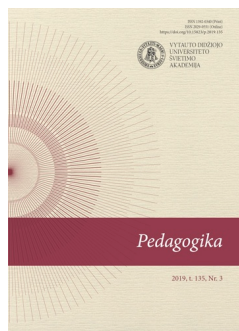


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The Integrated PBL-DMM: A Learning Model to Enhance Student Creativity

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Abstract. The present study aimed to test the effectiveness of two learning models, namely Problem-Based Learning (PBL) and Integrated Problem-Based Learning and Digital Mind Maps (PBL-DMM) in improving student creativity. This experiment employed a pretest-posttest control group design and involved 103 participants. An essay test was used to evaluate the participants' creativity. The results showed that both PBL and PBL-DMM had an effect on creativity, yet among these two learning models, PBL-DMM was considered more effective to boost student creativity.

Keywords: *Learning Model, Student Creativity, Problem-Based Learning, Digital Mind Maps.*

Introduction

Changes and a more competitive landscape in the 21st century require colleges and universities to be extra conscientious in preparing their graduates to embark on the work field and possess various skills needed for a particular job (Frydenberg & Andone, 2011). The 21st-century skills help learners to adapt to new changes. In other words, only those who have the knowledge and skills to deal with and adjust to new situations can succeed in this era of technology (Ongardwanich, Kanjanawasee, & Tuipae, 2015; Pheeraphan, 2013). Therefore, besides being academically challenged, university students also need to be socially skillful and competent in the workplace (Turiman, Omar, Daud, & Osman,

2012). Among the many important skills that need to be mastered by the students to survive in the current century, creativity should be considered paramount (Chu et al., 2017; Tan, Lee, Ponnusamy, & Koh, 2016).

Creativity includes an effort of finding the unknown, developing new solutions to every problem encountered, and putting things together in a new and different way (Hoseinifaret al., 2011; Reid & Petocz, 2004). Creativity produces new, varied, and unique ideas (Batey, 2012). Creativity is part of the 21st-century skills (Chan & Yuen, 2014) so that it needs to be empowered through learning (Csikszentmihalyi, 2012). Creativity plays a key role in the advancement of human civilization and affects human lifestyles (Chang, Wang, & Lee, 2016). It has social and economic implications and a positive effect on individuals' personality aspects (Chen, 2016). Yates & Twigg (2017) adds that by fostering creativity over the years, education can create an imaginative thinkers community. Creativity can act as an important aspect of competitiveness with innovation as its focus (Kuo et al., 2017).

The development of creativity is increasingly seen as a necessity in the field of education because creativity can encourage students to perform better (Hansenne&Legrand, 2012; Yusnaeni, Corebima, Susilo, & Zubaidah, 2017) and influence their future success (Castillo-vergara et al., 2018). However, numerous studies in Indonesia have reported the inability of university students to think creatively (e.g., Darmawan, 2014; Musadad, 2011). The importance of creativity has not been accommodated by a supportive learning process because some educators may not have the right pedagogical strategies to do so (Birsas, 2018; Chan & Yuen, 2014). In fact, most teachers consider students smarter when they can acquire, remember, and apply information that opposes creative perspectives (Brand, Hendy, & Harrison, 2015). Inflexible classroom rules and rigid learning environments can also prevent the students from thinking creatively (Castillo-vergara et al., 2018).

Referring to the explanations above, it can be ensured that to be ready to face 21st-century challenges, university students need creativity. Given the facts, that the majority of the students lack in this creativity, it is thus essential to discuss the importance of active learning strategies (Fuad, Zubaidah, Mahanal, Suarsini, 2017; Kim, Sharma, Land, & Furlong, 2013) in the classroom. Active learning strategies which involve the use of open-ended tasks can be useful in helping students to solve problems (Huang, 2017; Wu, Chang, & Chen, 2017). These strategies can also assist students in extracting information so that they can decide on further actions (Vong & Kaewurai, 2017). One of the examples of learning models that employ active learning strategies is Problem-Based Learning (PBL).

PBL is a learning model that prioritises the process of working in groups towards problems resolution (O'Grady et al., 2012). PBL incorporates two pillars of learning theory, namely social constructivism and cognitive constructivism (Wyness & Dalton, 2018). PBL facilitates students in contextualizing knowledge and practice (Applin, Williams, Day, & Buro, 2011). Tutorials, facilitation, problem-solving, independent learning, collaboration, and post-problem reflection are the key elements of PBL (Bridges, McGrath, & Whitehill, 2012). PBL can also be implemented in three stages: (1) pre-discussion, (2)

self-study period, and (3) presentation of results (Hmelo-Silver, 2004; Loyens, Kirschner, & Paas, 2012).

