The Application of Discovery Learning Model Assisted by Multi-Representation-Based Teaching Materials on Ecosystem Materials to Improve Students' Critical Thinking Ability and Independent Learning Attitudes

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Article Info	Abstract
	The purpose of this study is to analyze the effectiveness of the discovery learning assisted by teaching materials based on multi-representation to improve students' critical thinking skills and independent learning attitudes. The research applied used a pre-experiment type one group pretest-posttest design. The population in this study were students of class X MIPA SMA N 1 Kayen for the academic year 2020/2021. The samples in this study were students of class X MIPA 2 and X MIPA 7. The results showed that the two sample classes experienced an increase in critical thinking skills of 0.54 in the medium category and an increase in independent learning attitudes by 0.45 in the medium category. Before treatment, the pretest results were obtained with the results of 1.39% being a very critical category, 9.72% critical, 38.89% quite critical, and 50% less critical. After being treated with the application of the discovery model with multi-representation-based learning tools, the post test results showed that 26.39% of students were in the very critical category, 61.11% in the critical category, and 12.5% in the moderately critical category. From the results of the N-Gain test, students experienced an increase of 18.06% in the high category, 65.28% in the medium category, and 16.67% in the low category. Classically, 81.94% of students complete the KKM. The independent learning attitude of students has increased by 0.45, namely in the medium category. Students experienced an increase of 18.03% in the high category, 63.89% in the medium category, and 18.06% in the low category. Before learning, 25% of the students were in the very independent category, 63.89% of the students were in the independent category, and 11.1% of the students were in the moderately independent category. After learning, 80.56% of students in the very independent category, 18.05% of students in the independent category, and 1.39% in the moderately independent category. Based on the results of the study, it can be concluded that the application of the discovery learning with multi-representation-based learning tools on ecosystem materials is effective for improving students' critical thinking skills and independent attitudes.

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INTRODUCTION

The emergence of the Covid pandemic in 19 had an impact on the implementation of teaching and learning activities. The implementation of learning needs to be arranged according to the current conditions. Learning is still carried out, namely remotely. In these conditions, teachers and students need to prepare and adapt. The facts found in the implementation of distance learning are that the teacher gives teaching materials, explains the material, and gives some assignments. Students receive teaching materials, listen or listen to the teacher's explanations, and do assignments. This condition places students to learn independently, namely managing their own learning activities and not depending on the teacher, for example looking for additional learning resources, preparing study plans, and understanding subject matter. The ability to think that is important to have is the ability to think critically. As stated in the 2013 curriculum objectives, namely to equip students with the ability to think logically, analytically, systematically, critically, creatively, and be able to work together (Sari et al., 2017). Critical thinking is one of the 21st century skills that is implemented in the 2013 curriculum objectives.

21st century skills can be achieved through the application of learning models which include discovery learning, inquiry learning, problems based learning, and project based learning. In practice, there is still learning that is one-way so that it has not trained students to develop their thinking skills. Each individual has different critical thinking abilities according to his experience in using his thinking skills. The ability to think critically is one of the things that can be used for problem solving. Critical thinking involves the ability to reason, interpret, and evaluate information related to decision making (Chukwuyenum, 2013). Thus, individuals can independently perform all actions from the results of their own thoughts without relying on others in making a decision.

The results of observations in class X biology learning at SMA N 1 Kayen revealed that biology learning during the pandemic was carried out by means of teachers providing teaching materials, students were given time to study teaching materials, and followed by quizzes. The teacher gives several questions about the material being taught, students answer according to the provisions given by the teacher. Students who answer will get a score. In practice, there are students who only fill out the attendance list and do not take part in the lesson. Learning tends to be passive, there is no discussion, and students are not used to asking questions to the teacher so that they do not hone their critical thinking skills. Several things that cause the students' lack of critical thinking skills are the use of learning models that are less varied, limited learning tools, and learning time in class.

