International Journal of Instruction
e-ISSN: 1308-1470 ● www.e-iji.net

April 2022 ● Vol.15, No.2
p-ISSN: 1694-609X
pp. 329-348

Article submission code: 20210401081817

Received: 01/04/2021
Revision: 11/10/2021

Accepted: 05/11/2021
OnlineFirst: 29/01/2022

The Effect of E-Learning Based on the Problem-Based Learning Model on Students' Creative Thinking Skills During the Covid-19 Pandemic

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This study aims to analyze the effect of e-learning based on the problem-based learning (PBL) model on students' creative thinking skills during the COVID-19 pandemic. The research was conducted using quasi-experimental design and pre-test post-test control group design, which was conducted at As-Shofa Islamic Senior High School, Pekanbaru, Indonesia class XII Science. The research used random sampling techniques. The parameter of this research was the skill to think creatively with four indicators, namely fluency, flexibility, originality, and elaboration. Data were gathered through the use of a creative thinking test in the form of a multiple-choice consisting of 20 items. The data of Min, Nmax, Nmin, Sd, and the effectiveness of creative thinking were calculated with the interpretation of the N-gain index (g). The results showed that the post-test average score of students' creative thinking skills in the experimental class using the PBL model through e-learning was higher than the control class without the PBL model, and the N-gain of the experimental class was higher than the control class. In conclusion, the PBL learning model through e-learning during COVID-19 pandemic affects students' creative thinking skills and was more effective, especially the original thinking and elaborate thinking skills when compared to learning without the PBL model.

Keywords: creative thinking, e-learning, problem-based learning, students' creative thinking skills, Covid-19 pandemic

Citation: Yustina., Mahadi, I., Ariska, D., Arnentis., & Darmadi. (2022). The effect of e-learning based on the problem-based learning model on students' creative thinking skills during the covid-19 pandemic. *International Journal of Instruction*, *15*(2), 329-348. https://doi.org/10.29333/iji.2022.15219a

INTRODUCTION

Education is a systematic effort carried out by schools to create an active, creative and innovative learning process, to answer the learning challenges of the 21st century. Identifying the learning competencies is important in facing the 21st century (Zubaidah, 2017). Students in the twenty-first century are expected to have competencies in information, media, and technology, as well as learning competencies, one of which is creative thinking skill. (Effendi & Wahidy, 2019). This creative thinking skill is an important skill that must be mastered by students in this century and the online era (Redhana, 2019; Aldalalah, 2020). However, education today is constrained by the COVID-19 pandemic which has caused the education system, which was initially conducted face-to-face, to be shifted to distance learning in the form of e-learning. E-learning is the best learning system to be applied in the 21st century and during the COVID-19 pandemic, which emphasizes technological developments. This is in line with Redhana's (2019) study which states that effectiveness and flexibility are the main reasons for e-learning to become the learning system in the future. Besides, e-learning is effective for improving students' higher-order thinking skills, one of which is students' creative thinking skills (Redhana, 2019; Asmoro et al., 2020).

In the process of implementing e-learning to reduce the ineffectiveness of e-learning, three aspects must be completed, namely 1) curriculum design on content, instructor and student interaction, 2) creation of a sense of online learning community, 3) rapid technological advances such as facilities like computer devices, good internet network servers and effective strategy (Sun & Chen, 2016). Besides, according to Yustina, Halim, and Mahadi (2020), there are five online learning readiness, namely assumptions, curriculum, facilities, resources, and access. As-Shofa Islamic Senior High School is a school that implements e-learning and fulfills three aspects and five e-learning readiness, namely the existence of policies and support of the As-Shofa foundation for the implementation of e-learning, the curriculum design, and teacher learning tools that have been adjusted to the implementation of e-learning and adequate school facilities. These facilities include an internet network and computer facilities in each class. Besides that schools and students already have a Google Classroom account, Zoom Meeting, and Whatsapp group to support the interaction between teachers and students.

Apart from teachers and schools, students must also be ready to carry out e-learning. Based on the observations of hardware ownership of 55 students of **class 12 Science**, it is known that 72% of students have laptops, 27% of students have computers, and 100% of students have cellphones. As for software, 60% of students have wifi and 100% of students have private internet data. 100% of students at As-Shofa Islamic Senior High School already have an online learning community in the form of a Whatsapp group and a Google Classroom. As a result of the comprehensiveness of the student facilities, As-Shofa Islamic Senior High School is ready to implement e-learning.