PBL has been proven effective to improve student creativity. Students in PBL classes are more able to demonstrate professional skills such as communication, collaboration, innovation, and creativity than those who learn using traditional approaches (Alrahlah, 2016; Loyens et al., 2006; Bridges et al., 2012). PBL presents an appropriate learning environment to develop individual creativity (Siew, Chin, & Sombuling, 2017; Ulger, 2018; Zhou, 2015), so students can activate their prior knowledge and develop various skills (Gijbels, Dochy, Van den Bossche, & Segers, 2005).

However, PBL still has weaknesses in developing student creativity related to the nature of science (Moutinho et al., 2015). Since PBL mainly focuses on the elaboration of a student' prior knowledge and reflection on problem-solving processes, students rarely try to brainstorm ideas (Dell, Garrick, Romanowski, & Slifka, 2012). As a matter of fact, the activation of a student' prior knowledge allows the simulation of links between new and old information. However, brainstorming of ideas such as mind mapping can help students visualize previous knowledge in a broader conceptual form (Johnstone & Otis, 2006). Mind maps can develop student creativity (Siwczuk, 2005), assist students in summarizing PBL discussions, and enable student reflection on the learning process (Ravindranath, Abrew, De, & Nadarajah, 2016). As mind maps can act as a mediator in connecting one concept and another, this study attempted to integrate PBL and mind mapping (Hariyadi, Corebima, & Zubaidah, 2018).

Mind maps are diagrams arranged radially and sequentially. These diagrams are used to represent related concepts and ideas (Cuthell & Preston, 2008) using words, images, colors, and branches. Mind maps which are made digitally using technology (Laampere, Matsak, & Kippar, 2006; Siwczuk, 2005) are known as Digital Mind Maps (DMM). DMM comes in various forms of technology. These mind maps are created using technology-based applications to brainstorm and present ideas (Faste & Lin, 2012). They are arranged in a non-linear format with colors, numbers, fonts, images, or video (Papushina, Maksimenkova, & Kolo-miets, 2017; Simonova, 2015). Considering the role of information technology in student self-development (Turganbayeva & Moshkalov, 2013), DMM can be used to facilitate learning (Pumahapinyo & Suwannatthachote, 2014; Simándi, 2018).

The integration of PBL and DMM (Integrated PBL-DMM) can be expected to promote student engagement in creative problem-solving (Noonan, 2013). The activity of connecting images to concepts when drawing DMM is a creative task that requires thinking rather than memorizing (Papushina et al., 2017). The use of digital teaching can motivate students and make the learning process more interesting (Lebeničnik, Pitt, & Starčič, 2015; Qi, 2018). DMM can be saved as files, and those files can be shared between students and educators so that educators and students can collaborate more easily (Erdogan, 2009).

Based on the description in the background, the purpose of this study was to investigate the effect of two learning models, namely PBL and PBL-DMM on creativity. It was hypothesized that both PBL and PBL-DMM affected university students' creativity.

Methods

Research Design

This research employed a pretest-posttest control group design (Fraenkel & Wallen, 2009) this research design was appropriate to test the research hypotheses. The pretest and post-test were conducted to the three treatment groups (PBL, PBLDMM, and control). The data gathered from the control group were thus compared to the data obtained from the experimental groups. Learning models (PBL, PBLDMM, and traditional) were assigned as the independent variables of this study, whereas creativity acted as the dependent variable. The design of the study can be seen in Table 1.

Table 1

Research Design

Pretest	Treatment Group	Posttest
O1	Traditional	O2
O3	PBL	O4
O5	PBL-DMM	O6

Notes:

Traditional: Students who conducted learning using traditional methods

PBL : Students who conducted learning using PBL

PBL-DMM : Students who conducted learning using PBL-DMM

O1, O3, O5 : pretest scores

O2, O4, O6 : posttest scores

Research Samples

This experiment was carried out in the even semester of the 2017/2018 academic year. The research participants consisted of 103 students aged 19–20 years and had been registered for “Human Physiology and Anatomy” class. These students came from a university in Riau, which is located in Indonesia. Before selecting the samples, a test was distributed to the participants. This test contained 30 multiple-choice items which covered topics around animal development, cell biology, microbiology, and biochemistry. The test materials had been learned by the research participants in the previous semesters, so they could be used as the basis to examine the students’ academic achievement. The test result would determine three classes with equivalent academic ability. Each of the classes was randomly picked to act as the PBL group (37 students), PBL-DMM group (35 students), and traditional group (31 students).