One of the biology subjects that is considered quite difficult by students is ecosystem material. Ecosystem learning in high school requires basic knowledge competencies, namely "analyzing ecosystem components and the interactions between these components, as well as skill competencies, namely presenting works that show interactions between ecosystem components (food webs, biogeochemical cycles)". The scope of the material is quite broad, covering the components of ecosystems, energy flows and ecological pyramids, as well as biogeochemical cycles and ecosystem balance. Biological material deals with scientific facts about concrete natural phenomena and objects abstracts that need to be represented, for example, relate to cycles or processes in the body. The nature objects studied in biology are quite diverse, in terms of size (microscopic and macroscopic), affordability, safety, and language. In terms of size, ecosystem material objects are macroscopic and microscopic judging from its affordability, ecosystem material objects are very broad, such as deserts, tundra, and so on, so that objects need to be represented. Thus, to design biology learning on ecosystem materials, tools or teaching materials are needed that can describe or represent the processes, phenomena, or objects being studied. Characteristics of biological material require skills high-level thinking

Preparing teaching materials that are able to describe or represent biological processes, phenomena, and objects can be done by using various representations such as pictures, tables, diagrams, videos, and so on. Multi-representation is a way of delivering information in a certain format that is able to represent, describe, symbolize objects or processes through pictures, tables, graphs, and mathematics that aims to learn a concept, understand problems, and solve certain problems (Angin et al., 2016). Teaching

materials can be in the form of LKPD, booklets, supplementary teaching materials, and teaching media such as learning videos. In addition to compiling teaching materials, teachers need to develop lessons that can train students to think critically because the characteristics of biological materials require high-level thinking, one of which is critical thinking. Critical thinking skills can be trained through the learning model suggested in the 2013 curriculum, one of which is the discovery learning model. Discovery learning is useful for students, namely helping in understanding concepts, expressing ideas and developing critical thinking skills (S. Wulandari et al., 2018). Discovery learning trains students to learn how to analyze and interpret information so that students can understand what they are learning, not just providing information and memorizing.

Critical thinking is done by connecting concepts and information that they already have, not just memorizing and remembering. Concepts are obtained by students in learning activities through their thinking skills. Students build their knowledge through their learning experiences through discovery learning teaching materials multi-representation so that students can practice critical thinking skills and independent learning. Independent learning of students is constrained by the implementation of teacher-centered learning. Teachers should be more creative in choosing learning models by making students the center of learning activities. Learning independence makes students able to learn better, manage their learning activities more effectively, can control and direct themselves in thinking and doing an action, and not relying on others.

Distance learning activities on ecosystem materials are more meaningful when learning activities are carried out by applying discovery learning assisted by multi-representation-based teaching materials so that the authors conducted research on "the application of discovery learning assisted by multi-representation-based teaching materials on ecosystem materials to improve critical thinking skills and independent learning attitudes of students".

RESEARCH METHOD

The research was conducted at SMA N 1 Kayen for the academic year 2020/2021. The population of this study were students of class X MIPA SMA N 1 Kayen. Sampling was done by purposive random sampling. The sample in this study were students of class X MIPA 2 and X MIPA 7 with the total sample being 72 students. The data were analyzed quantitatively that is Critical thinking skills and independent attitudes analyze using Gain Test and Classical Completeness, and Spearman's Rho Correlation Test for analyze correlation of critical thinking and independent attitudes, and analyzed percentage indicators of critical thinking and independent attitude, whereas teacher responses, and student responses were analyzed classically using quantitative descriptive. The research was conducted online through the Microsoft Teams.

RESULTS AND DISCUSSION

The purpose of this study was to determine the effectiveness of discovery learning with multi-representation-based learning tools on ecosystem materials to improve students' critical thinking skills and independent learning attitudes. The applied learning can be said to be effective when it meets the predetermined effectiveness criteria, namely >75% of students complete the KKM, which is 72, the gain score is in the moderate to high category, and >75% of the students are in the very independent category.