Based on the results of the preliminary study in the form of observations of the implementation of e-learning for students of class 12 Science 2 As-Shofa Islamic Senior High School in July 2020, it was known that students' creative thinking skill was

classified as less creative with a percentage value of 45%. In the aspect of fluency, students were classified as quite creative, where they were able to answer questions fluently. However, in the aspects of flexibility, originality, and elaboration, students were still classified as less creative. In these aspects, students were still lacking in conveying various ideas or answers, lacking in coming up with unique or recent ideas or opinions, and students were still unable to give detail in their ideas.

Data analysis from the Center of Educational Assessment (PUSPENDIK) in 2019 shows that the statistical score of the 2019 As-Shofa Islamic Senior High School National Examination (UN) results in the Biology subject is still classified as "insufficient" with 25,0 as the lowest student score. Three of the seven main biology subjects tested at the National Examination are taught in grade 12 so that they require more attention; one of which is Mendel's Law and Mendel's Law Moot Deviations. Based on the daily test scores of the students of the class 12 Science at As-Shofa Islamic Senior High School 2019, in the material of Mendel's Law and Mendel's Law Moot Deviations, 90% of student scores are still below the minimum mastery criteria (KKM). Following the research of Adelima et al., (2020), inheritance topic is considered difficult by students because it must be memorized, requiring students to identify and conclude the relationship between genes, DNA, and chromosomes in inheritance, besides that students also find it difficult to learn about the mathematical calculations and abstract concepts which therefore require a contextual learning process.

From the problems found, a learning model that can develop students' creative thinking skills through e-learning is needed. Problem Based Learning (PBL) is one of the best learning models to be applied along with e-learning. This is because according to Puspitasari, et al., (2018), the implementation of the PBL model can improve students' creative thinking skills. After all, students are asked to discuss solutions to real problems. Also, the results of Amidi and Zahid's (2016) research, which show that using interactive e-learning in the PBL model will train students to be more active and creative in solving problems. In addition, Problem-Based Learning (PBL) is a widely used constructivist pedagogical approach in science education. Studies have shown that the use of PBL is an effective tool to enhance students' academic performance and 21st century skills. However, in the last five decades of its utilization up to now, there has been a need to update and analyze studies pertaining to its effectiveness. As such, the researchers used meta-analysis to evaluate the effectiveness of PBL as an approach in science teaching in enhancing students' learning achievements (Funa & Prudente, 2021). Besides, the PBL model is an effective model for teaching higher-order thinking skills, this type of learning process helps students to process ready-made information and compile their knowledge about the social world and its surroundings (Yustina et al., 2017; Bustami et al., 2020). So, how is the effect of e-learning based on the problem-based learning (PBL) model on students' creative thinking skills during the COVID-19 pandemic.

Based on this background, researchers are interested in conducting a study on How is the effect of the problem based learning model through e-learning during the covid-19 period on the creative thinking abilities of 12th grade science students?

METHOD

Time, Place, and Research Subject

This research was conducted at As-Shofa Islamic Senior High School, Pekanbaru in the class 12 Science from October 2020 to May 2021. This learning is distance learning that is carried out online using several platforms such as Zoom Meeting, Google Meet, Google Classroom. The population was all students of class 12 Science As-Shofa Islamic Senior High School as many as 60 students from 3 classes. Sampling was carried out by conducting a homogeneity test on the population using random sampling techniques (drawing), where in 12 Science 3 students was chosen as the experimental class, treated with PBL model through e-learning, and the class 12 Science 1 students as the control class which implemented e-learning without the PBL model. The research parameter was the skill to think creatively with four indicators, namely: fluency, flexibility, originality, and elaboration. The instrument used was a multiple-choice test consisting of 20 questions in the form of google form. The subjects of this research are Mendel's law and pseudo-deviation of Mendel's law

There are several ethical considerations in choosing schools for research, including: the existence of policies and support from the As-Shofa Foundation for the implementation of e-learning, SMA Islam As-Shofa Pekanbaru has used curriculum designs and learning tools that have been adapted to e-learning, schools and students have adequate facilities and infrastructure in implementing e-learning, namely hardware (computers, mobile phones) software (internet network, and internet packages), and have an online learning community (whatsapp group, zoom meeting, and google classroom).

Research Design

The research was a quasi-experimental study, with a pre-test-post-test control group design. At the beginning of the study, two groups (control and experiment) were given a pre-test to determine cognitive abilities (creative thinking) (Safitri & Suparwoto, 2018; Dewi et al., 2020). The research design was as follows:

EC	O1	X1	O3
CC	O2		O4

Figure 1
Research design (Safitri & Suparwoto, 2018)
EC = Experiment class
CC = Control class
O1 = Initial skill to think creatively in the experimental class
O2 = Initial skill to think creatively in the control class
O3 = Final skill to think creatively in the experimental class
O4 = Final skill to think creatively in the control class
X1 = Treatment in the experimental class using the problem-based learning (PBL) model through e-learning in subject Mendel's law learning materials and Mendel's legal deviations

Data Collection Technique

Data collection on students' creative thinking skills used test questions (Table 1). The pre-test was carried out before entering the subject matter, and the post-test was carried out after the material was finished and the entire test treatment process was conducted online using google form. The questions used for the pre-test and post-test were the same (multiple choice form).