Data Collection Tools and Procedure

The data of this study were collected using a syllabus, lesson plans, student worksheets, and an instrument to measure student creativity. The instruments of the study consisted of an essay test and a scoring rubric. The test contained 11 questions on human anatomy and physiology (Appendix 1), while the rubric was used to assess the students' answers to the questions. The scoring rubric was developed on the indicators of creativity adapted from Greenstein (2012), namely originality, fluency, flexibility, elaboration, and risk-taking. The creativity rubric is presented in Table 2.

Table 2
Creativity Rubric

No	Indicator	Score			
		4	3	2	1
1	Originality	Ideas are new and unique. No one has thought of them before	Ideas are unique and can be used to produce something new	Ideas mostly resemble others'	Unable to express a new or unique idea
2	Elaboration	Very proficient in using the ability to add certain details to ideas/work so that they can look much better	Able to add some details to ideas/work so that they can look much better	Not very proficient in placing some details to ideas/work so that the results are not very satisfying	Unable to think of certain ways to better an idea/work
3	Fluency	Very fluent in producing ideas (≥ 5) relevant to the problem	Able to produce some ideas (2–4) relevant to the problem	Able to produce some ideas (2–4) which are sometimes irrelevant to the problem	Only able to produce one single idea
4	Flexibility	Able to adjust the existing problem-solving approach to a new situation	Able to adjust the existing problem-solving approach to a new situation but experience trouble in providing reasons underlying the change	Able to adjust the existing problem-solving approach to a new situation but cannot explain why	Unable to adjust the existing problem-solving approach to a new situation
5	Risk-Taking	Be courageous enough to try or do something new to take lessons from it	Willing to try or do something new without acting beyond existing guidelines or instructions	Refrain from doing something that might cause trouble	Have concerns about and most likely to avoid things that are risky

Before data collection, all instruments had to undergo expert validation. Two lecturers conducted the validation of the lesson plans, student worksheets, and creativity rubric with expertise in learning and instructional materials. Each of the experts gave their evaluation based on the indicators provided on the validation sheet which comprised the identity of the lesson plans (such as subject to teach, materials coverage, and others), the indicators of the student learning achievement, the details of the classroom activities, the topics that are going to be discussed, and the use of language in the documents. The results showed high scores for the validity of the lesson plans, student worksheets, and creativity rubric (95.42, 94.58, and 96.15, respectively).

To measure the validity and reliability of the creativity test, the test was tried out to 101 students who were studying human anatomy and physiology. Statistical analysis was run, and the result indicated that the test was valid since $r\text{-calculated} > r\text{-table}$. $R\text{-calculated}$ for each item of the test was recorded in Table 3. The test reliability was determined using Cronbach's Alpha test, and the result confirmed the reliability of the instrument with a value of 0.750.

Table 3

The Results of the Creativity Test Validation

Item	Pearson Correlation	Sig. (2-tailed)	Remarks
1	.463**	0.000	Valid
2	.406**	0.000	Valid
3	.608**	0.000	Valid
4	.538**	0.000	Valid
5	.579**	0.000	Valid
6	.474**	0.000	Valid
7	.590**	0.000	Valid
8	.516**	0.000	Valid
9	.611**	0.000	Valid
10	.629**	0.000	Valid
11	.469**	0.000	Valid

*. Correlation is significant at the 0.05 level (2-tailed).

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

The implementation of the models was carried out following the syllabus and steps of learning which had been planned for a semester. To guide students, worksheets were printed out and distributed to them at the beginning of the research. The worksheets contained instructions and tasks that must be done by the students at every meeting. The students were assigned in groups to complete each task. Each class learned using different approaches based on a set of predetermined criteria of the learning models (i.e., traditional learning, PBL, and PBL-DMM).

The stages of learning in the traditional class began with teacher's delivering learning objectives. Then, students were guided to answer questions provided on their worksheet. The teacher explained materials, and the students listened carefully to the teacher to acquire information related to the materials. The process ended with a conclusion by the teacher. The role of the teacher or the lecturer was dominant in this type of classroom. Teaching methods used in this classroom were mostly lecture and discussion.

The main feature of the PBL classroom was students' involvement. The stages of learning in the PBL class consisted of activities which (1) oriented students to problems by presenting some actual problems related to the lecture materials, (2) organized students to learn by preparing references or learning resources that can support the problem-solving processes, (3) guided students in individual or group investigations, (4) encouraged students to present the results of the problem-solving discussions in front of the classroom, and (5) directed students to reflect or evaluate the processes they use to find the solutions.