Critical Thinking Of Students

Data on critical thinking skills were obtained from the results of the pretest and posttest which were analyzed using the n-gain test and classical completeness. The results of the n-gain test can be seen in table 1.

Table 1. N-Gain test results for critical thinking

Sample	Class X MIPA 2 and X MIPA 7
Average Gain Score	0.54

Average Gain Score Criteria Average	Total	
	Percentage	(%)
Gain Score Criteria "High"	13	18.06
Gain Score Criteria "Medium"	47	65.12
"Low" Gain Score Criteria	12	16.67

The gain test results show that the learning applied to the sample is effective for improving critical thinking skills because the sample class gets an average gain score of 0.54 which is the medium category with a percentage of 65.28%. The results of the classical completeness analysis can be seen in table 2

Table 2. The results of the classical completeness analysis

Component	Pretest	Posttest
Highest Average Score	81.67	95.83
Lowest Average Score	28.33	45.83
Sum Of Students Completed	2	59
Sum Of Students Who Did Not Complete	70	13
Classical Completeness (%)		81.94

Based on the results of classical completeness analysis, from the post-test results, students who completed the KKM experienced an increase of 59 students or 81.94% of students completed the KKM 72. Percentage of the category of critical thinking skills from the students' pre-test and post-test can be seen in the table below.

Table 3 Percentage of Critical Thinking Ability

Category	Pretest Category (%)	Posttest (%)
Very critical	1,39	26,39
Critical	9,72	61,11
Fairly Critical	38,89	12.5
Less critical	50	0

Table 3 shows that there is an increase in criteria critical thinking before learning as seen from the results of the pretest with the criteria of critical thinking after learning as seen from the results of the posttest. Before learning, students' critical thinking categories include very critical, critical, moderately critical, and less critical. After learning the critical thinking category of students includes very critical, critical, and quite critical with the results of the analysis of the indicators used are as follows.

Table 4 Analysis of Critical Thinking Ability Indicators.

Indicator	Pretest (%)	Posttest (%)	Difference (%)
Focusing questions	58.06	91.53	33.47
Induce and consider induction results	51.8	85	33.96
Consider reliable sources or not	39.44	77, 78	38.33
Considering an action	36.18	57.92	21.74

Table 4 shows that the applied learning has the most effect on increasing indicators considering reliable sources or not, which is marked by the highest difference between pretest and posttest , which is 38.33 while the indicator determines an action to obtain the lowest difference in pretest and posttest scores, namely 21.74.

Table 1, table 2, table 3, and table 4, show that the application of the discovery learning assisted by multi-representation-based teaching materials can affect students' critical thinking skills. The post-test results showed that students experienced an increase in critical thinking criteria. This is because students have been trained to think critically in learning activities. Discovery learning steps consisting of stimulus, problem identification, data collection, data processing, verification, and generalization can train students to use their thinking skills in finding important concepts or information and encourage students to participate more actively in learning activities. The use of multiple representations in learning can make it easier for students to understand the material because students can practice their ability to process information from various forms of presentation such as graphs, pictures, tables, or videos. In practice, the teaching materials used include power points, booklets, teaching supplements, videos, and student worksheets (LKPD). LKPD, compiled using discovery learning steps as a guide for students in discussion

activities, which includes pictures as a stimulus. Tables, schemas, or mind maps are used at the data processing stage. Discussion activities can train students to be active and responsive in participating in learning (Salter & Conneely, 2015).