Table 1
Indicator of creative thinking skills

Creative Thinking Indicators	Creative Thinking Indicators
Fluency	Answer with a number of answers if there are questions;
	Fluently expresses his ideas;
	Can quickly see the faults and weaknesses of an object or situation
Flexibility	Provide various interpretations of an image, story, or problem
	If given a problem usually think of a variety of different ways to solve it
Originality	After reading or hearing ideas, work on finalizing new ones.
Elaboration	Looking for a deeper meaning to the answer or problem solving by performing detailed steps
	Develop or enrich the ideas of others
	Tried/tested the details to see which way to go

(Liliawati, 2011)

Table 2
Creative thinking skills test layout

Creative Thinking Indicators	Creative Thinking Indicators	The Cognitive Level of the Question
Fluency	Able to quickly see faults and weaknesses of an object or situation	C4
	Fluent in expressing answers	C5
		C4
		C3
	Fluent in expressing ideas	C2
Flexibility	Able to provide interpretation of a problem	C4
		C5
		C4
	Look for many different alternative answers	C3
		C5
Originality	Able to make and determine the genotype of an individual	C3
	Able to analyze examples of a problem	C4
		C4
	Able to conclude a problem based on the data and explanation provided	C5
	Able to create/calculate data based on the data provided	C3
Elaboration	Able to enrich and develop an idea or product	C4
	Look for a deeper meaning to the answer or problem solving	C4
		C4
		C4
		C4

Note : Cognitive Level of the question (C1-C6) refer to Bloom's taxonomy

Data Analysis Technique

The score for the skill in each aspect of creative thinking was obtained from the distribution of the student's correct answer score by the number of scores then multiplied by 100. The criteria for the success rate of creative thinking according to (Sugiyono, 2017) are shown in Table 3 below:

Table 3
Criteria for creative thinking scoring

Interval	Criteria
85-100	Very Creative (VC)
75-84	Creative (C)
65-74	Fairly creative (FC)
55-64	Less creative (LC)
30-54	Very less creative (VLC)
0-29	Completely less creative (CLC)

To determine the increase in creative thinking, the data used were in the form of a gain score (g), which was the result of the reduction in the post-test mean (Sf) with the pre-test mean score divided by the maximum value (100) minus the pre-test average value. Interpretation of the gain index (g), according to the classification by (Hake, 2018), is in Table 4 below.

Table 4
Value of normalized gain index and its classification

Normalized Gain Index	Classification
(g) ≥ 0,70	Very effective
0,30 ≤ (g) ≥ 0,70	Effective
(g) < 0.30	Less Effective

FINDINGS

Descriptive data for the control and experimental classes can be seen in Table 5 below:

Table 5
Pre-test and post-test data in the control and experimental class

No	Test	Number of Students (N)	Minimum Score (min)	Maximum Score (max)	Mean (M)	Standard Deviation (SD)
1	Pre-test Control	19	30	75	**57,36**	13,94
2	Pre-test Experiment	18	30	75	**57,78**	13,60
3	Post-test Control	19	65	85	75,26	7,35
4	Post-test Experiment	18	70	90	80,56	6,39

Based on Table 5, it is known that the number of students for the experimental class (PBL) was 18 students and the control class was 19 students. In the descriptive test results for the experimental class, the pre-test data were obtained with 30 as the lowest score, 75 as the highest score, and 57,78 as the average score with a standard deviation of 13,6. The lowest post-test score for the experimental class was 70, the highest score was 90, and the average value was 80,56 with a standard deviation of 6,39. In the pre-test and post-test results of the experimental class, the standard deviation value was lower than the average value, which means that the data obtained were good and homogeneous, because the standard deviation that was lower than the mean indicating a

the data distribution was evenly distributed. In addition, homogeneity is known if the significance level on the Based On Mean > 0,05, then the variance between groups is homogeneous, and if the significance level Based On Mean < 0,05, the variance between groups is not homogeneous. From the descriptive test results for the control class, the pre-test data were obtained the lowest score was 30, the highest score was 75, and the average score was 57,36 with a standard deviation of 13.944. Meanwhile, the lowest score of the post-test results for the control class was 65, the highest score was 85 and the average score was 75,26, with a standard deviation of 7,35. In the pre-test and post-test results of the control class, the standard deviation score was lower than the average score, meaning that the data obtained was good and homogeneous. Overall, after both the control class and experimental class were being given a different treatment, the average post-test score in the experimental class was higher than the control class.