Unlike the traditional and PBL classes, the PBL-DMM class contained activities which: (1) reviewed students' initial knowledge and helped students connect with concepts learned through DMM creation, (2) directed students to problems so that students could formulate problems, (3) helped students to define learning assignments related to learning outcomes and prepare references for the problem-solving processes, (4) guided students to gather appropriate information in order to obtain explanations and solutions to the problems, (5) encouraged students to present the results of the problem-solving discussions and add details to the DMM, (6) helped students to analyze and evaluate the problem-solving processes and concluded the lesson. Students in this classroom carried out the learning process in groups.

Data Analysis

Data of the research were analysed using ANCOVA (a significance level of 0.05). If the result were significant, an LSD (Least Significance Different) test would be conducted. Before conducting the ANCOVA analysis, the data were examined using a normality test (Kolmogorov-Smirnov test) and a homogeneity test (Levene's test) ($p > 0.05$). The results of the tests showed that the data were distributed normally (p -value 0.200) and homogeneous (p -value $> \alpha$ ($\alpha = 0.05$) with p -values 0.663).

Results

Students' scores based on the indicators of creativity were summarized in Figure 1.

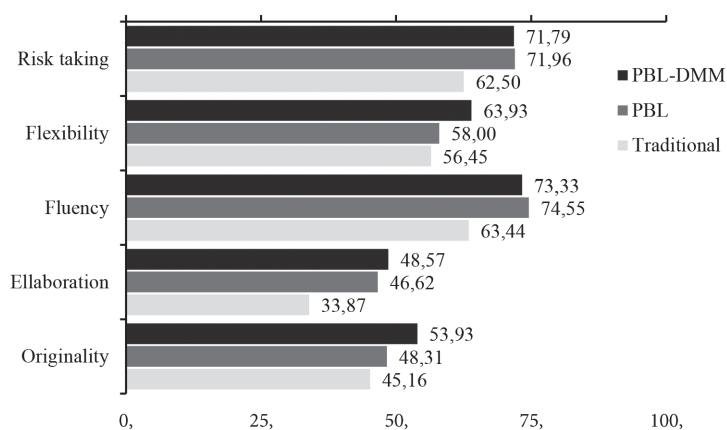


Figure 1. Students' creativity scores

Among the indicators of creativity, *fluency* reported the best outcomes. The highest score on *fluency* was found in the PBL class (74.55), followed by the PBL-DMM (73.33), and the traditional class (63.44). On the other hand, the poorest performance of the students was observed in *elaboration*. The average scores of *elaboration* of the traditional, PBL, and PBL-DMM classes were 33.87, 46.63, and 48.57, respectively.

The effects of the learning models (traditional, PBL, and PBL-DMM) on the students' creativity were determined based on the ANCOVA analysis of the students' pretest and post-test scores. The results can be seen in Table 4, followed by the LSD test presented in Table 5.

Table 4

The Results of the ANCOVA analysis on Students' Creativity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Learning Models	6705.611 ^a	3	2235.204	75.564	.000
Intercept	7499.508	1	7499.508	253.532	.000
Concept	5111.336	1	5111.336	172.796	.000
Classes	1230.678	2	615.339	20.802	.000
Error	2129.770	72	29.580		
Total	275551.633	76			
Total Average	8835.381	75			

a. R Squared = .759 (Adjusted R Squared = .749)

Table 4 shows the difference in the results of the treatments with $p\text{-value} = 0.000$ and $F = 20.802$. Since $p\text{-value} < \alpha$ ($\alpha = 0.05$), the research hypothesis which said that learning models affected student creativity shall be accepted.

Table 5
The Results of the LSD Test on Student Creativity

Class	Pretest	Post-test	Difference	Score Increase	Average Score	LSD Notation
Traditional	36.881	52.170	15.289	41.46%	53.292	a
PBL	40.236	61.196	20.960	52.09%	60.058	b
PBL-DMM	38.215	63.046	24.831	64.98%	63.269	c

The results of the LSD test summarized in Table 5 show that traditional learning, PBL, and PBL-DMM had different effects on the students' creativity. The PBL-DMM class reported a significantly higher average score than the other treatment groups. In fact, the highest creativity score was observed in the PBL-DMM class, while the lowest creativity score was found in the traditional class.

Discussion

Fluency in this research reported significantly higher scores than other indicators of creativity. It can be explained by the fact that the students were able to produce several ideas relevant to the problems. When the students were asked about diarrhea and respiratory disorders, for example, they could fluently talk about clean water, sanitation, the availability of toilets, and hygienic food. This finding is in line with that of Tan, Lee, Ponnusamy, & Koh (2016) who found fluency as a creativity dimension which can be easily mastered by students compared to other dimensions.