The stimulation stage is carried out so that students can explore teaching materials that present text and images to stimulate students' initial knowledge about the topics to be studied, for example pictures of several ecosystems (coral reef ecosystems, rice fields, and tropical rainforests), pictures of flowers and bees as representations of forms of interaction of living things, pictures of several biotic components that make up an ecosystem, and pictures of rain used to represent one of the biogeochemical cycles, namely the hydrological cycle. Through the use of multi-representation teaching materials, students are directed to focus on the topic being studied, for example at the stimulation stage, students are presented with several pictures of ecosystems and forms of interaction of living things to answer questions during the problem identification stage. The teacher directs students to identify the components of the ecosystem from the pictures presented, including rice field ecosystems, coral reef ecosystems, tropical rainforest ecosystems, and desert ecosystems. Students are trained to focus on questions and consider the answers given. Students provide answers about ecosystem components based on what they see in the picture, some even add ecosystem components which, according to students' thoughts, are in the presented ecosystem. For example, in the image of a rice field ecosystem, only plants, soil and sunlight can be seen. Students mention components other than ecosystem components that can be seen from the picture and may exist in the rice field ecosystem such as water, stones, worms, birds, frogs, and so on. Thus, the use of images in learning ecosystem components can stimulate thinking skills to consider criteria in answering or focus on questions when students identify ecosystem components and outline the interactions of living things through multi-representational teaching materials. Problem identification provides opportunities for students to express ideas in the form of hypotheses. When collecting data, students are trained to consider sources that can be trusted or not by means of students being given the freedom to collect relevant information from books or the internet which then in the data processing stage, students are trained to present the information obtained in certain representations. for example a table of differences in biotic and abiotic components, a food chain schematic, an ecological pyramid drawing, and a mind map of one of the biogeochemical cycles. Then at the verification stage, the teacher directs the discussion by asking questions. Students provide answers or arguments for these questions.

As revealed by Syafii et al., (2014) that in discovery learning, the teacher guides students in finding concepts. Finally, in the generalization stage, students make conclusions from what they have learned. Students make conclusions from general things being studied, namely at the generalization stage, for example at the first meeting, students identify the components that make up the ecosystem through a series of *discovery learning syntax.* During the generalization stage, students make conclusions about ecosystem components based on their identification results so that at the end of the lesson, students can distinguish between biotic and abiotic components. During the second meeting, students were presented with multi-representation teaching materials, namely teaching supplements and LKPD. The teaching supplement presents images and text to present information. LKPD presents a picture of the components that make up the ecosystem, which students are then asked to draw up a food chain scheme, food web, and draw an ecological pyramid which includes a pyramid of quantity, biomass, and energy. During the generalization stage, students are asked to make inferences from the sub-materials of energy flow and ecological pyramids so that at the end of the lesson, students can arrange and distinguish food chains, food webs, and ecological pyramids. Therefore, multi-representational teaching materials used in *discovery learning* help students' thinking processes to induce and consider the results of induction. In the test instrument, students are given five pictures of patterns or types of interactions between living things, then students determine the type of interaction and give reasons. Through drawing conclusions, students can improve their thinking skills (Santoso, 2015).

Based on table 4, it can be seen that each indicator critical of thinking has increased. The critical thinking indicator that experienced the most improvement was the indicator considering reliable sources or not, from 39.44% to 77.78% with a difference of 38.33%. The increase occurs because when students collect

and process data about ecosystem materials, multi-representation teaching materials are presented in the form of text, images, tables, schematics, and mind maps. Text is used to explain the topic of ecosystems, pictures are used during the stimulation stage to stimulate students' thinking and represent an ecological pyramid, schematics are used to construct food chains, and mind maps are used to represent students' understanding of biogeochemical cycles. For example, on the topic of ecosystem components during the data collection stage, the teacher provides opportunities for students to seek information through various sources of information, both printed books and from the internet. Students of course choose which sources of information are used as references, which are then summarized when processing data. On the topic of ecosystem components, students are asked to complete a table of differences in biotic and abiotic components and the form of interaction between ecosystem components based on the data that has been collected. When it comes to energy flows and ecological pyramids and the topic of biogeochemical cycles, students collect data in the same way as the topic of ecosystem components. Furthermore, at the data processing stage, students were asked to make several food chain schemes and draw an ecological pyramid from one of the food chains that had been made and on the topic of biogeochemical cycles students made a mind map of one of the biogeochemical cycles. Thus, the use of multi-representation teaching materials helps students to process and process the information that has been obtained during the data collection process. Furthermore, *pretest* and *posttest* presented are for students to describe their opinions about the causes of reduced energy at the trophic level and the effect if there is an addition or subtraction of living things in a trophic level based on pictures of food webs.