Student Creative Thinking Test Results

The detailed results of the skill to think creatively before and after the learning process in the control class and experimental class (Table 6) are as follows:

Table 6
The results of the creative thinking test of the control class and the experimental class

No	Creative Thinking Skill Indicators	Class Score Control		Category		N-gain	Experimental Class Score		Category		N-gain
	Pre		*Post*	*Pre*	*Post*		*Pre*	*Post*	*Pre*	*Post*	
1.	Fluency	66,32	80	FC	C	0,4 (effective)	66,67	83,33	FC	C	0,5 (effective)
2.	Flexibility	56,84	75,55	LC	C	0,43 (effective)	56,67	82,22	LC	C	0,59 (effective)
3.	Originality	55,78	68	LC	FC	0,27 (less effective)	57,78	75,55	LC	C	0,42 (effective)
4.	Elaboration	50,52	63,33	VLC	LC	0,25 (less effective)	50	75	VLC	C	0,5 (effective)
Average creative thinking skill		57,36	71,72	LC	C	0,33 (effective)	57,78	79	LC	C	0,5 (effective)

Note : VC (Very Creative), C (creative), FC (fairly creative), LC (less creative), VLC (very less creative). Based On Table 3

From the four indicators of creative thinking in Table 6, it is known that the creative thinking skill of the control class is as follows: the skill to think fluently in the pre-test with a value of 66,32 (quiet creative category) increased to 80 (creative category) in the postest with an n-gain of 0,4 and effective classification. The skill to think flexibly at the pre-test with a value of 56,84 (less creative) increased at the post-test to 75,55 (creative) with an n-gain score of 0,43 (effective classification). Original thinking skill with a pre-test value of 57,58 (less creative) increased to 68 (quite creative) with an n-gain of 0,27 (less effective). The skill to think elaborately at the pre-test with a value of 50,52 (very less effective) increased at the post-test to 63.33 (less creative) with an n-gain of 0,25 which was classified as less effective.

In the experimental class, the skill to think fluently in the pre-test with a value of 66,67 (creative enough) increased in the post-test to 83,33 (creative), with an n-gain of 0,5 (effective). The flexible thinking skill of the experimental class at pre-test 56,67 (less creative) increased to 82,22 (creative), with an n-gain of 0,59 (effective). The original thinking skill of the experimental class at the pre-test was 57,78 (less creative) increased to 75,55 (creative) with an n-gain score of 0,5 and was classified as effective. As well as the elaborate thinking skill of the experimental class at the pre-test, namely 50 (very less creative), increased at the post-test to 75 (creative) with an n-gain of 0,42 which is classified as effective.

Overall in table 5, the pre-test average scores in the control class and experimental class are 57,36 and 57,78, both classes with a difference in the value of 0,42. By knowing that the difference in the abilities of the two groups is not much different, the results obtained after students receive treatment in the next stage will be more precise and appropriate. Thus, it is known that the two classes used have the same initial ability

Viewing from the post-test mean score, it can be seen that the difference in the score is quite significant between the control class and the experimental class, that the experimental class has a value (79) greater than the control class average (71,72). That is, the skill to think creatively in the experimental class is higher than the control class with each creative category and with n-gain values of 0,33 and 0,5 respectively, it is categorized as effective in increasing creative thinking. Reviewed in detail in the control class, the original thinking skill score was 68 (creative enough) and elaborative skill with an average value of 63,33 (less creative), with n-gain 0,27 and 0,25 respectively indicating the less effective category to increase creative thinking in the control class.

DISCUSSIONS

The ability to think creatively in each class increased, but the n-gain index of the control class using e-learning without PBL tended to be lower than the experimental class using the PBL model through e-learning. This means that the provision of the Problem Based Learning model through e-learning is more effective in increasing students' creative thinking skills compared to e-learning classes without the PBL model. This is known by comparing the increase in test scores for each indicator of the experimental class and the control class, whic is known as normalized gain score. In line with the research results of Jeno et al. (2019) and Raehan et al. (2020), students' creative thinking skill in problem-based learning is better than students who implement conventional learning. This is because students in problem-based classes are required to be active in online class. Based on research results Simanjuntak et al (2021), from the first phase to the final phase of PBL, students were required to practice and exhibit their creative thinking skills to think fluently when solving a problem. During this process, students asked many questions to their classmates and the teacher. They also attempted to answer several questions that emerged during the problem-solving process. They also express their ideas and work faster in solving the given problem-as compared to conventional learning. Students were trained to showcase authentic thinking to build new ideas and the solution to problems that were not thought of by others.