Fluency, indeed, showed the highest average score among all creativity indicators; however, the students were unable to accelerate in ideas *elaboration*. Elaboration is the ability to add details to information to make it more understandable and aesthetically pleasing (Vasilyeva & Erdyneeva, 2016; Greenstein, 2012). The students' lack of skills in elaborating ideas can be caused by their poor concept mastery. The results of the research conducted by Wu, Cheng, Ip, & McBride-chang (2005) indicate that knowledge can improve individuals' performance in creative tasks because there is a connection between task structure and knowledge base. Also, Diakidoy, Constantinou, & Constantinou (2001) also suggest that knowledge of relevant concepts can provide the basis for appropriate creative solutions.

Compared to *elaboration*, other creativity indicators such as *risk-taking* and *flexibility* have yielded better results. Risk-taking is related to the willingness to take risks because a creative individual is less worried about trying something new, even though there is uncertainty about the results. Research shows that there is a significant relationship between creativity and risk-taking (Tyagi, Hanoch, Hall, Runco, & Denham, 2017; Simmons & Ren, 2009). While elaboration deals with the capacity to consider various approaches to solving a problem, flexibility plays an important role in assisting an individual in generating new and innovative ideas (Kenett, Levy, Kenett, Stanley, Faust, & Havlin, 2018).

The difference in creativity scores obtained by the students in the traditional, PBL, and PBL-DMM classes can be associated with the learning processes carried out in the classrooms. The PBL-DMM class was supported by mind mapping activity that can trigger the students' creativity. The making of DMM at the early stage of learning is useful for the students to relate their background knowledge to materials being studied. Despite using the same application, the students could create different DMM. Figure 2 and 3, for example, display two different DMM which indicate that the students used distinguished patterns, colors, and branches to explain the blood circulatory system.

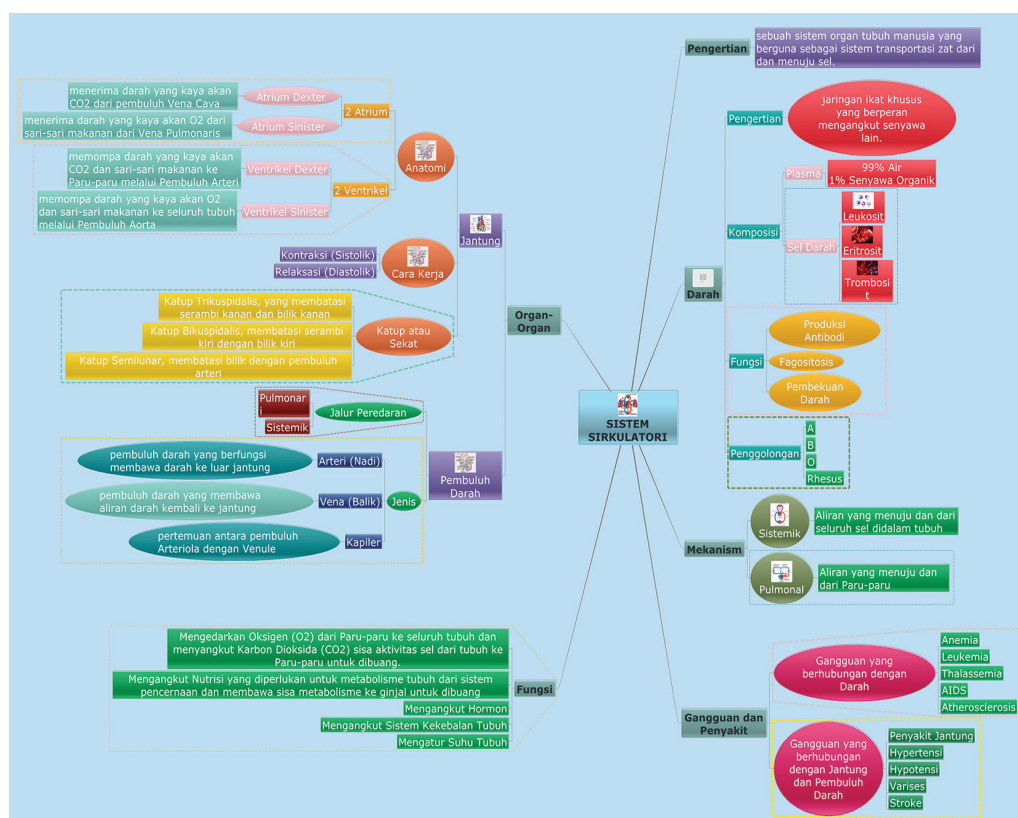


Figure 2. An Example of DMM on the Circulatory Using the Image Pattern

In Figure 2, the student put an image of the blood circulatory system in the center of his DMM. From this point outward, the student drew straight lines to explain the following five major components: circulatory organs, blood, definition, function, and circulatory diseases.