The critical thinking ability that has increased the least is an indicator of determining an action, from 36.18% to 57.92% with the lowest percentage difference of 21.74% teaching materials multi-representation form of learning videos from YouTube, only presented in the form of links placed in the LKPD. During learning activities, videos about biogeochemical cycles have not been presented directly so that students are limited to studying LKPD and booklets. The indicator determines an action has not been taught through discovery learning syntax. The teacher has not provided a stimulus in the form of a learning video and the teacher has not directed students to see the learning video first. Students are directly directed to open LKPD. Indicators determine an action taken by students when answering questions at the end third which learns about biogeochemical cycles and ecosystem balance because the questions are prepared based on critical thinking indicators, namely determining an action. In the pretest and posttest, students are asked to make a mind map about the biogeochemical cycle, provide solutions to prevent or reduce the impact if the Sum of plants decreases, provide arguments about the role of living things in the biogeochemical cycle, provide solutions or prevention of the impacts of deforestation, and provide arguments about the relationship between biogeochemical cycles and ecosystem balance. Outside of learning activities, indicators determine an action can be carried out independently by students, for example after the teacher provides teaching materials, students can study them first so that students have prior knowledge before learning activities while the process can only be done with the awareness of each students. Therefore, the applied learning needs to be designed by considering the discovery learning and indicators of critical thinking skills that have been determined.

The application of discovery learning assisted by multi-representation-based teaching materials can improve students' critical thinking skills. This is supported by a questionnaire of student responses related to the implementation of learning, students to think quickly and precisely, train to understand concepts, understand the material, and train their thinking skills. Each critical thinking indicator used, has been trained during learning activities. Indicators focusing on questions are part of the aspect of providing simple explanations trained at the stimulation stage and problem identification at the first meeting. Indicators considering sources that are reliable or not are part of the aspect of building basic skills, trained at the stage of collecting and processing data in the first, second meetings, and the three indicators inducing and considering the induction results are part of the aspect of concluding, the sub-indicators used are stating general things, having been trained at the generalization stage at the first, second, and third meetings, where students make conclusions from what they have learned. The indicator of considering an action is part of the aspect of determining strategies and tactics, which are trained when students answer questions at

the end meeting, with sub-indicators, namely formulating alternative solutions. If applied to everyday life, examples can be taken when students are given teaching materials, of course there are students who immediately learn teaching materials and some who ignore so that it can be seen in discussion activities.

Rachamatika et al., (2021) stated that critical thinking skills do not arise by itself so that teachers need to make efforts so that students get learning experiences. Lalang et al., (2017) stated that critical thinking and concept understanding are connected abilities. Therefore, students need to be trained to find concepts independently to build critical thinking skills. The use of multiple representations can influence students in finding concepts and building their own knowledge. Information can be presented in several representations but the concept of the material is not given directly. Students need to use their thinking skills to find a concept. Thus, the information received is easily understood and stored for a long time by students. Informative learning, meaning that students are directly given the information they need, so what they learn will be easy to forget.

Information processing theory explains that the source of information is captured by the senses. All forms of information are responded to through a coding process. The result is short term memory. If there is no repetition of information then the information is easily lost or forgotten. If there is repetition of information then the information can survive in memory. Therefore, the presentation of information or sources of information presented in the form of images, videos, or diagrams, is more easily coded by students so that the information obtained can last longer in memory. Multi-representation can be used to improve critical thinking skills.

