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Biological Science Curriculum Study 5E Model Based on Multiple Representations in Ecosystem Materials on Problem Solving and Metacognitive Abilities

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Abstract

This study analyses the students' problem solving and metacognitive abilities by applying the BSCS 5E model based on multiple representations to ecosystem material. This research is a pre-experiment using the One-Shot Case Study design. The methods used in data collection include tests, interviews and questionnaires. The results showed that the problem-solving ability was in the "medium" category with an average score of 58.8 and the students' final score was in the "medium" category with an average of 60.4. Metacognitive abilities are in the "ok" category. The study journal is in the "high" category. Also the implementation of the learning model is in the "high" category. The calculation results obtained rcount = 0.509 while rtable with dk = 65 and a significant level of 5% is 0.244. Because rcount> rtable, HO reject and accept H1 means a significant relationship between problem-solving and metacognitive abilities. Contribution of problem-solving abilities to metacognitive abilities was 26%. Based on the results of the study, it can be concluded that the students ' problem-solving abilities are in the "medium" category and the students' metacognitive abilities are "ok" by applying the BSCS 5E model based on multiple representations on ecosystem material.

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INTRODUCTION

21st-century skills have recently become a much-discussed topic; demanding various skills must be mastered by people. Specific skills that need to be empowered include critical thinking skills, problem-solving, metacognition, communication, collaboration, innovation and other skills. In line with this, the Ministry of Education and Culture formulates that the 21st-century learning paradigm emphasizes the ability of students to find out from various sources, formulate problems, think analytically and collaborate and collaborate in solving problems (Litbang Kemendikbud, 2013).

Education in Indonesia currently uses the 2013 curriculum. The focus of the 2013 curriculum is to encourage students or students to be better able to observe, ask, reason, and communicate (present) what they get or know after receiving learning material at school (Anwar, 2014). Biology itself is a part of Natural Sciences (IPA) which deals with finding a concept systematically and scientifically related to understanding concepts and principles. Biology must teach lessons that allow students to develop their own abilities and build their own concepts. Based on the results of observations, there were not many teachers in implementing the problem-solving abilities, this was evidenced by not many lessons containing an analysis of problem-solving abilities, so researchers tried to provide evaluation questions to students in the form of problem-solving analysis. Problem-solving can improve students' scientific attitudes in the learning process so that problems can be solved or resolved and are appropriate to be applied in scientific biology learning as one of the 21st-century skills demands. Also, problem-solving learning can be used to develop students' metacognitive abilities. Metacognitive abilities are believed to play an important role in many cognitive activities, including understanding, communication, attention, memory, and problem solving (Kusumaningtias, 2013).

The problems that arise so far students still have difficulty relating what they learn to their surroundings and solving problems. An ecosystem is a material that requires a special representation because it relates to energy flow, biogeochemical cycles, and interactions. Students need a special delivery so that the ecosystem material can be understood by students, easily applied in the surrounding environment, and easier to find solutions to problems because it is related to everyday life. Choosing the right learning model can make it easier for students to understand the material presented. One of the learning models suitable for achieving these goals is the BSCS 5E (Biological science curriculum study 5E) model. The BSCS 5E instructional model has wide acceptance, indicating that its instructional design to develop 21st-century skills is strongly supported by science educators and science teachers (Bybee, 2009). Learning that is suitable for the BSCS 5E model is multiple representations that combine text, images and graphics. Learning with multiple representations is expected to bridge students in understanding biological concepts and reduce student difficulties in learning.

RESEARCH METHODS

The research was conducted in class X students in the even semester of the 2019/2020 school year. The study population was all class X IPA students in 2019/2020. The research sample was class X IPA 2 and X IPA 5, taken by purposive sampling. This type of research is pre-experimental with the One-Shot Case Study's research design in which one group is treated, and the results are observed. Data collection methods used include tests, interviews and questionnaires. The data analysis method used in this assessment was in the form of a learning model feasibility. It consisted of teacher response questionnaires, student responses, and a quantitative descriptive learning implementation questionnaire. Also, it analyzed problem-solving abilities. Metacognitive abilities in learning journal assessments and metacognitive questionnaires entered into a categorization. Besides, the correlation table between variables is descriptively quantitative.

RESULTS AND DISCUSSIONS

This study aimed to analyze the students' problem solving and metacognitive abilities by applying the BSCS 5E model based on multiple representations of ecosystem material. Students were declared to be in the "high" category if the average value of problem-solving ability and the final score were in the range of 61-80. Students' metacognitive abilities were said to be effective when the "Ok" category reaches 75%. The learning implementation based on the result of student and teacher questionnaires is in the "high" category.