Despite using a similar topic, the student in Figure 3 picked a different layout. Compared to Figure 2, the DMM in Figure 3 has more branches (line pattern) that discuss the definition and function of the circulatory system, blood vessels, heart, the blood circulatory mechanism, and circulatory diseases. Figure 2 and 3 thus indicate that every student may employ a distinctive way to construct a DMM based on their ideas.

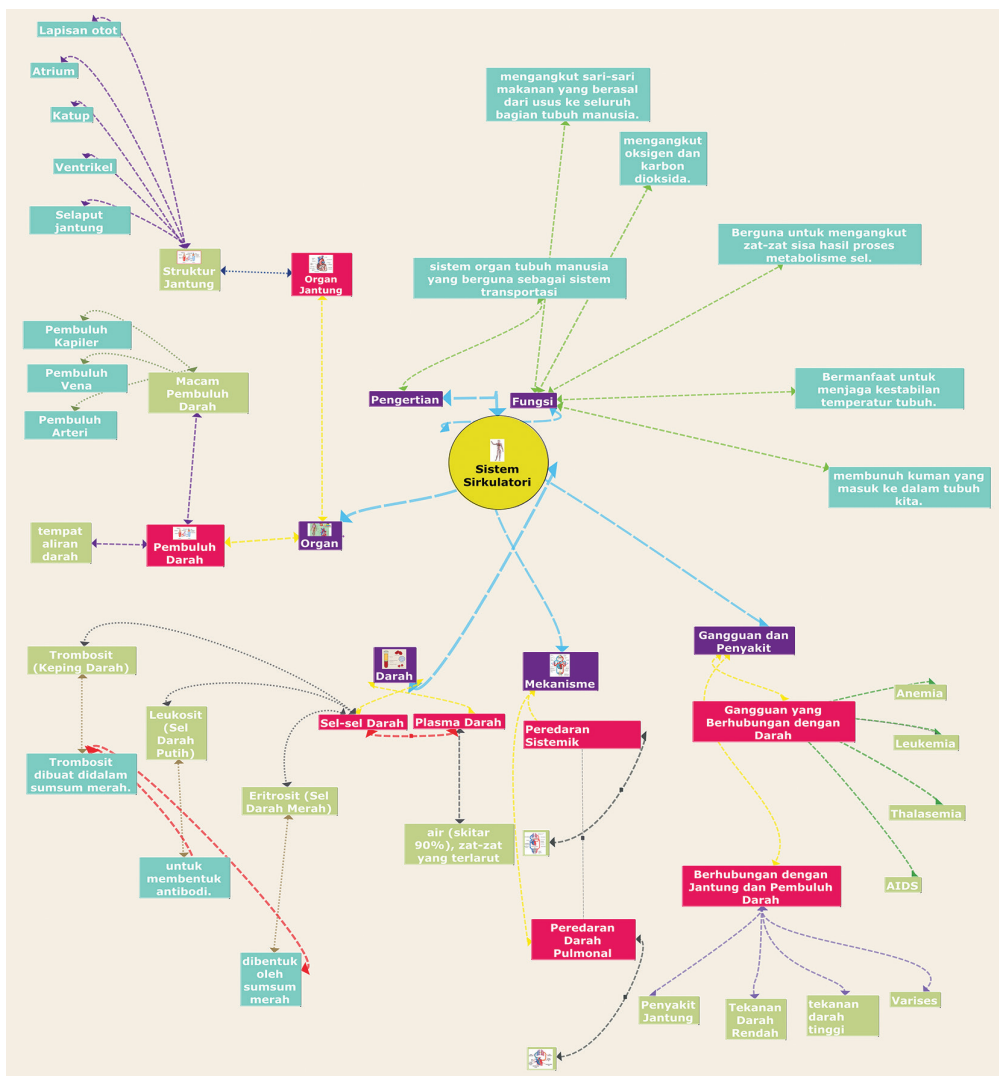


Figure 3. An Example of DMM on the Circulatory Using the Line Pattern

The findings showed that every student had a different way of exploring colors, lines, branches, pictures, and videos to convey ideas (Chan, 2013). Research has proven that mind maps, either in the form of DMM or paper mind maps (PMM), can boost student creativity (Dell et al., 2012; Mahmud, Islam, & Rawshon, 2013). DMM can affect student creativity because through DMM, students are allowed to be creative. They are allowed to combine the accuracy of the materials with various attractive images and to draw a mind map based on their preferences. Learning autonomy and flexibility can provide a foundation for students to explore their potentials and produce more creative ideas. Studies have shown that inflexible learning methods and rigid class schedules can hamper student creativity (Tan et al., 2016). Creating DMM requires a lot of kinetic movements and energy; therefore, students need to be creative (Edwards & Cooper, 2010). DMM need to be informative and artistic. Thus, to make the map more informative, students need to be careful in choosing materials to be inserted into the map. Besides, to make the map more artistic, the students can select various colors or design a map that suits their preferences. The visualization of concepts or materials into colorful images is one of the aspects that can reflect student creativity (Ainsworth, Prain, & Tytler, 2011).