Teaching materials multi-representation also affect the increase in critical thinking skills. From the student responses questionnaire, it can be seen that the teaching materials are quite diverse and provide various representations, which are easy to learn and understand. Presenting information in various representations can train students to use their thinking skills. As information processing theory explains that information captured by the senses is then responded through a coding process. The result is short-term memory. When information is lost, the information is retained in memory. Critical thinking skills emerge through meaningful learning efforts (Rachamatika et al., 2021). Learning principle or law Thorndike states that learning will be successful if students have readiness, practice a lot, and repeat what they get. The results of research by Kalsum et al., (2019) stated that students' critical thinking skills increased after going through discovery learning using multiple representations. Because the stages in discovery learning can support and stimulate students' critical thinking skills (Ikalor et al., 2019). Teaching materials Multi-representation can be used to improve thinking skills (Khotimah et al., 2017).

Independent Learning Attitudes of Students

Data on independent learning attitudes were obtained from a questionnaire on the independent attitudes of students which were distributed via Google form and carried out before and after the implementation of learning. The questionnaire data was then analyzed to determine the category of students' independent learning attitudes. The category of independent attitude of students can be seen in table 5.

Table 5 Category of independent attitude of students

Independent attitude category	Sum of students		Percentage (%)	
	Before	After	Before	After
Very Independent	18	58	25	80.56
Independent	46	13	63.89	18.06
Sufficient Independent	8	1	11.11	1.39
Less Independent	0	0	0	0.00
Total	72	72	100	100

From table 5, it can be seen that before treatment, the most categories were independent. After treatment, most categories were very independent. Next, the N-gain test was carried out to determine the magnitude of the increase in independent learning attitudes which can be seen in table 6.

Table 6. N-Gain test results for independent learning attitudes

Category	Total	Percentage (%)

High	13	18.06
Medium	46	63.89
Low	13	18 .06
Average Gain Score		0.45

Based on table 6, it shows that after being given treatment, both classes obtained an average gain score in category. Classically, the results of the analysis can be seen in table 7.

Table 7 classical completeness test results

Category	Amount	
	Before	After
Very Independent	18	58
Independent Students	46	13
Sufficient Independent	8	1
Less Independent Students	0	0
Classical completeness	80.56	

The results of the gain and classical completeness test analysis showed that the application of the discovery learning with multi-representation-based learning tools can improve the independent learning attitude of students with the category of "medium" gain score and classical completeness of 80.56%. Aspects of independent learning attitude used are self-confidence, responsibility, initiative, and decision making. The results of the analysis per aspect of independent attitudes can be seen in table 8.

Table 8 Analysis of aspects of independent learning attitudes

No	Aspects Assessed	Average Percentage		Difference
		Before	After	
1	Confident	72.59	78.38	5.79
2	Responsibilities	76.57	86.20	9.63
3	Initiatives	74.44	82.50	8.06
4	Decision Making	75.05	86.81	11.06

Table 5 shows that applied learning can improve students' independent learning attitudes, the highest is in the aspect of decision making and the lowest is aspects of confidence, seen from the difference in the average percentage before and after the implementation of learning.

The application of discovery learning assisted by multi-representation-based teaching materials on ecosystem materials can improve students' independent learning attitudes, which is indicated by >75% of students being in the category of very independent attitudes and increasing the percentage of each aspect (Table 8). The aspect of self-confidence increased the least because it was still seen that students copied their friends' answers when answering the teacher in apperception and discussion activities. Aspects of responsibility increase because students when participating in learning are trained to answer quiz questions and discussions according to the time limit given. The initiative aspect has increased because when learning at the verification stage of the second meeting, students were asked to show a picture of the ecological pyramid and the verification stage at the third meeting, which was to show a mind map of one of the biogeochemical cycles that had been made. The decision-making aspect has increased the most because students at the stage of collecting and processing data are trained to choose sources of information that are used as references to understand the concepts of the material being taught.