This distinction is because in PBL through e-learning, students are given problems and are actively involved in formulating the problems, formulating hypotheses, gathering data, and analyzing data. This learning activity encourages and trains students to think creatively (Puspitasari, 2015). Meanwhile, e-learning serves to strengthen modeled learning through exercises and the development of educational technology content (Yustina et al., 2020). The level of creative thinking of students has experienced significant changes in utilizing e-learning (Safitri & Suparwoto, 2018). An e-learning atmosphere will "force" students to play a more active role in studying (Sawitri et al., 2019). This is in line with the characteristics of the problem-based PBL model and requires students to take an active role in solving problems. Problem-based learning with e-learning which has characteristics that encourage students to find problems and elaborate them by proposing conjectures and formulating solutions is very close to the aspects of creative thinking, namely fluent thinking, flexible thinking, original thinking, and detailed thinking (Amidi & Zahid, 2016).

The details of each indicator of the skill to think creatively are described in sequence as follows.

Fluency

The aspect of fluency is viewed from the skill of students to answer questions and convey their ideas (Table 1). This can be seen from the students' skill to answer question number 1, Mention things that make Gregor Mendel did not choose the pea plant as the object of research for the following reasons. In this question the students would answer correctly if they were able to tell the incorrect reasons regarding the selection of pea plants as the research object. Also in question number 10, ABO blood type in humans is determined by a multiallelic system; IA and IB are codominant and dominant to Io. If a newborn has blood type A and the mother has blood type O, the possible genotype of the father is ? in this question, students were able to identify the genotype of the parental blood group if only the genotype of the child's blood group was known. Questions on this aspect of fluency are designed to stimulate students' thinking patterns to generate various ideas. In addition, Problem-based learning is one of the student-centered learning models. Its use is intended to develop a variety of advanced cognitive abilities such as problem solving.

Based on the mean score of the post-test and the n-gain index, the students' skill to think fluently in the experimental class was higher than in the control class. This is because, in the learning process of the experimental class, students were accustomed to being given problems or phenomena that they had to solve which train them to smoothly answer questions with a variety of ideas. The learning process began by the teacher sending discourse and media as well as instructions/questions related to the learning topic asynchronously. Then the class continued to discuss problems found by students synchronously; this condition helps to prepare students with various insights and various alternatives to contribute to providing solutions in solving problems posed by teachers through challenging questions with interesting strategies so that students are motivated to participate.

This kind of learning process shows that a person's creative thinking skill will be higher if one can show many possible answers to a problem properly (Amidi & Zahid, 2016). Whereas in the control class, learning tended to be one-way, where only the teacher actively explained or provided learning material, while students only listened to the teacher's explanation. In line with research results of Yustina, Syafii, and Vebrianto (2020), conventional learning applies one-way communication that causes students to only become passive listeners and the learning process only transfers knowledge from teachers to students. So, this makes the quality of students uncreative and unable to develop their skills.

Flexibility

Flexibility is seen from student's skill to provide various interpretations of a picture, story, or problem; think of all kinds of different ways to solve it; classify items according to different divisions (categories). According to Yustina, et al., (2020) a person who can think flexibly can provide various interpretations of an image, story, or problem and generate various ideas. This can be seen from the student's skill to answer questions, such as in question indicator number 2, Mrs. Anita had to go to a gynecologist to get special treatment in her second pregnancy due to the blood type that Mrs. Anita and her husband had. Factors that may interfere with the safety of the birth of the child are?, in this question, students were able to analyze the factors that affect the birth of a fetus based on the problem, where various possible answers (factors) were presented. As well as the question indicator number 5, Testcross conducted on purple flowered Lathyrus odoratus (CCPp) resulted in 480 purple and white flowering plants. The number of purple and white flowering plants produced, respectively, is ?. In this question, students were able to determine and solve the filial number of *Lathyrus odoratus* flowers in various ways if a testcross was known. The questions given were related to the problems they might encounter in their environment. Following the results of Amidi and Zahid's (2016) research, problems in problem-based learning are contextual and interesting (contextual and engaging), thus stimulating students to interpret from various perspectives. Besides, e-learning which is applied to the learning process will increase the flexibility required to solve problems from a different point of view and approach (Fisher et al., 2019).

