah & Sahda, 2023). Students are increasingly enthusiastic about learning, supported by the display of interactive teaching materials which are colorful and equipped with animated images. The understanding of the concepts obtained by students from the videos and images is applied when working on discussion sheets by students in groups and formative assessments at the end of each sub-material. The display of interactive teaching materials applied by researchers is in the form of a flipbook, so that each sheet can be flipped back and forth like learning using a printed book. This is in line with the research results of Putri *et al.*, (2023) which stated that the use of flipbook-based electronic modules provides the sensation of learning using a printed book (can be flipped) so that it can increase students' enthusiasm and independence in learning biodiversity material. The title of each sub-material is highlighted so as to minimize the monotonous presentation of the material and trigger students' initial enthusiasm for learning. The results of a literature study conducted by Rosadi *et al.*, (2021) revealed that the use of color combinations in learning media makes it easier for students to remember the material being studied. Two aspects of the enthusiasm indicator are that students actively discuss with fellow students in completing assignments and students try to do assignments according to their abilities. The interactive teaching materials applied by researchers are equipped with discussion sheets. At the beginning of the lesson, the researcher carried out a diagnostic test first to determine the group and type of questions that suited the students' interests and learning styles. Group learning encourages students to exchange opinions in completing assignments so that a complete understanding of the concept is obtained. Wijayanti & Isnawati (2023) in their research stated that the application of interactive learning materials based on flipbook-based nervous system material was effective in increasing students' learning motivation because flipbook-based electronic modules provided features that helped increase students' enthusiasm for learning such as video, audio and animation. Sholeh *et al.*, (2023) in their literature study stated that the use of electronic modules can make it easier for students to understand the material and increase students' learning motivation. This

explains that the application of interactive teaching materials in the form of Discovery Learning-based interactive teaching materials can help increase student learning motivation with an increase in the category of 0.41 which is included in the medium category.

Collaboration ability data was obtained through two methods, namely self-assessment and observation. The research results from Figures 1.4 and 1.5 show that the collaboration ability of treatment class students has increased in each indicator, both in self-assessment and observation. The indicator of collaboration ability of treatment class students with the highest score in the self-assessment is the flexible indicator, while on the observation sheet it is the indicator of mutual respect. The difference in the average collaboration score between the treatment and control classes was obtained through the Independent Sample t-test or the Mann Whitney test (nonparametric test). The results of the Mann Whitney test obtained the Asymp value. Sign (2-tailed) $(0.00) < 0.05$ (see Table 3.21) which means there is a difference in the average collaboration ability of students who apply interactive teaching materials and students who use school textbooks. The N-Gain score for the treatment class was 0.46, which is included in the medium criteria (see Table 1.3).

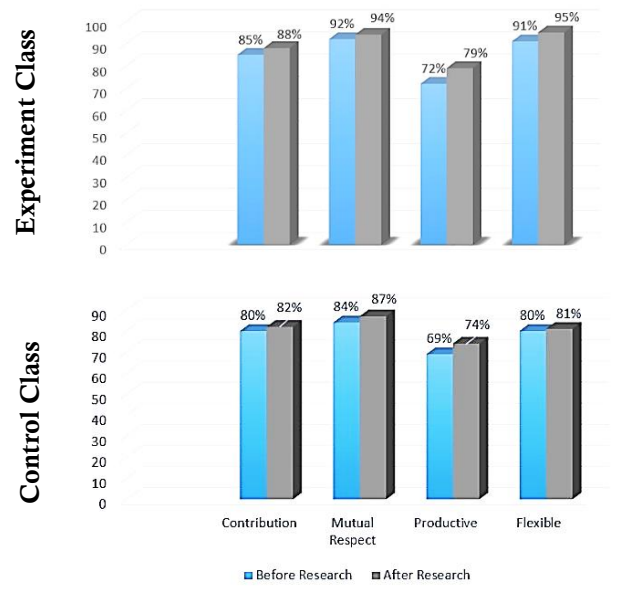


Figure 1.4 Level of collaboration ability of students in each treatment class and control class the indicator is self-assessment

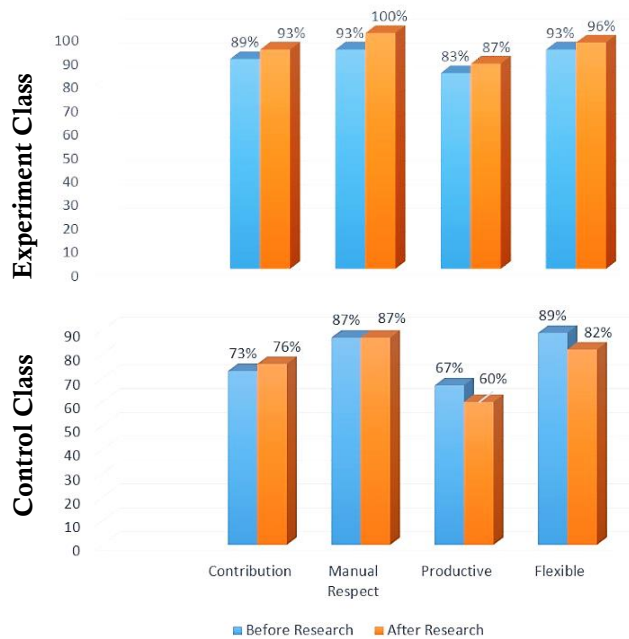


Figure 4.5 Level of collaboration ability of treatment class and control class students for each indicator on the observation sheet