Aspects of self-confidence are trained when the teacher provides motivation so that students continue to study well. The self-confidence aspect is also trained when students give opinions and answer teacher questions in apperception and discussion activities. Aspects of responsibility are trained when students complete assignments on time and participate in learning on time. The initiative aspect is trained when students ask for material or assignments that are not understood, draw conclusions from the results of discussions, and convey reflections without being appointed by the teacher.

The Confidence aspect increased from 71.9% to 79.6%. When students have high independence, self-confidence appears (Egok, 2016). Aspects of responsibility increased from 76.6% to 86.3&. The characteristics of responsible students are being able to complete tasks without the help of others, not

delaying time and being able to solve their own problems (Hendrayana, 2014). The initiative aspect increased from 74.9% to 82.9% and the decision-making aspect increased from 74.2% to 84.8%.

The gain test results show a change in independent learning attitudes in the "medium" category. This is related to the implementation of distance learning which has been going on for more than a year. During this time, students have gradually adapted to distance learning. The limited learning time in class is able to foster an independent learning attitude. Applications online to facilitate distance learning can increase learning independence (Oknisih et al., 2019).

In practice, learning is carried out through the Microsoft Teams in a non-interactive or asynchronous manner. The teacher provides teaching materials one day before the learning takes place so that students can prepare themselves for the material to be taught. When learning begins, the teacher enters the virtual, gives an introductory sentence as an opening for learning activities, checks the attendance of students, and continues with a quiz. Students who answer quiz questions get a score liveliness. Followed by students are directed to open student worksheets (LKPD) for discussion activities to closing activities. Students get one score each when answering quizzes, participating in discussions, and making conclusions at the end of the lesson. When learning takes place, there are some students who are late and there are students who take part in learning at the beginning and at the end. This is related to the low motivation to learn and the obstacles faced by each student, such as an unstable internet network.

In the learning process, the teacher has facilitated teaching materials that aim to make students have the willingness to learn and better prepare themselves to learn. Activity the preliminary furthermore, in the core activities, the stage of stimulation, verification, and generalization, students are trained to be confident in expressing opinions or answers to a question. Through discovery stages, students are trained to build their own knowledge, especially during discussion activities. Discussion activities can increase self-confidence (Ikalor et al., 2019). At the end of the lesson, students have the responsibility to complete and collect LKPD. This is so that students can review what they have learned. When experiencing difficulties, students will practice making decisions to ask others or find answers on their own through additional learning resources.

Discovery learning can increase the independence of students (Meylinda & Surya, 2017). Discovery learning trains students to be independent in finding solutions to problems, train thinking skills, and provide self-confidence (Hermawati & Andayani, 2020). Students are active learners in building their own knowledge so that learning independence increases (Anis, 2017). Through discovery learning, students are expected to be able to think critically and store information for a long time because students are involved in concept discovery and achieve independent learning (Wulandari, 2016). The sum of students in the critical thinking gain score category high, medium, and low, has a difference with the gain score category for independent learning attitudes. The relationship between critical thinking and independent learning was analyzed using the Spearman's Rho correlation test based on the posttest and the final data of independent attitude. The result is as follows.

Table 9 Correlation Test Results of Critical Thinking and Independent Attitude Learning

			Critical Thinking	Independent Learning
		Correlations		
Spearman's rho	Critical Thinking	Correlation Coefficient	1,000	.393**
		Sig. (2-tailed)	.	.001
		N	72	72
	Independent Learning	Correlation Coefficient	.393**	1,000
		Sig. (2-tailed)	.001	.
		N	72	72

**. Correlation is significant at the 0.01 level (2-tailed).

The results of the correlation analysis showed a significance of 0.001 < 0.005, meaning that there was a correlation between critical thinking and independent learning attitudes with a correlation coefficient of 0.393 indicating a sufficient relationship between critical thinking and independent learning attitudes in table10