Multiple Representation Based BSCS 5E Model

The BSCS 5E learning model's implementation based on Multiple Representations in this study was measured using a questionnaire on teacher and student responses along with teacher interviews. The student response questionnaire consisted of 20 statements that have 4 categories of answers, namely Strongly Agree (SS) with a score of 4, Agree (S) with a score of 3, Disagree (TS) with a score of 2 and Strongly Disagree (STS) with a score of 1.

Table 1. The results of categorizing the level of implementation of BSCS 5E based on multiple representations of the experimental class ecosystem material

BSCS 5E level of compliance category		
Implementation of BSCS 5E	**Frequency**	**Percentage (%)**
Low	0	0
Medium	0	0
High	65	100%

The percentage of the frequency of the implementation level of the BSCS 5E model was 100% in the high category. These results indicate that the BSCS 5E learning model runs well. Students still carry out the assigned assignment, this was shown by students who explore the environment around their homes even though learning was carried out online. Students stated that the application of the BSCS 5E model based on Multiple Representations was more helpful in understanding the material. Research conducted by Sari (2015) proves that learning using all three levels of representation can improve high school students' mastery of concepts and problem-solving abilities.

Table 2. Questionnaire of teacher responses to the implementation of the BSCS 5E model based on multiple representations of ecosystem material

Indicators	Score	Total Score
Subject Identity	38	40
Formulation of Learning Indicators and Objectives	16	16
Learning materials	12	12
Selection of Learning Model	15	16
Learning Activities	19	20
Selection of Learning Resources	12	12
Assessment	19	20
Score Acquisition	**91**	**96**

The questionnaire results for the implementation of learning by the teacher obtained a score of 91, which means that the model's implementation is in the high category. Besides, there are also 9 teacher interview sheets. After applying the BSCS 5E model in learning, interviews were conducted with the teacher.

Based on the results of interviews with teachers, it can be said that the implementation of the BSCS 5E model was carried out well. This result follows Ajaja and Urhievwejire's (2012) research, which states that the Multiple Representation-based 5E learning models can also increase students' concept retention of biological concepts. Besides, according to Bahri (2013), the use of multiple representations can help students identify and describe a problem more completely and solve it with stronger understanding, reasoning, and argumentation. Paul et al. (2014) stated that a cognitive process that involves multiple representations in learning describes information into different forms consisting of visual and verbal information.

Problem Solving Ability of Ecosystem Material Students

The student's problem-solving ability was measured using a post-test, which consisted of 11 description questions validated by expert lecturers. Post-test questions were given at the end of the learning ecosystem material in the two experimental classes. The maximum score obtained by students is 86.3, and a minimum of 35. The problem-solving ability test score in this study was defined as the ecosystem material test score, which can be seen in Table 3.

Table 3. The results of the posttest score on the Problem Solving ability of students on ecosystem material

Groups	N	Lowest Scores	Highest Scores	Average Scores
X MIPA 2	33	35	86,3	58,01
X MIPA 5	32	35	84	60

Research conducted by Afcarino (2008) shows that problem solving can improve students' thinking skills, such as asking questions and answering problems to be solved. Darmawan (2010) also states that problem-solving can improve critical thinking skills, which are very meaningful. Students become more critical, be it in issuing opinions, asking questions, identifying, or solving existing problems.

The value obtained from the problem-solving ability is then accumulated with the LKS value with the ratio of Problem-solving questions: LKS 1: LKS 2: LKS 3, namely 3: 1: 1: 1 so that the final score is obtained. Students' final grades can be seen in the table below.

Table 4. The results of the posttest final score and student worksheets at SMAN 1 Donorojo on ecosystem material

Grade	NA Minimum	NA Maksimum	Average
X MIPA 2	45,5	76,8	60,4
X MIPA 5	43,6	76,9	60,4

Students are said to be in the high category if the average final score is 61-80. Based on the results of this study, students are in the "medium" category. Based on research (Novitasi, et al., 2015), problem-solving skills in the form of a dossier description have advantages. Among others, it can be used to measure students ' problem-solving skills, the reliability of the questions is relatively higher, can measure the extent to which students' ability to solve problems, which cannot be measured using objective tests; the possibility of guessing the answer is challenging; student knowledge outcomes can be broadly measured; can be used as a diagnostic tool for understanding student material; can be used to measure verbal ability because students can organize answers with their own opinions, the degree of accuracy and student truth can be seen from the sentences in the answer, the preparation of questions does not take a long time. The results of statistical analysis in Supiandi and Julung's (2016) study show that the learning model has a significant effect on students' problem-solving ability and cognitive learning outcomes.