Originality

The aspect of originality is viewed from students' skill to answer questions based on their own opinions or findings, which come from their minds. This can be seen from students' skill to answer questions, such as question indicator number 18, Polymery events affect the appearance of several characters in living things, which one do you think is an example of a phenomenon caused by polymery ?. Students would be able to answer correctly if they could relate the characteristics of polymery with the answer options regarding examples of events caused by polymery correctly. As well as the question indicator number 11, A mother with blood type A has her first child, a boy with blood type A, a boy with blood type B, and a third daughter with blood type O. The genotype of her father's blood type is ?. Students would be able to answer the questions correctly if they were able to analyze the types of quasi-legal deviations that occur based

on the cases and data presented. Indicators of original thinking questions are made to stimulate students' skill to have opinions and generate ideas based on their thinking. Based on test results, the aspect of the original thinking skill of the experimental class was higher than the control class after the implementation of the PBL model through e-learning. This is because, in the experimental class, students' original thinking skill was trained when discussing answering e-worksheet questions; students were trained to convey their ideas or opinions about the questions in their sentences. In line with the results of Yustina's et al., (2020) research on original thinking skill, students can provide answers to their findings and differ from what has been given by the teacher, because students are used to finding new things or answering with variations in answers and by using sentences without copying sentences in books or the internet.

Elaboration

The aspect of elaboration is seen from the students' skill in detailing an idea and looking for a deeper meaning to answers or problem-solving. This can be seen from the student's skill to answer questions, as in question number 6. The curly hair factor is dominant over straight hair. If it is known that both parents (Parental) have curly hair, which of the following statements is true?. In this question, students would be able to answer correctly if they were able to analyze the right statements about the possible characteristics of the child if their parental characteristics were known. These questions stimulate students to look for deeper meaning about each option so that students' elaborate thinking skills are trained. The elaboration thinking skill of the experimental class students was higher than the control class students. This is because based on the observation of the experimental class learning process, students were trained to develop and deepen ideas when making group presentations in their way. Students at the presentation were trained to develop their ideas. In line with the research results of Elizabeth and Sigahitong (2018), at the stage of developing and presenting the work, students' language development can be optimized. In PBL learning, students are accustomed to actively discussing, working together in groups, and presenting the results of discussion activities to the class so that students' mathematical creativity develops well (Ladjar et al., 2018).

Learning with the PBL model through e-learning supports the development of the four aspects of creative thinking skill, and has a positive impact on online learning as seen from the test results and observations. However, in applying the PBL model through e-learning to develop creative thinking skill, there are several challenges. *First*, some aspects of creative thinking skill, such as aspects of originality and elaboration, will be more developed if students conduct experiments or make products and then present them. However, this cannot be applied to e-learning, because learning is carried out remotely. In line with the research results of Yustina's et al., (2020), at the stage of delivering stimulus, the aspect of elaboration has the greatest impact compared to other aspects, but it takes a long time. This is because students are trying to develop an existing idea or product, or add details to the product.

Second, at the beginning of the meeting where students have just adjusted to the PBL model through e-learning, students are still used to the usual learning that teachers use

during e-learning. *Third*, students are also not familiar with the e-worksheet provided, so teachers need more time to guide them in working on the e-worksheet. *Fourth*, during group discussions in the breakout rooms zoom meeting, several group members just sat there and relied on their friends to answer e-worksheet questions, without giving ideas or opinions so they did not actively explore their knowledge. *Fifth*, the reduction in learning hours which results in a lack of time for group presentations.

Therefore, there are several attempts made by researchers to overcome these obstacles. *First*, in addition to using test results, researchers also used observation sheets to observe students' creative thinking skill while studying. This observation was carried out by two observers, which was carried out by observing student activities when learning through an online platform (zoom meeting), and giving a scale score of 1 to 4 for each indicator of students' creative thinking that appeared according to the assessment rubric that had been made. In addition, researchers also used video recordings from zoom meetings to re-observe student activities so that the data obtained was more precise. The ability to think creatively through observation is assessed in groups, each group consists of four to five people, on the basis of the ability of students in the group is the same. This is known by the researcher when conducting pre-research observations when the civil servant teacher teaches. *Second*, the teacher sent the discourse or video of the problem into the google classroom first, so that students had more time to search for literature related to the problems given. *Third*, e-worksheet was sent first, instructions for filling in e-worksheet were also delivered offline via google classroom, and study groups were formed first. *Fourth*, students were emphasized that their activities during group discussion activities were observed and assessed individually. This was done so that students in the learning process could understand and carry out the learning process optimally. Besides, the role of the teacher in guiding students to discuss must be optimized so that students' discussion interaction activities during learning also took place optimally

CONCLUSIONS

Based on the results, discussions, and the normalized gain score it can be concluded that the experimental class with the PBL learning model through e-learning has a more effective effect on improving students' creative thinking skills on indicators of fluency, flexibility, originality, and elaboration, than the control class that does not use the PBL learning model.

SUGGESTION

The Problem Based Learning (PBL) model through e-learning is a learning model that can help students improve their creative thinking skill as well as their learning motivation. As a result, it can be used as a learning model in online learning or e-learning by focusing on some attempts, such as making observations during the learning process, providing discourse and tasks asynchronously in advance, and carrying out discussions synchronously.