Table 10 Differences in Critical Thinking Gain Score Category and Independent Learning Attitude

Category Gain Score		Number of Students
Critical Thinking	Independent Attitude	
High	High	2
High	Medium	8
High	Low	3
Medium	High	9
Medium	Medium	31
Medium	Low	7
Low	High	2
Low	Medium	7
Low	Low	3
Total		72

Table 10 shows that students whose critical thinking skills are in the high to medium score category, have an independent learning attitude in the low, medium and high. Cognitive learning theory, learning outcomes are not only changes in behavior but changes in perception and understanding. Learning is not just a stimulus and response relationship, learning is a complex thought process, in which there are barrier variables on aspects of one's cognition.

Critical thinking is a cognitive ability that needs to be trained repeatedly while there are habits that affect the learning process of students. These habits can be in the form of learning and daily activities such as postponing a job because there is another job. As the results of experiments conducted by Pavlov, one of the figures who played a role in behavioristic theory stated that in learning, repeated practice is needed, while the habits inherent in a person can affect the learning process (Abdurakhman et al., 2015).Thinking ability is related to a person's level of intelligence while attitude is related to daily habits and experiences. There are factors that affect the cognitive and affective aspects of a person. The ability to think critically as a cognitive aspect and an independent learning attitude as an affective aspect are two different things. Critical thinking is influenced by several things, not only independent learning (Sulviana & Pasaribu, 2021). Critical thinking as a learning outcome is influenced by several things, such as the level of intelligence, learning methods, and infrastructure (Rahmayani, 2019). Critical thinking skills can be improved through the relationship between application discovery learning, intellectual level, and subject matter (Forawi, 2016). Discovery learning can affect critical thinking skills by considering factors that influence students' learning desires (Dafrita, 2017). Critical thinking ability is related to logic and intelligence level while learning independence is related to learning motivation (Afandi et al., 2012). So it can be said that the independent learning attitude does not have a significant effect on critical thinking skills or the effect is weak. There are factors outside of learning that indirectly affect the conditions and learning motivation of students. Associated with affective, attitude or behavior is not formed suddenly but started since childhood. Parenting patterns of parents or family have an important influence on the independence of a child.

There are two factors that influence a person's attitude, namely exogenous factors such as family and endogenous factors such as motivation, study habits, and physical conditions (Mulyadi & Syahid, 2020). Likewise, cognitive abilities are influenced by several things, namely heredity, environment, physical and psychological maturity, and freedom of thought (Oroh et al., 2020). Learning is something that happens naturally under certain conditions. The conditions in question are internal conditions such as self-preparation, while external conditions such as learning situations that have been designed by the teacher (Pane & Dasopang, 2017). Gagne in his learning theory states that learning is influenced by individuals and the environment in the form of family, friends, and society.

Through discovery learning steps, students are directed to find knowledge and the teacher acts as a facilitator. The use of LKPD, which is prepared in a discovery format, is used as a discussion guide so that students can build their own knowledge through the active learning process. The use of multi-

representation helps students process the information obtained because the sources of information presented in several forms of information presentation will be given more attention. Thus, students who are trained to build their own knowledge will experience changes, both abilities and behavior.

Constructivism theory assumes that humans construct and interpret knowledge through their own experiences. The essence of constructivism learning is that students individually find and transfer information to form their own knowledge (Rifa'i & Anni, 2016). In this case, the cognitive structure plays a role in giving meaning from experience to the information obtained. According to Bruner, the essence of effective education is the independence of students. The essence of constructivism learning is an active learning process because understanding comes from each individual (Sugrah, 2020).

CONCLUSION

Based on the results and discussion, it can be concluded that the application of the discovery learning with multi-representation-based learning tools on ecosystem materials effectively increases students' critical thinking skills is the medium category with the percentage of classical completeness that is 81.94% and effectively improves the independent attitude of students is the medium category with the percentage of classical completeness that is 80.56%.

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