Table 4.3 Results of the N-Gain score test for collaboration abilities

N-Gain Score	Experiment Class (using Discovery Learning Model)		Control Class (using Conventional Learning Model)	
	PD	Obv	PD	Obv
Highest	1.00	0.80	1.00	0.80
Lowest	-0.67	-0.67	-2.67	-0.20
Average	0.5	0.46	0.05	0.36

Description: PD: self-assessment and Obv: Observation

Aspects of the flexible indicator consist of students being willing to cooperate with group members and students always helping other members who are experiencing difficulties. Discussion sheets and student worksheets contained in interactive teaching materials are integrated with Canva with a more interactive and less monotonous display. Learning activities in the sub-material structure and digestion mechanisms ask students to work in groups to discuss questions on differentiated discussion sheets. During discussions, students interact with each other and help each other when they encounter difficulties so that the questions on the discussion sheet can be filled in. This discussion activity helps students to socialize with classmates and increases mutual respect between friends in the same class. The types of questions on student discussion sheets and worksheets are differentiated in the form of auditory, visual and kinesthetic question types according to the results of the student's diagnostic analysis. When working on discussion sheets, students actively discuss with fellow group members because the types of questions match students' interests. The indicator with the smallest percentage is productive, namely the aspect that students are able to answer questions rationally. The large capacity of interactive teaching materials means that interactive teaching materials can only be accessed when the internet signal is smooth and the quota required is large enough. This causes students not to be able to open teaching materials too often so that students' understanding of concepts is less than optimal. This less than optimal understanding of the concept has an impact on students' inability to answer questions correctly and rationally. Priana & Pebryansyah, (2023) said that the application of electronic modules in informatics project learning succeeded in increasing the average score of students' collaboration skills by 41.5% and the completeness of student learning outcomes by 68%. The application of interactive teaching materials based on Discovery Learning on digestive system material can help improve students' collaboration abilities with the improvement category being moderate.

The learning implementation data in the treatment class is guided by the learning syntax of Discovery Learning, specifically Guided Discovery Learning. The results of the analysis of the implementation of each Discovery Learning syntax are in Table 1.4. The learning syntax that was implemented quite well included apperception, namely inviting students to recall previous material, problem statements (formulating problems), and reviewing (see Table 4.4). The value of learning implementation for each meeting is listed in Table 1.5 in the good category, thus it can be said that the implementation of learning using Discovery Learning syntax in the treatment class is said to be successful.

Table 4.4 Implementation of learning based on Discovery Learning syntax

Sintaks	Value (%)	Criteria
Orientation	100	Good
Apperception	80	Pretty Good
Motivation	90	Good
Providing References	100	Good
Stimulation	93	Good
Problem Statement	80	Pretty Good
Data Collection	93	Good
Data Processing	100	Good
Verification	90	Good
Generalitation	87	Good
Review	80	Pretty Good
Evaluation	100	Good
Follow-Up	100	Good

Table 1.5 Implementation of Discovery Learning learning at each meeting

Meeting On	Learning Implementation Value	Criteria
1	92%	Good
2	93%	Good
3	92%	Good

The results of the analysis of learning implementation in Table 4.5 show that the learning syntax of Discovery Learning can be implemented well by 77% and the syntax is implemented quite well by 23%. Learning about the digestive system material was carried out in four meetings with a total of 10 lesson hours. The material discussed at the first meeting on January 9 2024 was the structure and mechanisms of digestion. At this first meeting, the learning activities carried out were a pre-test, distribution of links to Discovery Learning-based interactive teaching materials to students, delivery of material concepts on structure and mechanisms of human digestion, student discussions, and presentation of student discussion results. Discussion activities help students form their own knowledge through the experience of discovering concepts in groups (Nursyahrobby & Bakar, 2022). Discussion activities allow students to interact to help each other if they encounter difficulties (Sofyan, 2021). The second meeting on January 23 2024, the material studied was food substances and their functions. The learning series carried out included providing links to student worksheets, food testing practicum, and presentation of practicum results. During practical activities, students were very enthusiastic about testing several food ingredients that they were interested in. Practical activities facilitate students to discover material concepts through experiments, so that the concepts obtained can enter long-term memory (Mukaramah *et al.*, 2020). At the third meeting on January 30 2024, the learning activity carried out was the presentation of students' practicum products. The results of students' practicum at the second meeting are packaged in practicum products in the form of power points, videos or posters. Students are given the freedom to choose the practical product they will make. At this third meeting, the entire group can present their practical products in front of the class. At the fourth meeting on February 1 2024, learning activities could not be carried out, this was due to socialization activities that class XI students had to take part in for two class hours. At this fourth meeting, students only submitted assignments to write papers related to digestive system disorders in accordance with the guidelines included by researchers in interactive teaching materials. At the end of the meeting, the researcher gave a posttest to students to measure students' critical thinking abilities. The Discovery Learning model which is integrated with differential learning is considered capable of increasing students' motivation and collaborative abilities, this is because the Discovery Learning model which is integrated with differential learning provides wider space for students to actively discover material concepts in groups (Basir *et al.*, 2023). In Table 4.6 it can be seen that the percentage of learning implementation from the first to the third meeting falls within the good criteria, namely 92%, 93% and 92%. The implementation of good learning in this research is in line with the results of research conducted by Yulianti *et al.*, (2023) which is characterized by the achievement of learning objectives by students, namely in the learning process students are active in interpreting, analyzing and explaining the concepts of the material presented.

CONSLUSION

The application of interactive teaching materials based on Discovery Learning material on the human digestive system can improve critical thinking skills, learning motivation and collaboration abilities of class XI MIPA students at SMAN 4 Semarang in the high and medium improvement categories.

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