ACKNOWLEDGEMENT

This research was funded by the DRPM Fund of the Ministry of Education and Culture in the education year 2021, Science Sector Skim. The author would like to thank the Indonesian Minister of Education, Mr. Nadiem Anwar Makarim, BA. M.B.A., Chairperson of the LPPM UNRI for making this research possible, and the TEAM for their collaboration and participation in this study.

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APPENDIX

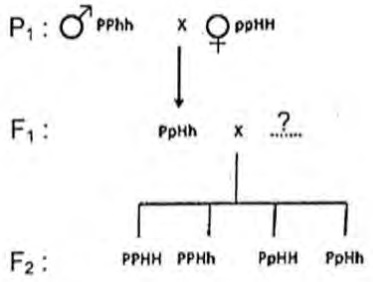
CREATIVE THINKING QUESTIONS

School: As-Shofa Islam Islamic High School

Subject : Biology

Class/Semester : XII/I

Main Material: Mendel's Law and Mendel's Law Pseudo Deviations

Indicator of creative thinking ability	**Questions**
Fluency	1. Mention things that make Gregor Mendel did not choose the pea plant as the object of research for the following reasons.. a. Quick to produce seeds b. Many have varieties of traits c. Produce many offspring **d. Unable to self-pollinate** e. Easy to cross
Flexibility	2. Mrs. Anita had to go to a gynecologist to get special treatment in her second pregnancy due to the blood type that Mrs. Anita and her husband had. Factors that may interfere with the safety of the birth of the child are… a. hemophilia b. Thalassemia c. crescent cell **d. Rhesus factor** e. Agglutinogen
Fluency	3. To obtain superior varieties, rice with fluffier quality, but not pest resistant (PPhh) rice is crossed with pest-resistant rice quality (ppHH). The results of the cross are shown in the following diagram.  If F1 is crossed with rice of a certain genotype and phenotype, it will produce offspring (F2) as shown in the diagram, namely rice with quality pest-resistant fluffier rice (PPHH, PPHh, PpHH, and PpHh), the possible genotype and phenotype being crossed with F1 is …. a. pphh – pera can't stand pests

b. ppHH – pest resistant formula
c. PPHH – fluffier pest resistant
d. PpHh – fluffier pest-resistant
e. PpHH – fluffier pest-resistant

Elaboration

4. Pay attention to the following table of chili plant characters...

Characteristics	Dominant	Recessive
Flower position	Axial (A)	Terminal (a)
Rod length	High (H)	Dwarf (h)
Flower color	Purple (P)	White (p)

If plants with heterozygous genotypes for these three characters are allowed to self-pollinate, the percentage of offspring with homozygous genotypes for the three dominant traits is ….
a. 1.56%
b. 3.12%
c. 6.25%
d. 12.5%
e. 42.19%

Flexibility

5. Testcross conducted on purple flowered Lathyrus odoratus (CCPp) resulted in 480 purple and white flowering plants. The number of purple and white flowering plants produced in a row is ….
a. 480 and 0
b. 300 and 180
c. **240 and 240**
d. 180 and 300
e. 120 and 360

Elaboration

6. The curly hair factor is dominant over straight hair. If it is known that both parents (Parental) have curly hair, which of the following statements is true...
a. Cannot have straight-haired children because the parents are homozygous
b. Can have straight-haired children as long as both parents are heterozygous
c. Can have straight-haired children as long as the parents are all homozygous genotypes
d. Unable to have straight-haired children due to recessive straight hair factor
e. Can't have straight-haired children because curly hair is more dominant

Originality

7. In a cross, the phenotype ratio of the offspring is 34: 33. Which is the genotype of the two parents?
a. Aa >< aa
b. AA >< bb
c. Aa >< Aa
d. AB >< ab
e. AA >< aa

Elaboration

8. Two Himalayan rabbits are fighting over by a white rabbit breeder and a black rabbit breeder. From your understanding of the nature of heredity, the one who has the right to own the rabbit is the rabbit…
a. White because the coat color of the Himalayan rabbit has a lot of