Studies have shown that PBL can also affect student creativity (Alrahlah, 2016; Birgili, 2015; Bridges et al., 2012; Chan, 2013; Siew et al., 2017; Ulger, 2018; Zhou, 2015). One of the stages in PBL provides opportunities for students to develop their work. The students in this study were asked to make a video about someone who experienced spasm and compiled a report based on the predetermined problem statement. To be able to write an understandable and attractive report, the students, needless to say, had to generate ideas and explore their creativity. Since creativity is related to the ability to recognize ideas, find new solutions, and maximize efforts to produce something different (Al-oweidi, 2013; Batey, 2012; Hoseinifar et al., 2011), the report writing task can be one of the alternatives to improve student creativity (Tan et al., 2016).

In addition, the three different treatments (PBL, PBL-DMM, and traditional) provided the students with distinctive tasks, learning methods, and activities. Compared to the traditional class, the students in the PBL and PBL-DMM classes were able to achieve high scores in creativity. It was found that the lecturer of the traditional class often delivered learning materials through lectures, and there was no assignment designed for the students to foster their creativity. This ineffective pedagogical practice may result in poor student performance in creative skills because pedagogical practice is important in creativity coaching (Davies et al., 2013). Effective pedagogical practices include designing learning assignments that can stimulate creativity, create flexible and independent learning experiences, and present an open and collaborative atmosphere to communicate.

The results of this study have proven that PBL and PBL-DMM are effective in improving student creativity. Therefore, learning processes at colleges or universities should be focused on empowering student creativity. Equipped with creativity, university graduates are expected to be ready to be competitive in the work field and survive the

21st-century challenges. In addition to creativity, university students also need to arm themselves with other 21st century skills namely critical thinking (Butler, Pentoney, & Bong, 2017; Zubaidah, Mahanal, Rosyida, Lutfi, Sholihah, & Ismirawati, 2018;), creative thinking (Ersoy & Başer, 2014; Fuad et al., 2017; Yusnaeni et al., 2017), communication skills (Taveira-Gomes, Mota-Cardoso, Figueiredo-Braga, 2016; Yusof & Halim, 2014), and behavioral skills (Said, Al-emadi, Friesen, & Adam, 2018).

Conclusions and Recommendations

Based on the findings of this study, it can be concluded that the two learning models, Problem Based Learning (PBL) and Integrated Problem Based Learning and Digital Mind Maps (PBL-DMM), have an effect on student creativity despite the fact that PBL-DMM is more effective in improving student creativity.

This research has been conducted only to a certain level of education and discipline. Therefore, future researchers should consider exploring the effectiveness of PBL and PBL-DMM in a wider context, such as at different education levels and in different fields. It is also recommended for further investigation to discuss gender as one of the research variables.

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Appendix 1



Name :
ID :

CREATIVITY TEST

INSTRUCTIONS

1. Please write your identity on the space provided.
2. Read the questions carefully.
3. Write your answer directly on the question sheet.
4. You have 90 minutes to complete this test.
5. This test encourages you to use your creativity, explore new ideas, and solve new problems.

QUESTIONS

1. The following keywords should be used as the main topics of mind maps. Choose one of the words and create a mind map based on it! Then, give your mind map a title!

- a. Blood
- b. Muscle
- c. Gastric

2. Look at the figures below. Choose one of the pictures that are appealing to you and explain why! If a glass of milk is added to each of the pictures, will you still choose the same picture or will you change your preference? Explain why!



Figure 1. Vegetable



Figure 2. Fruit



Figure 3. Bread and Noodles

3. You are involved in social activities in a remote village. There, you find many children and toddlers experience abdominal pain, suffer from stomach cramps, and have runny stools. What scientific question do you want to examine? Write down as many questions as possible. For example, "Where do the people get clean water from?"

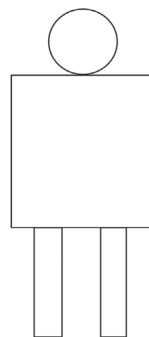
4. Look at the following picture. If the picture is used to explain organ systems in the human body, what details can you add to the picture (picture/symbol/text).