The Level of Metacognitive Awareness of Ecosystem Material Students

Metacognitive awareness was measured using an inventory sheet and a metacognitive journal. In this study, the students' metacognitive awareness scale was measured using non-test techniques in the form of a metacognitive awareness inventory sheet instrument consisting of 52 statements and consisting of 4 scales, namely Strongly Agree (SA) with a score of 4, Agree (S) with a score of 3, Disagree. (D) with a score of 2 and Strongly Disagree (SD) with a score of 1 so that a total score of 208 was obtained.

Table 5. Recapitulation of the Metacognitive Questionnaire for SMA N 1 Donorojo students on ecosystem material (continued)

Students' scores	Total	Categories
0	0	*Not yet*
0,1-83,2	0	*At risk*
41,7-83,2	0	*Not really*
83,3-124,8	1	*Developing*
124,9-166,4	46	*Ok*
166,5-208	18	*Super*

As many as 1.53% of students were in the developing category, 70.76% were in the ok category, and 27.69% were in the super-category. In research, Eriawati (2013) states that the large metacognitive score indicates that the student respects or cares about the ongoing learning process and is interested in studying the material to try to take PBM seriously and enthusiastically.

Measurement of the ability to use a study journal was carried out 3 times. Each learning journal contains 5 indicators, namely the learning experience gained, what is understood, what is not understood, the constraints and efforts made with each score of 2 so that the total score is 10.

Table 6. Recapitulation of Metacognitive Journal Scale for students of SMA N 1 Donorojo on ecosystem material

Journal	N	Lowest Scores	Highest Scores	Averages
1	65	50	100	81.23
2	65	50	100	77.07
3	65	50	100	72.61

The recapitulation results show that the lowest scale in metacognitive journals 1, 2, and 3 is 50, while the highest scale is 100. The average score of journal 1 is 81.23, journal 2, with an average of 77.07, and journal 3, with 72.61. Students who have metacognitive abilities can have a strong understanding of problems and solutions by using logical opinions to make students confident in learning and solving problems. Metacognition skills can help students understand how to do tasks well and help manage to learn to plan, monitor cognitive activities, and evaluate the results (Irmayani and Viyanti, 2013). The results of Otaya's (2015) study show that some students try to assess themselves objectively. Still, in fact, most of the students tend to rate themselves positively (better) to show positive optimism. It can be said that the questionnaire instrument does not necessarily reveal how the students' metacognitive knowledge actually is.

Research Variable Correlation Test

A correlation test is used to determine how big the relationship is between problem-solving and metacognitive abilities. The hypothesis used is as follows.

$\rho xy = 0$ (There is no relationship between problem-solving ability and metacognitive ability)

$\rho xy \neq 0$ (There is a relationship between problem-solving abilities and metacognitive ability)

The test criterion was Ho reject if rcount> rtable for a significant level of 5%. The calculation results obtained r count = 0.509 while r table with dk = 65 and a significant level of 5% is 0.244. Because rcount> rtable, then reject HO and accept H1 means a significant relationship between problem-solving abilities. After obtaining the correlation (r), the coefficient of determination (KD) was determined to determine the problem-solving ability's contribution to metacognitive abilities. The coefficient of determination is 26%.

Metacognitive skills and problem-solving show a relationship where metacognitive skills influence cognitive learning outcomes. Problem-solving can make it easier for students to achieve metacognitive awareness. Problem-solving and cooperative learning aspects are the core aspects of learning, which have become a forum for students to develop students' metacognitive awareness (Aryatama, 2012). The results of this study support previous research conducted by Paidi (2008), who reported that PBL and PBL strategies combined with metacognitive strategies, can improve problem-solving abilities in biology learning.

Research on applying the BSCS 5E model based on multiple representations of problem-solving and metacognitive abilities in ecosystem material at SMAN 1 Donorojo had obstacles, including limited research time. Not all material was conveyed. At the exploration stage, a lot of time was still wasted. Learning was carried out online so that the data obtained is limited. Besides that, it required a relatively long time and cannot directly observe student activities. After the LKS, there were still students who did not contribute. In solving problem-solving problems, students did not check again, there were still many students who had difficulties, and several students' answers were the same. This research also has shortcomings. Namely, the evaluation questions used do not include the meaning of exploration. This is because the research was carried out during the pandemic. Students explored their respective homes, not in a predetermined place, and the LKS assessment was carried out in groups, not individually.

CONCLUSION

Based on the results of the research and data analysis obtained, it can be concluded that the problem-solving ability was in the "medium" category, the students' metacognitive abilities were in the "high" category with the application of the BSCS 5E model based on multiple representations on ecosystem material. Meanwhile, learning based on questionnaire responses from students and teachers was in the "high" category.

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