	white b. It's black because the rabbit is in the black rabbit's cage c. White because the rabbit is suckling the mother white rabbit d. Black because black alone is the most dominant over white e. **Black because white rabbit fur color is the most recessive of other rabbit fur colors**
Originality	9. *Linaria maroccana* plants with purple flowers with genotype AaBb were crossed with each other. The a allele indicates the presence of anthocyanins and the b allele indicates the liquid is alkaline. The results of these crosses are shown in the table below.. <table><tr><td rowspan="2">Parental</td><td colspan="3">Percentage of offspring genotype</td></tr><tr><td>Purple</td><td>Red</td><td>White</td></tr><tr><td>AaBb x AaBb</td><td>56,25%</td><td>18,75%</td><td>25%</td></tr></table> Based on the data above, there is a deviation from Mendel's law in this cross which is called…. a. Cryptometry b. polymer c. Espistasis d. Hypostasis e. Multiple alleles
Fluency	10. ABO blood type in humans is determined by a multiallelic system; IA and IB are codominant and dominant to Io. If a newborn has blood type A and the mother has blood type O, the possible genotype of the father is . . . . a. A, B, or AB b. A, B or O c. Only O **d. A or AB** e. A or O
Flexibility	11. A mother with blood type A has a son with blood type A, a son with blood type B, and a daughter with blood type O. The genotype of her father's blood type is… a. IAIO b. IAIB **c. IBIO** d. IOIO e. IBIB
Originality	12. In monohybrid crosses, the parent will share the same number of gene pairs on the sex cells. For example, the male Mm genotype forms M sperm and M sperm in the female Mm genotype forms M and M ova. From the results of these crosses, in F2, a genotype ratio of 1: 2: 1. This event is an event based on the law of inheritance which is called ... a. Mendel's Law of Asortation b. Mendel's Laws of Deviation c. Hardy Weinberg's Law d. Mendel's law of assortment and Mendel's law of segregation

	e. Mendel's law of segregation
Fluency	13. Chickens are unique in inheritance, namely when both parents are bred, the offspring will produce wattles that are different from their parents. This is caused by…… a. Genes that can mask the appearance of other genes b. Different genes that affect the same trait c. Genes whose traits are covered by other genes d. Genes whose nature can appear if there is the appearance of other genes **e. Multiple genes that give rise to many phenotypic variations**
Fluency	14. An American expert who discovered that chromosomes contain many genes and the mechanism of inheritance deviates from Mendel's Second Law is ... **a. T.H Morgan** b. W. Bateson c. R.C Punnet d. Nelson Ehle e. G.N Collins
Elaboration	15. White Lathyrus odoratus flowers are crossed with white Lathyrus odoratus as well to produce F1 purple flowers. If purple flowers are crossed with each other, a purple: white F2 phenotype ratio of 9: 7 will be obtained. a. Epistasis-hypostasis b. Intermediates c. Cryptometry d. polymer **e. Complementary**
Originality	16. A farmer crosses a citrus plant that bears heavy fruit, sour taste with orange plant that bears little fruit, sweet taste. The resulting F1 all bear fruit, sweet taste. Furthermore, F1 is mated with each other. If the number of F2 produced is 640 plants, the number of plants that bear little fruit and taste sour is … plants a. 10 **b. 40** c. 120 d. 360 e. 640
Flexibility	17. Consider the following table of character genotypes in the shape of a chicken's comb... Genotype Fruit Flies Walnuts R_P_ Ros R_pp Pea rrP_ Single rrpp Walnut-combed chickens bred with roses produced 4 single-bred, 5 peas, 12 roses, and 13 walnuts. The genotypes of both parents are... a. RRPP >< RRpp b. RRPp >< rrPp c. RrPp >< RRpp

	d. Rrpp >< Rrpp **e. RrPp >< Rrpp**
Originality	18. Polymery events affect the appearance of several characters in living things, which one do you think is an example of a phenomenon caused by polymeric... **a. Skin pigmentation** b. Chicken comb type c. ABO blood type d. Straight hair or curly hair in humans e. Fur color in rabbits
Flexibility	19. In humans, the H factor causes black skin, the more H factors the darker the skin color. On the other hand, the h factor causes white skin color. If the individual contains all H factors, the skin color that appears is black, 3 H has dark brown skin color, 2 H has medium skin color, 1 H has light brown skin color. If a dark brown-skinned woman marries a light brown-skinned man, then the probability of her offspring is... a. All children are medium skin **b. Children with medium brown skin : light brown = 3 : 1** c. Children with dark brown skin : light brown = 2 : 1 d. Children with dark brown skin : medium brown : light brown = 2 : 1 : 1 e. Children with dark brown skin: medium brown: light brown = 1: 2 : 1
Elaboration	20. M gene (red), epistasis to H gene (green). Both genes are dominant to their allele (yellow). A cross between a red leaf plant (MMHh) and a green leaf plant (mmHH) resulted in two red leaf plants with different genotypes. When a cross is made between the two red-leafed plants, the phenotypic ratio obtained is …. **a. red : green = 6:2** b. red : yellow = 3: 3 c. red : yellow = 15:1 d. red : green : yellow = 4 : 3 : 1 e. red : green : yellow = 9 : 3 : 4