5. In 2015, the forest fire in Riau has potentially caused a smog disaster. The haze might contain substances which are harmful to the respiratory organs such as carbon monoxide, methane, ammonia, and sulfur dioxide. As a biology student, what will you do to reduce the harm? Write down as many efforts or steps as possible.

6. A kidney-failure patient receives a dialysis treatment from a hospital. After years of undergoing dialysis, he learned that kidney failure could be helped by a kidney transplant. But he still has doubts between continuing to do dialysis or kidney transplantation because both methods have their own risks. If you are asked to give advice to the patient (dialysis or kidney transplantation), what advice would you give? Give the reason!

7. Make a writing composition that contains as many "bone" words as possible so that the ideas can flow logically!

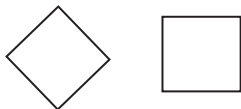
8. While on a trip, you saw someone fall from a motorcycle and suffered a cut on his leg that produced a lot of blood. The people around the location have provided first aid by closing the wound, but the blood was still flowing. What would you do in a situ-



ation like this? Connect the decisions you take with the knowledge you have about the circulatory system!

9. Keira and Selly were running on the school ground. After running for about 30 minutes, Keira felt exhausted and fainted immediately. Selly knew that pungent aroma stimulation such as that possessed by cajuput oil could be used to wake up someone who has passed out. But at that time, Selly was not able to find cajuput oil nearby. If you had been Selly, what steps would you have taken to wake Keira up? Provide reasons!

10. Use a combination of the following two shapes (diamond and rectangle) to make a picture that can explain the organ system in the human body. Include the diamond and the rectangle as part of the picture that you are about to make. The diamond and rectangular shapes can be used more than once to produce meaningful images. Try to think of images that no one can think. Add details to tell the full story with your picture and provide the picture with a title!



11. Suppose that there are two physically healthy people standing before you. How can you test the health of these two people's kidneys? Please write down any possible methods, simple principles, and procedures that you can do to examine their kidneys.

Integruotas probleminis mokymasis ir skaitmeniniai minčių žemėlapiai: mokymosi modelis studentų kūrybiškumui gerinti

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Santrauka

Šis tyrimas pagrįstas studentų kūrybiškumo svarba, ypač vykstant šios epochos progresui. Atsižvelgiant į tai, kad Indonezijoje daugumai studentų trūksta kūrybiškumo, būtina rasti sprendimą, kaip pagerinti studentų kūrybiškumą. Kūrybiškumas susideda iš sugebėjimo vystyti įvairias ir unikalias idėjas bei kurti daugybę problemos sprendimų

būdų. Kūrybiškumo rodikliai apima originalumą, sklandumą, lankstumą, kruopštumą ir rizikos prisiėmimą. Kūrybiškumas gali būti įgalinamas pasitelkiant probleminį mokymąsi (angl. *Problem Based Learning*) arba integruojant skaitmeninius minčių žemėlapius (angl. *Digital Mind Maps*) ir probleminį mokymąsi (angl. *Problem Based Learning*) (sutr. angl. *PBL-DMM*). Šiuo tyrimu buvo siekiama patikrinti mokymosi modelio efektyvumą studentų kūrybiškumui gerinti. Atliekant šį eksperimentinį tyrimą, prieš testą ir po testo buvo pasitelkta kontrolinė grupė, kurią sudarė 103 būsimi priešmokyklinio ugdymo pedagogai iš Indonezijos Riau universiteto, Biologijos mokymo katedros. Dalyvių kūrybiškumui įvertinti buvo parengtas kūrybiškumo testas ir balų lentelė. Rezultatai parodė, kad probleminio mokymosi ir integruoto probleminio mokymosi su skaitmeniniais minčių žemėlapiais modeliai turėjo įtaką moksleivių kūrybiškumui. Tiesą sakant, lyginant probleminio mokymosi modelį, integruotas probleminio mokymosi su skaitmeninių minčių žemėlapiais modelis buvo veiksmingesnis mokinių kūrybiškumui gerinti. Abu – probleminio mokymosi modelis ir integruotas probleminio mokymosi su skaitmeninių minčių žemėlapiais modelis – gali būti naudojami klasėje, siekiant skatinti mokinių kūrybiškumą. Todėl rekomenduojama šiuos mokymosi modelius diegti klasėse.

Esminiai žodžiai: *mokymosi modelis, studentų kūrybiškumas, probleminis mokymasis, skaitmeniniai minčių žemėlapiai.*

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